ELECTRIC
UP AND AWAY

Learning to fly Electric Powered Radio Controlled Model Gliders

(A handbook for both beginner and instructor)

The BMFA Approved Flight Training Manual for R/C Electric Glider Flying

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TO THE READER

This handbook has been written for both the instructor and the embryo pilot. By studying the book the instructor will understand the path the student will follow from his first flying lesson and be able to base all his training on the lessons in the book.

The pilot learning to fly can refer to the lesson both before and after the flight and extract the maximum benefit from his time in the air. Not only will he know what is coming but he can go back to the book when the lesson is over and refresh on any points which he may have missed or not fully understood.

A great deal of other useful information is in the BMFA Member's Handbook and you should refer to this whenever you need to.

In addition, should the student change instructors the new instructor, teaching from this book, will know the point in his training which the student has reached and can carry on exactly where the previous instructor left off.

Good luck to you both!

BRITISH MODEL FLYING ASSOCIATION

The British Model Flying Association which, as the S.M.A.E., was established over eighty years ago is the national body for model flying and is recognised as such by the Civil Aviation Authority, the Sports Council and many other national and international organisations.

Much of the BMFA's time and effort is taken up in liaising with government bodies, local authorities and other organisations in order to safeguard your interests as model flyers. In spite of this, it also finds time to promote and control many other facets of model flying.

The BMFA Chief Executive and our other full and part time staff are based in our permanent office in Leicester and they are there to further the running of the Association.

They can answer most of your queries and can put you in touch with BMFA officers when necessary. Both staff and voluntary officers are always pleased to hear from members and to help where they can.

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ELECTRIC UP AND AWAY

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ELECTRIC UP AND AWAY

This manual is one of a series which have been written to help the beginner who wants to learn how to fly Radio Controlled Model aircraft. The first of the series is the “Up and Away” booklet originally written by John Long FSMAE and aimed at learning to fly using an IC powered trainer. Some sections of that document are equally applicable to both IC Powered and Electric Powered models, and (with John’s kind permission) have been incorporated in this later version. Certain sections of the original document have been re-written so as to be relevant to electric models but it is important to recognise the significance of John’s original work in this area.

The development of electric power in model flying is relatively recent, and there are several advantages, not least of which is the environmental benefit of reduced noise levels. For this reason electric flight has traditionally been considered to be part of Silent Flight, but the developments have now advanced to the point where almost any type of model can be powered either by an IC motor or by an electric motor. This particular document covers a class of model usually referred to as “Electric Gliders” i.e. those models which have the same proportions and performance as a normal R/C. glider but which are fitted with an electric motor used primarily to climb the model to a height from which it can be flown as a normal glider. There is a second “Electric Up and Away” booklet which is intended to apply to any training program undertaken using a model which might still be classified as a powered trainer, i.e. a high wing electric powered model with an undercarriage.

INTRODUCTION

So, you want to fly radio controlled model aircraft? Are you sure?

Think about it for a moment… it is going to be time-consuming, frustrating at times… and it may be expensive.

On the other side of the coin, it is a most rewarding sport giving tremendous satisfaction and great companionship. Think about it again and if you are still convinced that it is for you --- read on !

This handbook is designed to be your guide and mentor from now (before you invest your hard-earned cash in a model and equipment) until the time when you are a proficient pilot at a ‘safe solo’ standard. Read it with care: make sure that you understand every paragraph and re-read the appropriate sections again and again whilst you are learning to fly. The time you spend in the air is comparatively brief, so it must be reinforced by reading and re-living every moment of your air time to analyse what you did and appreciate how to do it better next time.

In this book you will find no sections on building aircraft or installing control systems, no complex aerodynamics, no treatise on motor technicalities… there are enough books on these subjects already and expert personal tuition is available at your local model club. What you will find though, are easily understood sections which will take you step-by-step through the process of learning to fly.

But you will need some help and the ear of someone knowledgeable with whom to discuss your problems. The first step you have already taken --- by beginning to read this book. Your next step must be to join your local model flying club ---- your model shop will tell you whom to contact, or you can write, check out the website or e-mail the British Model Flying Association (BMFA) who will give you contact details for nearby clubs. Then get up to the flying field and introduce yourself

to the members and tell them that you are interested and want to learn to fly. You will find them enthusiastic and will quickly find someone to talk to you and discuss your interests and problems. Tell him all your hopes and fears and --- above all ---LISTEN.

No one yet learned how to fly by reading a book and this one can only point you in the right direction and help you to make the most of your instruction so that you learn quickly and easily, getting everything you can out of every lesson

NOW READ ON

CHAPTER 1
YOUR QUESTIONS ANSWERED

WHAT DO I NEED TO START?

Obviously a model aircraft--- and we'll discuss the best one for you a little later on. As well as the airframe, which you can either build or buy, you will need accessories like flight battery , glues, and finishing materials which often don't come with the model kit. You will also need a suitable electric motor (plus maybe a gearbox) and the right radio control equipment.

In addition you must have support equipment – field charger, 12 volt leisure battery, leads, tools and spares.

Undoubtedly the best way to decide what equipment you need is to look over that used by club members and discuss your needs with them, but we'll guide you towards what is necessary in a subsequent chapter.

HOW MUCH DOES IT COST?

The costs in starting up vary so much that it is impossible to give you an accurate answer to this one but it will probably be several hundred pounds. Your local model shop will be able to give you a clear idea of prices of various items and your local model club can tell you if any good second-hand items are available You will find that the costs will compare very favourably with those you will incur making a start in any other sport.

HOW LONG WILL IT TAKE TO LEARN TO FLY?

Can't give you a straight answer to this one. It depends upon too many variables. You can learn up to the solo stage in a month or so if you fly frequently. On the other hand, if you only fly at week-ends or occasionally, it can take quite a long time since at each lesson you are really only re-learning the last lesson and not making progress. As an average, given reasonable weather conditions and reasonably frequent flying sessions, let's say six weeks to first solo and perhaps three months to your 'A' Certificate. seems a long time? How long did it take to learn to drive a car? And model flying is much more complicated.

HOW DO I FIND AN INSTRUCTOR?

That's easy! Once you have joined your local model club and made contact with the members, simply ask who teaches newcomers and you will be pointed in the right direction.

It will be likely that several club flyers are BMFA Approved instructors so you will be able to choose the one whom you feel to the most sympathetic. Normally, if you ask an instructor to teach you he will accept immediately unless he is already too heavily committed with others learning to fly.

HOW MUCH WILL IT COST TO LEARN?

Nothing - absolutely nothing! He will teach you for the sheer pleasure of initiating a newcomer into our fascinating sport. But do remember that he wants to fly too, so don't expect him to spend all day with you. On average you can expect to fly three or four times in a flying session. You'll probably find that this is about all the instruction your can absorb in one day!!

WHAT DO I DO BETWEEN FLIGHTS?

You watch others flying. You watch hard and store away the information you acquire. Ask your instructor if you can 'hang on' when others are being taught and try to learn from their flying. Watch other aircraft in the air and imagine that you are doing the flying. Follow the control movements and try to predict the next move. Study aircraft flying at a distance and make sure you know which way they may be turning - and what the appropriate control movement will be to straighten up the turn. Talk to other flyers and LEARN all the time. You will undoubtedly find conflicting views - discuss them with your instructor

REMEMBER

Flying is Fun. If you are not enjoying it, then something is wrong.

It might be you, it might be your aircraft, it might even be your instructor….or any number of things. Discuss it with your instructor and sort out what is wrong.

CHAPTER 2
THE FIRST STAGE - GETTING STARTED

Are you sitting comfortably? Good, now let's look in detail at all the equipment you will need to get flying.

THE MODEL

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. The ideal trainer is a high wing electric glider of around 1.5 to 2.2 metres 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 will almost certainly have no undercarriage being intended for hand launching and landing on grass using the fuselage underside. The wings are best held on by rubber bands to enhance its crash-proof qualities.

Most electric gliders are designed for 3 functions (throttle, elevator and rudder) but some have ailerons in addition. You can learn equally well whichever type is selected. Finally, and importantly, it should be 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 is a steadily increasing range of reasonably priced ARTF models available in your local model shop. Each club will have its own ideas on a suitable model and you should look around on the flying field and seek advice from one of the senior club members.

THE POWER SYSTEM

Whatever aircraft you buy, make sure that your intended motor/gearbox/battery pack 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 climb 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.

All commercial electric gliders should have a recommended motor size and some ARTF models are supplied complete with motor and propeller. There is a bonus in choosing a powerful motor in that it will be suitable to power more advanced aircraft when the time comes. Many flying fields have noise limitations with which your model will have to comply. Any electric model should have no difficulty with this but you should still have your model checked.

PROPELLER

You will also need a suitable folding propeller for your model. Generally the size you will need will be dependant upon the motor you use, the number of cells in the battery pack, and the gear box ratio (if used). This sounds complicated but the instructions with the model should give recommendations. If you decide to use a different system to that recommended then seek the advice of experienced club members.

Several manufacturers have a range of propellers specifically for electric flight. By the way, when referring to propeller sizes such as 10" by 6", the 10" refers to the diameter of the propeller in

inches and 6” 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.

BATTERY PACKS

You will need to buy at least two pre-assembled battery packs. These are individual Nickel Cadmium or Nickel Metal Hydride cells commercially assembled into packs. There are various sizes available both of individual cells and of the number of cells in the pack and you may again need to seek advice in this matter.

The size of the individual cell will control the capacity of the packs in milli-ampere hours (mAh) and the number of cells will control the voltage of the pack. The nominal voltage per cell is 1.2 volts and therefore the voltage of the pack is 1.2 x number of cells. The capacity in mAh will determine the length of power run you can obtain with adjustment for the average throttle setting.

Generally speaking, you should only buy the best quality “fast-charge” cells available since these will perform better and last longer. The commonest size of cell is the “sub-C” and the commonest pack size is 7 cells. Any advice provided with the model or the motor should cover the recommended battery pack.

Lithium Ion and Lithium Polymer batteries offer greater capacity at reduced weights but are more expensive and more complex to charge and maintain. Safety considerations with these batteries are much more significant that those for Nickel based packs.

RADIO

Now we come to the single most expensive part of your equipment so you need to get it right. The whole success of your operation depends on your radio gear and the range of radio equipment is formidable. Each model shop will fiercely defend the quality and performance of the brand it sells - and rightly so. However, you must have some guidance so we’ll try to steer you through the jungle.

First of all, which brand do you buy? Your local club members are usually a reliable guide. Look around in your 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. 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 etc.

The question then becomes what facilities do you need? Whilst it is quite possible to learn to fly with fewer channels, we would unhesitatingly recommend that you buy a basic set with a minimum of 5 or 6 channels (to control at least elevator, throttle, rudder and aileron). 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 or 6 channel set will give you more options in the future. You do not really need the complications of a computer controlled set to start with and many flyers never buy such equipment. However, costs are coming down and computer controlled sets are becoming an option even for beginners. Do not buy a cheap 2 or 3 channel set - you will be placing unnecessary restrictions on yourself from the start.

There is a frequency band available solely for model aircraft use at 35 MegaHertz (written ‘MHz’) and this is the normal band used by model flyers. There are 25 frequencies available, channel numbers 55 through to 90. We would very strongly recommend that your radio be in this band and, in fact, nearly all model flying sets sold are on 35 MHz. There are other allocated modelling frequency bands of which the 27 MHz band is the best known.

Unfortunately it is open to use by CB radio enthusiasts as well as other modellers with cars, boats etc. so you are more likely to experience interference on this band. The 40 MHz band is for the exclusive use of surface modellers and must not, under any circumstances, be used for flying. Beware of 40 MHz transmitters that look like model flying equipment. There are many about and you may be sold one but they are ILLEGAL for model flying. There is also a model aircraft band available in the UHF range, but there are very few sets available and since it is very unlikely to be your first choice, we will not refer to this band in detail.

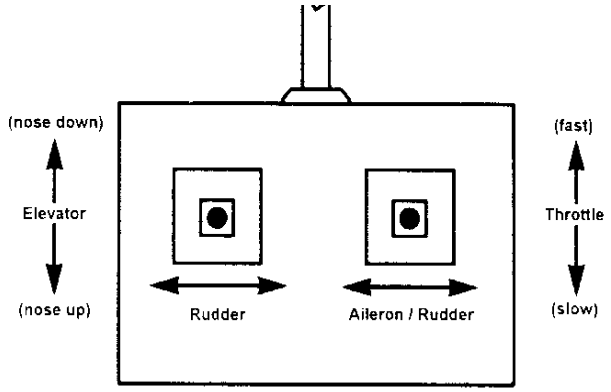
You may also be offered the choice between a set equipped with nickel-cadmium batteries (ni-cads) or ordinary torch batteries - always choose the ni-cad set. Although slightly more expensive initially you will save in the long run since ni-cads can be recharged almost indefinitely whereas torch batteries have a short and somewhat uncertain life. Whatever set you buy, it is very important to make sure that it is set up in the 'mode' used by the majority of flyers in your club. This simply means that the functions controlled by each 'stick' are standardised .

It may surprise you but in any club you care to look at, the flyers are either nearly all mode 1 or nearly all mode 2 with very few clubs having a mixture of the two. Most of them will be very defensive about the mode they fly too.

Whatever the champions of mode 1 or 2 say to you the truth is that there is no 'best mode' and you can learn successfully with either.

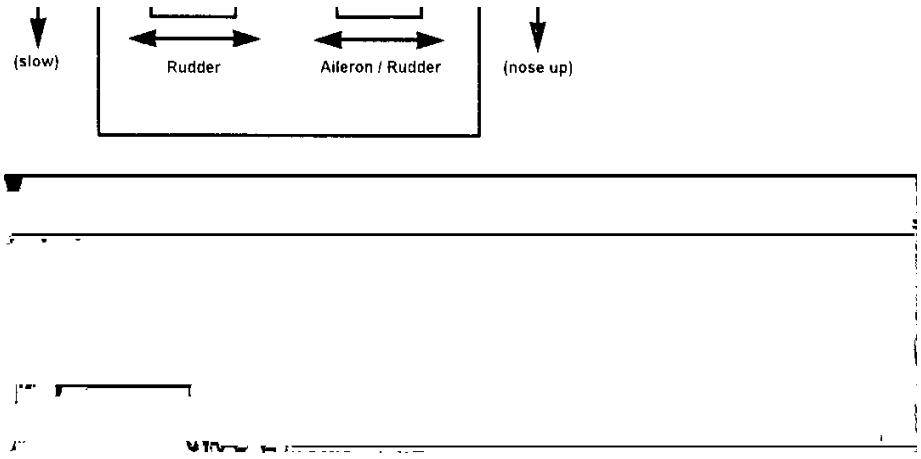
The critical thing is that you will need help to learn to fly and it is very useful indeed if the majority of pilots in your new club can fly your model. This is why you should check what mode is mainly used by the club and buy equipment set up on the same mode.

In **MODE 1**, (sometimes called 'throttle right') the right-hand stick controls the throttle and rudder (or ailerons if the model has them and you are using 4 channels) and the left-hand stick operates the elevator alone (or elevator and rudder when 4 channels are used). The set-up will look like this:



Mode 1 (Throttle Right)

In **MODE 2**, (sometimes called 'throttle left') the right-hand stick controls the elevator and rudder (or ailerons when 4 channels are in use) and the left-hand stick operates the throttle alone (or throttle and rudder when 4 channels are used). The set-up will look like this:



The most used mode at club level is mode 2 (by a factor of about two to one) so we will concentrate on that mode. If your club flies mode 1 then you and your instructor should make the appropriate allowances when reading through the latter chapters.

The important thing when buying a mode 2 set is to ensure that the stick with the ratchet on it (the throttle) is ALWAYS on the left and moves back and forth. You can make the other control perform any of the other functions by simply swapping round the plugs on the receiver.

The actual operating frequency of your set is determined by the crystals fitted There are two crystals in your gear – one in the transmitter and one in the receiver, and sets are normally sold with crystals fitted and ready to go. If you have not yet bought your radio, discuss with your proposed instructor or other club members which frequency is the best one for you to start on (you don t want to choose a frequency that already has five or six pilots queuing up to fly) You will find that your supplier will usually be willing to deliver your set with crystals of your choice. Again, note that 35 MHz crystals are referred to by channel number between 55 and 90. You can always change frequency (within your operating band) by buying a new pair of crystals.

You MUST ALWAYS obey the code of conduct laid down by your club on the control of frequencies, whether it is a pennant on your transmitter aerial, a frequency disc or most usually a peg system. **NEVER, NEVER SWITCH ON** your transmitter unless you have 'the clearance' your club requires.

You should talk to club members about this and make sure that you have a full and complete understanding of how the system works and what actions you should take to operate it. This is extremely important as if you make a mistake it won't be your model that will be lost but that of one of your fellow club members with all the implications that might entail.

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) A charging battery to allow you to recharge your flight batteries at the flying field. 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.

(b) A field charger which is an electronic component used in conjunction with the 12 volt battery to recharge the flight batteries. We will give more information on the unit later in this booklet.

(c) The appropriate frequency marker (your club will advise you on this).

(d) A small voltmeter to check cell voltages and circuits.

(e) Tools - small and medium screwdrivers, plain and cross-point, spanners for the propeller collet and other components, plus any other small items you think you may need.

You will see flyers on the field using other equipment and you will almost certainly eventually acquire a flight box with space for all of your equipment. You may even be able to buy these second hand through club contacts and there is no reason you should not, especially if the price is right.

CHAPTER 3
THE POWER TRAIN.

This is the term we use to describe all of the components of the drive system for an electric powered model. Everything in the model which is a part of the process of developing the thrust to fly the model is included in the train, and although there are variations from model to model, the following elements of the system need consideration.

FLIGHT BATTERY

As previously covered, the flight battery provides the electricity which drives the electric motor. It consists of a number of cells (most commonly 7) connected in series to form a pack. The size of the cells varies but the general principle is that the larger cells are heavier but have a higher capacity. The cells are held together as a pack by heat-shrink sleeving and the format of the cells can be chosen to fit into the available space.

Packs are always arranged with short lengths of flexible, colour coded (red for positive, black/blue for negative) wire which should be multiple strand cable of low resistance. The ends of the wire are fitted with connectors so that a pack may be disconnected from the system for recharging and/or replaced by another fully charged pack. These connectors should be polarised, i.e. they should be designed so that it is not possible to mistakenly connect a pack with the polarity reversed, and they should be insulated to avoid shorting. The best connectors are gold plated sleeve connectors but other types can be suitable.

ELECTRONIC SPEED CONTROL (ESC)

The power supplied from the battery pack to the motor is controlled by the ESC. This is an electronic throttle which is connected to the throttle servo output of the receiver and increases or decreases the power supplied to the motor in accordance with the position of the throttle stick on the transmitter. Almost all modern ESCs have the facility to automatically determine the position of minimum and maximum throttle and require no adjustment by the modeller. Most have a series of additional features which are useful in electric flight and these might include:-

(1) A brake; this is a particularly useful feature for an electric glider. When the throttle stick is returned to zero the brake stops the rotation of the propeller and allows it to fold correctly. Without this effect the propeller might continue to windmill acting as an airbrake and spoiling the glide of the model.

(2) An arming switch; a safety feature which is used to allow the drive system to remain isolated until immediately before launch.

(3) A B.E.C.; this is a battery elimination circuit which allows the controller to feed 5 volts to the receiver through the throttle channel and removes the need to have a separate battery for the receiver and servos.

(4) A safety cut-out; this is essential with BEC and avoids the possibility of reducing the capacity of the drive battery to the point where there is insufficient power to operate the receiver and servos. The ESC monitors the voltage of the drive battery as it reduces with flight time. When it has dropped to a value of around 5.5 volts the ESC cuts off all supply to the motor and the remaining battery capacity is available only to the receiver and servos, thus allowing the flight to be safely continued in the glide mode.

It should be remembered that if a 7 cell pack is drained until its voltage under load is down to 5.5 then it's remaining capacity is limited and it is unwise to attempt to extend the remaining portion of the flight too far.

More sophisticated (and generally more expensive) ESCs may have many extra features such as slow start-ups, thermal cut-outs, over-current cut-outs, and even certain programmable features.

THE MOTOR

These are available in many different sizes and types. They are divided into two main groups; "brushed" and "brushless" motors. In the first group the magnets are fixed in position on the outer case of the motor whilst the rotating core or "armature" carries the coils of wire. The current is transferred into these coils via a set of brushes which are carbon blocks shaped so that they are in contact with copper pads (commutator) mounted on the armature. As the armature rotates the current is switched from coil to coil to provide the electromagnetic power which drives the propeller mounted on an extension of the armature shaft.

In the second group of brushless motors the situation is reversed with the magnets mounted on the armature so that they rotate whilst the coils are fixed in position on the outer case. This system requires neither brushes nor commutator but the sequencing of the current required to produce rotational power is achieved by complex electronics included in the special controllers used for brushless motors.

Even brushless motors themselves are subdivided into two categories, those which use electronic sensors to provide the information used by the controller to sequence the power (known as "sensored brushless") and those which use a more complex software driven feedback system to obtain the information (known as "sensorless brushless").

The latest range of brushless motors are known as "Outrunners" and have the magnets fixed to the inside of the case whilst the coils are on the central, non-moving armature. The operation of this type of motor involves the outer case revolving around the fixed armature with the propeller attached directly to the rotating case. Mounting such motors requires care to ensure that rotating components do not come into contact with any other part of the model but they do develop greater torque and can therefore drive larger propellers without the need for a gearbox.

Additional variation within motors results from the use of different materials for the magnets. The simplest (and cheapest) material is a moulded magnetic iron oxide (ferrite motors). Other more powerful magnetic metals are available and more expensive motors use cobalt or neodymium based magnets. Almost all brushless motors use these “rare earth” materials.

The cost of an electric motor will vary depending upon its size and power output. The cost of a powerful and efficient rare earth brushless motor and controller can be high, but conversely a simple ferrite brushed motor (such as the ubiquitous 400 class) can be extremely cheap and can provide very effective power to a suitable electric glider.

GEARBOXES

A gearbox is a particularly useful component for the power train of an electric glider. It is fitted to the front of the motor so that it reduces the speed of the output shaft (step-down ratios of between 2/1 to 5/1 are typical) and offers two main advantages. Firstly the motor is allowed to run at a higher speed e.g. a 4/1 gearbox will allow a motor to run at 20,000 rpm whilst the propeller is at 5000 rpm, and electric motors generally increase their efficiency as the armature rpm increases. Secondly it allows the power train to run a larger diameter propeller at a given current e.g. an 8” x 5” at 8000 rpm direct drive drawing 14 amps, or a 12” x 8” on a 2 to 1 gearbox drawing 14amps at 4200 rpm propeller speed. With a slow flying model such as an electric glider the larger propeller is more efficient and will produce an additional 25% thrust.

Motor and gearbox combinations are available from the model shop but you can buy the units separately. The main types are:-

(a) offset gearboxes, a simple spur gear arrangement with a small pinion mounted on the motor shaft and a larger spur gear on the output shaft. The simplest and cheapest arrangement but it can be difficult to position the system in the model so that the output shaft is correctly aligned. Also remember that the motor shaft and output shaft will rotate in opposite directions and you need to modify the connections to allow for this.

(b) Concentric gearboxes, either a layshaft arrangement with two gear reduction stages or an epicyclic gearbox. These units are more complex (and expensive) but are much easier to position in the model because the motor shaft and the output shaft are in line. In this case the motor and output shaft rotate in the same direction.

With larger motors there are a number of toothed belt drives which can be used to obtain a reduction ratio.

You will also need to consider minor components of the drive chain such as cables and connectors (already mentioned), an isolation fuse (to prevent overload damage), and a propeller adapter for the output shaft.

If the model is an ARTF with a motor included then most of the additional components should be provided or should be recommended in the instructions.

SAFETY

This aspect of electric 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.

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.

CHAPTER 4
BATTERY CHARGING.

Before you take your aircraft to the flying field you must ensure that your transmitter and receiver batteries (if you are not using BEC) 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. 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 2 hours of charging time to top up the batteries. So if you have, say, four flights in a day you will need to charge for at least 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 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 = 31/2 hours of charging time 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.

Ni-cads and NiMH batteries are very tolerant and will easily withstand an overcharge, especially if you are trickle (or 'slow') charging them. Don't ever be afraid to give an overnight charge if you have any doubt at all about the state of your batteries.

With regard to your flight batteries there are some differences. The procedures we covered for the R/C batteries are based upon ‘trickle charging’ which uses a small current for a long period. Some modern R/C sets are designed so that the batteries may be charged at a faster rate but the instruction booklet will cover this. Almost all flight batteries are built from cells which can be ‘fast charged’ which uses a higher current for a much shorter period of time.

The problem with fast charging is that there has to be an automatic cut-off once the batteries are full otherwise they will be damaged. This process involves ‘delta-peak’ detection during which the charger detects the end of the charge by measuring the rate of voltage change. For the whole of the charging period the voltage increases steadily but at the very end it begins to reduce. The charger detects this reversal and switches off the charge.

Fast charging can occur at rates much higher than trickle charging e.g. a sub C battery pack can be safely charged at 3 to 4 amps so that a 2000 mAh cell can be fully charged from empty in around 40 minutes. This is important if you are re-charging your packs at the flying field so that you can have a series of flights in one session.

The chargers are commercially produced units which are quite advanced electronic instruments. They operate from the 12 volt ‘leisure’ lead acid battery we mentioned earlier, and their cost depends upon a number of features. Basic units should include an automatic full-charge cut-off (delta peak detection) but then the cost increases as the features available become more sophisticated.

The kind of features you might look for would include two or more charging outlets, increasing cell counts (basic units are generally for 4-8 cells only), variable charging current, LCD display for programming and capacity recording, selection of cell types (NiCd, NiMH, Lead acid, Li Ion etc.), and cell cycling programmes. In the most sophisticated (and most expensive) units, you might look for a discharging facility, complex balancing and testing programmes, and even an interface with a PC for data recording.

You will need connection leads for both the input (lead acid battery to charger) and output (charger to flight battery) with suitable connectors. The operation of these units is fairly foolproof but, as ever, do read the instructions carefully.

Of course you can reduce the amount of field charging you need by taking two or more fully charged packs with you to the flying field. A discharged pack after the first flight can be re-charging whilst you are enjoying the next flight with one of your replacement packs.

In the case of Lithium Ion and Lithium Polymer batteries you MUST use a charger which clearly indicates that it has been designed for use on such batteries. The charging process is more complex and needs greater care and supervision. You should always seek specialist advice on the charging and maintenance of these batteries before utilising them."

CHAPTER 5
WHAT THE CONTROLS DO

Assuming the use of Mode 2 radio, then as you already know, on the transmitter the right-hand stick controls the elevator and the rudder (ailerons in 4 channel mode). Moving the stick towards you will raise the nose of the aircraft in level flight: moving it away from you will lower the nose.

Moving the stick to the left or right will cause the aircraft to bank in the same direction - and turn - that way.

These controls are spring loaded so that they always return to the neutral position when released.

This particular stick is the equivalent of the control column in a full-size aircraft and is therefore often referred to as 'the stick'.

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. Side to side movement on this control 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.

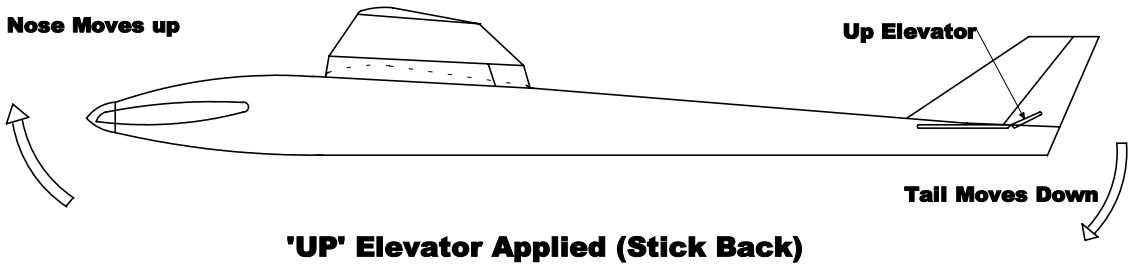
Alongside each of these controls on the transmitter are sliding levers which are the trims for each control. What they effectively do is to alter the neutral position of the related control so that by using them when the aircraft is in the air you can cancel out any out-of-balance forces which make the aircraft tend to climb/dive or turn. They work in the same sense as the stick they are associated with. If you pull 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 simply won't 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 when you look up!!

Now, having told you all about the controls on your radio, let us see how these relate to the control surfaces on your aircraft.

Elevator

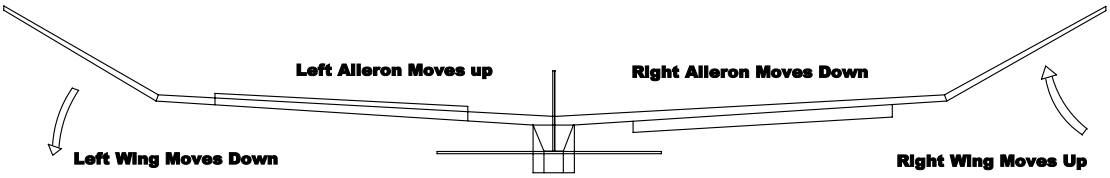
The elevator controls the pitching movement, that is to say that it raises and lowers the nose of the model like this:



'UP' Elevator Applied (Stick Back)

Aileron

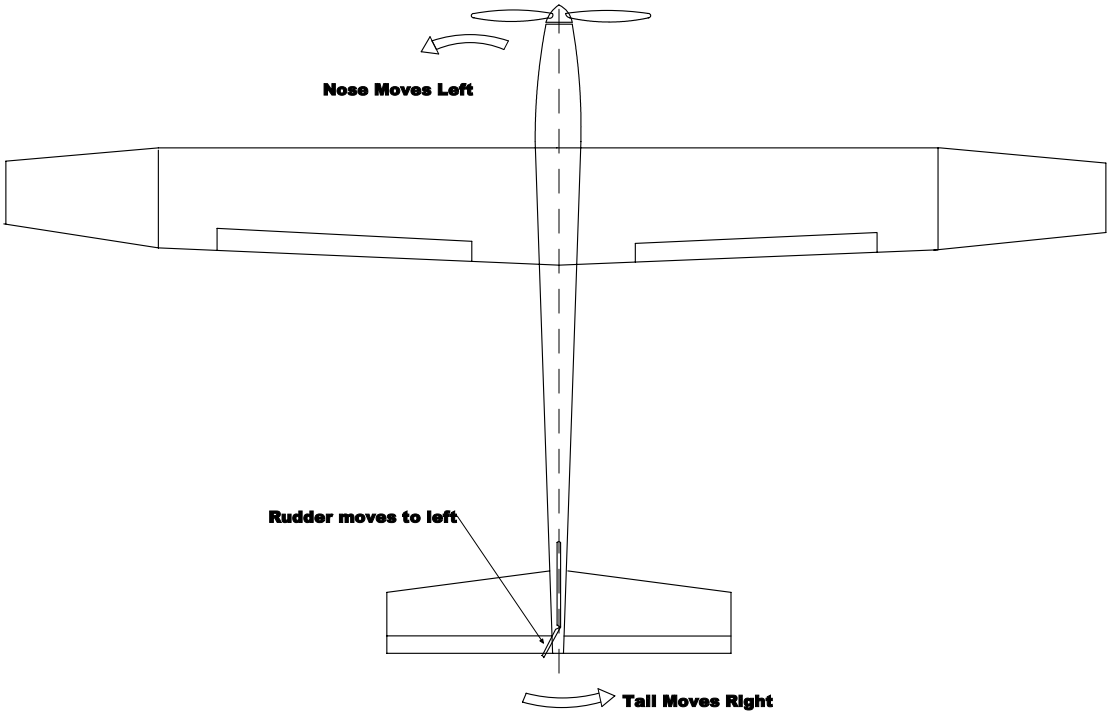
The ailerons give lateral control, banking the wings from side to side, like this:



'Left Aileron Applied (Stick Pushed Left))

Rudder

The rudder moves the nose of the aircraft to the right or the left. Like this:



'Left Rudder Applied (Stick Pushed Left))

Throttle

The throttle lever controls the power which the ESC delivers to the motor - fully forward gives full power: fully back will stop the motor running (and apply the brake if the ESC has one).

Let's look at an aircraft in level flight and see how the controls work.

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 applied. 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 to "pick up' the wing which is down. 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 20° use the control to stop the aircraft banking 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 bank the aircraft back until the wings are level (relaxing the back pressure on the elevator) 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 (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.

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 in an electric glider 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.

Throttle

As we have already said, the throttle control determines the amount of power the motor is providing to fly the aircraft. Full throttle is used for launch, overshooting and many aerobatic manoeuvres. 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. 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.

CHAPTER 6
YOUR INSTRUCTOR

As we said earlier, each club will probably have several members who are BMFA Approved or Registered instructors and who will willingly teach newcomers to fly, but here we would like to give you one or two words of advice!

Firstly, your instructor's word is law when your aircraft is in the air. If he tells you to do something - do it immediately and without question. By all means discuss it on the ground AFTER the flight if necessary, but obey implicitly in the air.

Secondly, you must not hold your instructor responsible if the aircraft crashes during a test flight or at any other time. No responsible instructor will allow your aircraft to crash if he can possibly avoid it and he will do all he can to prevent the aircraft getting into a situation which could result in an accident. But he is only human and during your training there will be many occasions when you are required to fly near the ground when safety margins are very small (take-off and landing for example) so hard landings and worse are an unavoidable hazard of the sport. Accept these hazards, trust your instructor and have confidence in the robustness of your aircraft.

Thirdly, try to stay with the same instructor throughout your training. Each instructor has his own style and if you switch from one to another you may well get confused and it will certainly take you longer to learn -even though all instructors may be working from this manual.

Some instructors use the 'Buddy Box' system, linking two transmitters together so that the instructor can take over control instantly when necessary. The big advantage of this system is that early flying can be done at a lower altitude safely so that the aircraft can be seen more clearly and mistakes more quickly appreciated. During take-off and landing training, too, the instructor has a greater latitude in taking over when a difficult situation develops. However the system has a disadvantage in that two similar transmitters are needed to start with and at later stages of training the student can become too dependent on the instructor to take control when things go wrong when really the student should be relying on his own ability to correct errors. In other words, the system can speed up early training but cause problems later on.

In describing what he wants you (or the aircraft) to do the instructor will say 'left' when he means YOUR left on the transmitter. For example, if he says 'turn left' he will expect you to move the control to the left and consequently the aircraft will turn to its left - although it may not appear so to you at times! When he says 'Up' he means 'pull' on the elevator stick and 'down' means 'push'.

CHAPTER 7
FLIGHT TRAINING

FINAL CHECKS

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

BALANCE.

Make sure that your aircraft balances at the Centre of Gravity point shown on the plan. 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. At home, switch on the transmitter, then the receiver, and move the sticks to check the controls: stick forward - elevator down: stick left - left aileron comes up, right aileron goes down: rudder left - rudder moves left. Remember the safety warning about the motor. If your R/C system has a separate receiver battery then you can carry out the checks without fitting a flight battery. If you are using BEC then you should remove the propeller for safety before If your check is done at the flying field, you must ensure that the frequency control system is complied with BEFORE switching on.

POWER TRAIN

If you have only bench tested your power train then now is the time to test it in the model. Carefully connect the fight battery to the rest of the system. Check that the throttle stick on your transmitter is at the minimum position and switch on the transmitter. Hold the model (or preferably get a friend to hold it) in a safe and secure position so the revolving propeller cannot come into contact with anything. Switch on the receiver, arm the ESC (if an arming switch is available),

And check that the transmitter control operates the throttle correctly without any trace of stiffness. Check that 'fully forward' on the throttle stick gives full power: and that 'fully back' gives a satisfactory brake to a stop

If any of these controls are out of adjustment, re-set them correctly.

You are now ready to get to the flying site for your first flying lesson!

THE FIRST FLIGHT

Right, now you have the aircraft and the necessary support equipment and are raring to go. Your instructor will get the appropriate frequency control sorted out and check your model. 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.

(e) Radio installation, security of all plugs and sockets, security of servos, clevises and all hinges.

(f) Radio range.

(g) Correct position of the Centre of Gravity (balance point).

He will then point out any corrections which are necessary. When he is satisfied that everything is in order he will ask you to prepare for the launch of the model.. He will ensure that the power train operates correctly, that all of the controls operate in the correct sense. He will explain to you throughout what he is doing. He may launch the model himself, he may ask you to launch it, or he may ask another experienced flyer to launch it

With the trims on the transmitter at neutral he will advance the throttle stick to maximum and launch or have the model launched with a firm horizontal push with the wings level. He will climb the model to a safe height and 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.

After suitable checks he will close the throttle so that the motor stops, the propeller closes and the model is gliding. He may check some of these manoeuvres again whilst gliding but will complete the flight by landing the model smoothly on the grass. After landing 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.

The model will then be re-launched to check the trimming and, at a safe height he will hand the transmitter over to you to have a go.

Hold the transmitter in both hands - 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, 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.

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.

Throughout your first flight just try to keep the aircraft on an even keel with the wings level. 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 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. He may use a buddy box to supervise your flying or, more likely, will stand close by you 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 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 looks!! But don’t despair - it will all fall into place quite quickly.

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.

SUBSEQUENT FLIGHTS

As you progress through the training, your instructor will take you through a series of flights. He will not hurry your progress and he will allow you to advance at a rate he thinks best suited to your abilities. Each flight will include repetition of things you may not have covered adequately in previous flights and perhaps some additional aspects to maintain your interest. This booklet will not try to cover this process in great detail but will give a series of descriptions of the manoeuvres you will be introduced to as you progress.

Remember as you read these notes that the electric glider you are training on is intended to fly in a fairly simple pattern. It can be flown both power-on and power-off on the glide and it may behave quite differently in each case. Your instructor will try to make you familiar with all aspects of the model which will be important during the training period up to the point where you have become a safe and competent solo pilot. To reach that point you will need to cover all of the following facets of flying an electric glider.

CHAPTER 8
STANDARD FLIGHT MANOEUVRES

LAUNCHING

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.

STRAIGHT AND LEVEL FLIGHT AND TURNS.

This aspect of the training is the basis upon which all of your flying will be based. Your instructor will be right with you in all of your early training, ready to correct any errors which may put the aircraft in a difficult or dangerous position. If you get too low, too high, or too far away he will take over from you to bring the aircraft back to the right position.

If the model is correctly trimmed then the model will fly an automatic straight and level path at a cruise throttle setting. In the glide of course, the model can be flown in a straight path but this will involve a gentle descent.

Turns are initiated by gently pushing the rudder stick to right or left and releasing the pressure when the model has turned onto the flight path you are aiming for. 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 ease back gently on the stick 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 degrees of bank is quite sufficient at this stage.

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 were 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. After each session you should discuss your progress with your instructor and ask questions on anything you did not fully understand. This flight pattern will be repeated until your instructor is satisfied that you can control the aircraft adequately.

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

CLIMBING, DESCENDING, AND TRIMMING.

When you have gained confidence in your flying ability and are able to turn the aircraft in either direction in level flight so that you can keep it in clear view at all times and 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 at a cruise setting, or from the glide, 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 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 will be improved.

Once again -any problems you have should be put to your instructor.

As before, these procedures 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 and glide. Your instructor will also get you to practise trimming the aircraft correctly by handing the aircraft over to you with it out-of-trim so that you can sort it out yourself!

STALLING

When you are able to 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. Your training to this point has concentrated on keeping the speed of the aircraft reasonably constant. Your instructor will now take you through what happens when the speed is allowed to fall off.

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 nose drop sharply despite the application of full ‘up’ elevator. One wing may also go down. This is the stall.

Recovery is straightforward. Open the throttle, release the back pressure on the stick and allow the nose to go down and the aircraft to dive. If the model is gliding then the procedure is identical apart from the use of the throttle. 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:

a. 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.

b. Remember the recovery action - power ON and/or lower the nose then ease the aircraft out of the dive.

c. 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 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 TO LEVEL FLIGHT.

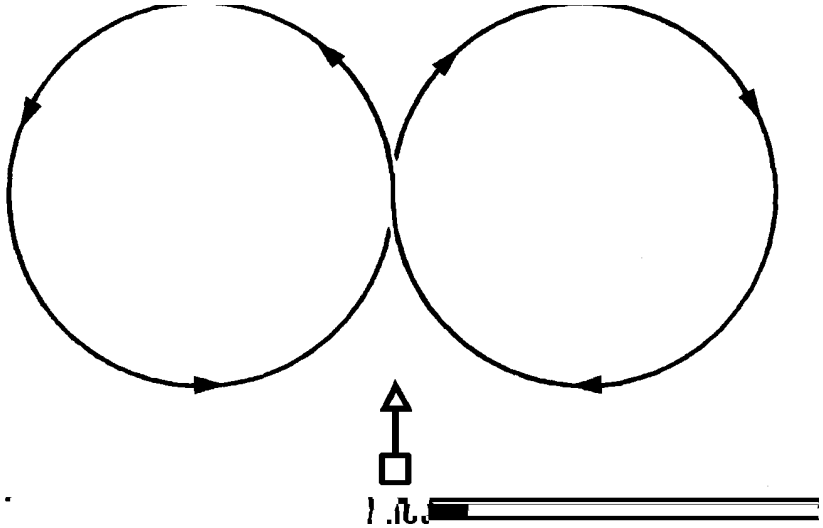
COMBINED MANOEUVRES

When you have covered the basic manoeuvres individually you will begin to combine them together to make a complete flight. You will be able to fly the model from the launch up to your normal flying height. Level out here and reduce to cruising power or close the throttle entirely and enter the glide. Now you can see the point of all the previous exercises! Electric gliders should spend most of their flight gliding and one is usually hoping to find some thermal lift. Thermals are areas of air which, because they are warmer than the surrounding air, are actually rising. If the model is gliding 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.

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. 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.

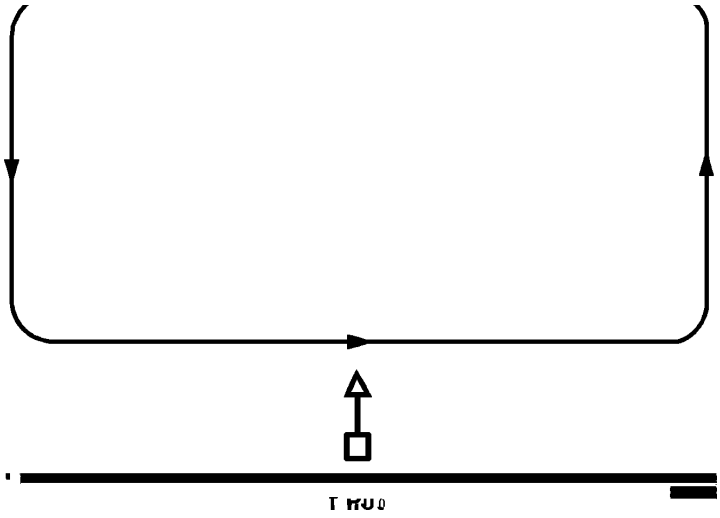
To carry on with the development of your training, fly a 'figure of eight', which will look like this, with the cross-over point directly in front of you:

The turns should be steady with a constant angle of bank not exceeding 30 degrees. 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 constant. Note that one half of the manoeuvre is a left-hand turn, the other is to the right.



When you perform a thermal turn the pattern is very similar except that you turn in one direction only (either way) and you allow the model to drift with the wind.

As a variation, you should also fly in a square pattern like this:



Fly these square patterns with both right and left-hand turns. Don't let the model get too far away and let the 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 some distance away (but keeping an eye on you!). He will always remain within earshot so that, if you call for help, he can be with you quickly.

After some practise with these patterns, 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.

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

CHAPTER 9
FURTHER TRAINING

PRE-FLIGHT AND POST-FLIGHT CHECKS

Whilst your instructor will have carried out the necessary pre-flight and post-flight checks on your aircraft on its first few flights and explained to you what he was doing, it is now time for you to do these yourself and let them become a matter of ingrained habit. The sequence of checks before you fly (pre-flight checks) will be:

(a) 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.

(b) 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.

(c) Check that the motor is securely mounted and that no screws of bolts have vibrated loose. Ensure that the propeller is undamaged and securely bolted on.

(d) Obtain your correct frequency peg or clearance, switch ‘ON’ the transmitter followed by the receiver. 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.

(e) Carry out a range check if the radio has been out of use for more than a week or so, 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 returned if your range is down.

(f) With the aircraft held safely and securely, open up to full power and re-check all flying controls once again.

(g) Throttle back the motor to a full stop. If you do not intend to fly for a time disconnect the flight battery, switch OFF the receiver, then the transmitter and lower the aerial. Clear your frequency control system. Recharge if necessary.

With these checks completed your aircraft is ready for its first flight of the day. For subsequent flights you need only perform post-flight checks after every flight. After every flight, your post-flight checks should be:

(a) Disconnect flight battery, receiver OFF, transmitter OFF

(b) Clear your frequency control system

(c) Check propeller and airframe for any damage sustained in flight or on landing

(d) Check all fastenings for security (wings firmly attached, motor secure etc.)

(e) Take a deep breath and slow the adrenaline down to a gallop!!!

REMEMBER - NEVER FLY WITH A DAMAGED AIRCRAFT OR A DAMAGED PROPELLER

THE EFFECT OF WIND ON THE AIRCRAFT IN 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.) the wind will blow fairly steadily from a constant direction once the aircraft is above about 50 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 heading 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 you drain your flight batteries so that you have no power 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.

ORIENTATION

One thing you will have discovered 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:

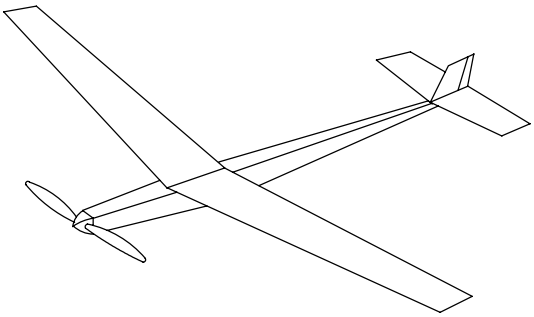


Fig 1 Model turning left

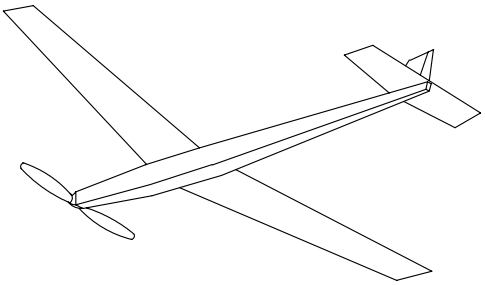
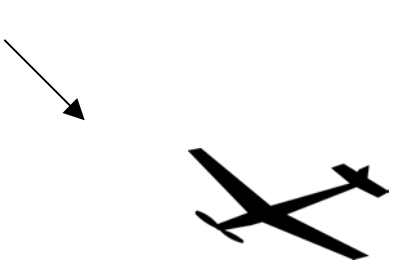


Fig 2 Model turning right



Both look the same at 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. 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

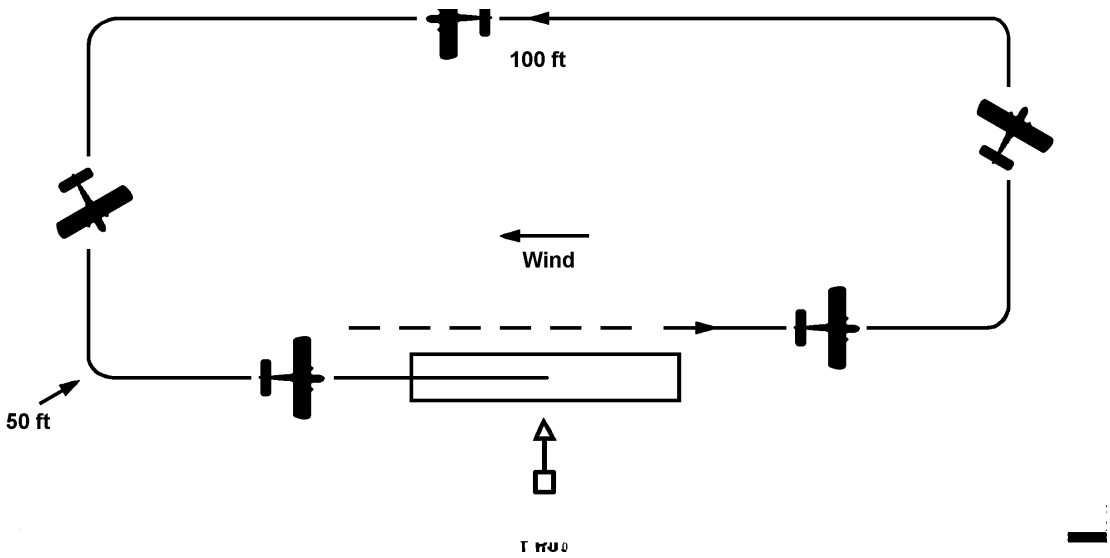
transmitter stick to the left slightly. If the model banks in the same way as your control movement the aircraft is flying AWAY from you: if it banks in the opposite way it is flying TOWARDS you. If the aircraft is flying across your line of sight, turn it until it is flying towards/away from you and apply the same test.

COMPLETING A FLIGHT – APPROACH AND LANDING.

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 model should be landed directly into wind (as with the launch) since it's speed relative to the ground will then be at it's lowest. Then aim is to bring the model towards the intended landing spot at the correct height and in the correct attitude so that the model gradually descends towards the ground and makes a gentle contact before sliding across the grass and coming to rest.

The approach to the landing position should commence with the model gliding into wind and upwind of the pilot at a height of 50 to 100 feet. It should then be controlled through an approach as follows:



Although a left-hand circuit is used to illustrate this lesson, the circuit can be either right or left-hand.

After settling your aircraft at the correct height and positioning it correctly into wind, fly about 50 meters upwind of your position and turn crosswind. Remember that the wind will tend to blow your aircraft towards you so keep it heading 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 meters out.

Once established on the downwind leg, allow the model to descend steadily until it has passed level with you and gone a further 20 meters, or so, and then turn onto the final crosswind leg, again 'crabbing' the model so that it does not drift further downwind. Aim to turn the model to line

up with the landing path at a height of about 30 to 40 ft at the end of this leg. Alternatively, the final crosswind leg can be flown as a smooth continuous turn. Don't forget that this is a descending turn and the nose of the model will be down to maintain speed.

The aircraft should now be heading straight for the landing point, directly into wind, with the wings level and descending steadily. If the aircraft is undershooting the planned touchdown point, you may be able to extend the flight path by using some gentle power. Do not use full power unless you intend to abort the landing and repeat you approach. If the aircraft is overshooting you may apply a little down elevator to accelerate the rate of descent but remember that this will increase the speed of the aircraft Basically it is best if you can let the model land itself.

When the aircraft reaches a height of about 3 ft. give a touch of 'up' elevator and fly level with the ground, and then, providing the wings are level and the model is in a stable flight path, allow it to smoothly land itself. If you have judged all of the various elements of the approach correctly it will do so within the landing circle.

This is the whole landing sequence but your instructor will probably start you off by getting you to fly the 'square' 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 throttle back to stop the motor 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, heading 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! A few more runs like this and your instructor will get you to do the whole sequence on your own:

(a) Launch

(b) Climb to circuit height

(c) Fly the square circuit

(d) Approach and land

You have now gone solo - though you may not have fully realised it at the time!

CONGRATULATIONS!

REMEMBER - NEVER TRY TO LAND OFF A POOR APPROACH – A BAD APPROACH WILL MEAN A BAD LANDING.

GO ROUND AGAIN AND HAVE ANOTHER GO

CHAPTER 10

CONTINUATION TRAINING AND THE BMFA SILENT FLIGHT ELECTRIC 'A' CERTIFICATE

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

(a) Launch and climb to safe height

(b) Turns, figures of eight, squares and general flying

(c) Square circuits and overshoots (both right and left-hand circuits)

(d) 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 Registered Examiner and your club should have at least two such Examiners. The test is very straightforward and consists of:

1. Carry out all relevant pre-flight checks as required by the BMFA Safety Codes. Particular attention should be given to airframe, tow hook, control linkages and surfaces.

2. Ensure that the radio frequency to be used is available, utilising the frequency control system in use at the site and prepare the model for launch. The motor start and stop switch/speed controller will be demonstrated safely to the examiner

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

4 Clearly announce, "model launching" and launch the model under full control. Any deviation from straight flight to be corrected smoothly and quickly. .

5. At the Examiners call the model should be stalled into wind and recovered smoothly with a minimum loss of height.

6. Perform 3 consecutive 360^{O} thermal turns to the right or left ending on the same heading as the entry with minimum loss of height. The turns should be under control with no tendency to stall or enter a spiral dive.

7. Perform 3 consecutive 360^{O} thermal turns in the opposite direction to above ending on the same heading as the entry with minimum loss of height.

8. Fly the model up wind smoothly under full control, with no tendency to stall and with minimum loss of height, to prepare the model for the landing phase.

9. Call "landing" and prepare the model for a landing with a down wind leg, followed by a base leg and final approach.

10. Land the model into wind within 20m of a predetermined spot.

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

12. Repeat the above schedule a second time.

13. Answer at least 5 questions on safety matters from the BMFA Safety Codes.

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

The Certificate is official recognition of the fact that you have achieved ‘safe solo’ standard and that you may now fly unsupervised, depending on your club’s rules. Remember that, whilst the gaining of this Certificate is an important milestone, it is a long way from being the end of the road and a licence to fly as you please! Your aim now should be to polish your flying and begin to explore the world of electric flight.

You should try to become fully confident in handling your aircraft in the air and 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.

ONE THING TO REMEMBER ABOVE ALL

FLY SAFELY

CHAPTER 11
NEXT STEPS

Now that you can fly your basic electric glider competently you should continue to fly it for several months longer. 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, understand why, repair the aircraft and go on exploring. Eventually the time will come when you will recognise that you have 'out grown' the basic model and you are ready for the next step.

Your next aircraft should be a more advanced electric model with different abilities. It could be a more advanced and powerful electric glider or one of the aerobatic electric models known as 'hot ships'. It could even be a scale model. It could have a low or shoulder-wing with a semi-symmetrical airfoil section and, of course, ailerons. If you powered your first electric glider with a bigger motor than recommended then the same motor may be suitable for your next model. You should think of this model as an '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.

FLIGHT CHECK RECORD

STUDENT ……..

DATE	LESSON / FLIGHT RECORD	PASS / REPEAT	INSTRUCTOR

The sample flight check record on the previous page can be copied and used by both student and instructors. Photocopy the page onto a record card or generate your own similar pages and paste them into a notebook. You will find such information especially helpful if more than one instructor is involved in your training but keeping a record of your progress will always be worthwhile even if you have one instructor throughout.

Your first page might look like this.

FLIGHT CHECK RECORD

STUDENT ***N. E. W. FLIER*** **……..**

DATE	LESSON / FLIGHT RECORD	PASS / REPEAT	INSTRUCTOR
6/5/99	Start and first flight. Check trims and rates	PASS	Fred Jones
6/5/99	Straight and level - turns	R	FJ
6/5/99	Straight and level - turns	R	FJ
14/5/99	Straight and level - turns	R	Fred Jones
14/5/99	Straight and level - turns	R	FJ
14/5/99	Effects of wind – Climbing and glide	R	FJ
26/5/99	Climbing and descending – use of power	R	Fred Jones
26/5/99	Trimming	R	FJ
4/6/99	Straight and level - turns	R	Alec Smith
4/6/99	Trimming	PASS	Alec Smith
4/6/99	Stalling	R	Alec Smith
15/6/99	Straight and level – turns	R	Fred Jones
15/6/99	Straight and level – turns - stalling	R	FJ
15/6/99	Orientation – Use of Power	R	FJ

NOTES FOR INSTRUCTORS

Advice to instructors can be of great benefit to both instructors and their pupils as both then know exactly why things are being done as they are.

The notes published here are quite basic and interested instructors and pupils should contact the BMFA Leicester office for copies of the new ‘Guidance Notes for Instructors’ booklet. This contains detailed advice on many matters involved in instructing and will be invaluable, especially to the new instructor just starting out.

An instructor with problems of any kind is encouraged to seek the advice of the local Chief Instructor or to contact the Controller of the Instructor Scheme via the BMFA Leicester Office.

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 to be 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 the 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 Up-and Away 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.

The ‘Guidance Notes for Instructors’ booklet has a much more detailed version which you may find even more useful, even though it is based on R/C power instructing.

NOTES ON THE FLIGHT PATTERNS

First of all, read the book right through - this will give you a feel for both the background and what is to come. Start with your student by checking that he has read and understood Chapters 1 to 6. Question him, particularly on Chapter 5.

The important part of the book for you starts at Chapter 6. Note what your student has been told and appreciate the areas in which he will look to you for advice.

PRE AND POST FLIGHT CHECKS

When you are checking his aircraft, TELL him what you are doing - and why. Follow the line of instruction in the lesson and reinforce what he has read by teaching exactly as planned.

- **ALWAYS** discuss with your student before the flight what you are going to do and ALWAYS discuss after the flight how it all went and what he needs to concentrate on next time.
- **ALWAYS** be encouraging in your comments. Spur him to better efforts and never criticise to the point of eroding his confidence.
- But **DON'T** let him get away with any deliberately unsafe flying. Over-confidence is worse than under-confidence.

TURNS

The major student tendency in this lesson is over-banking. The student applies bank to get into the turn then forgets to neutralise the stick to hold a steady angle of bank. Teach him to be aware of this tendency and to hold a steady angle of bank once into the turn.

BRIEFINGS

Briefings are intended to reinforce your instruction - not to replace it! The briefings are there so that he can have the information to hand to read over at any time. If you do not fully understand any of the points made, refer either to your local Chief Instructor or to the Controller.

STALLING

This has been included as a separate exercise to emphasise the point that low speed can lead to sudden problems. Take the opportunity to explore slow flight in parallel with this exercise.

CIRCUIT AND APPROACH

The teaching in the manual is based on the ‘square’ circuit since this is a requirement for the Silent Flight Electric ‘A’ Certificate test and because of the fact that a ‘square’ circuit is good training in control of the aircraft. However, it is recognised that many clubs require a ‘racetrack’ circuit and it is quite permissible for this to be taught up to the solo stage, after which the square pattern should be practised for the ‘A’ test.

Once on the approach path it is most important to teach the student to keep the wings level. If this is done the aircraft does not deviate from the approach path and the chances of a good landing are much enhanced.

Overshooting **MUST** be taught at **FULL POWER**. Anything less will cause trouble at some time or other.

GLIDE LANDINGS

Coping with a BEC cut-off and a dead motor in flight must be taught in a positive manner. It must be approached calmly with the aim of getting the aircraft to the correct position in the sky to enable a safe glide landing to be made. Once he can recognise the correct initial positioning points he is halfway towards getting his aircraft down at the right place on the landing strip. Let him try out the sloppiness of the controls when gliding by cutting the motor very high, giving plenty of time for practise manoeuvres.

Once the student has got the hang of coping with a BEC cut-off from an upwind position, gradually give him more difficult positions from which to make a glide landing. Regular practice will dispel all fears he might have and enable him to get his aircraft down safely under almost all circumstances.

CONTINUATION TRAINING AND THE BMFA SILENT FLIGHT ELECTRIC 'A' CERTIFICATE

When the student has gone solo you should aim him at the 'A' Certificate. Concentrate on polishing his limited flying ability so that he can perform the test accurately every time. Don't forget to take him through the BMFA Safety Code on General Flying as well..... and don't forget to ensure that he is familiar with the Club Rules!

NEXT STEPS

When he has obtained his 'A' Certificate it may be as well to let him fly on his own for a while to gain confidence in his ability and to make mistakes and recover them successfully. He will still need help from time to time, sometimes urgently, and you should be available if needed. Be ready to take him onto aerobatics when he is ready for them.

GENERAL

This whole training system is not intended to be a rigid one. It is fully accepted that different instructors may approach a lesson in a slightly different way. However, it is vital that the basic principles of the system are followed so that a properly standardised flying training system is achieved throughout. After the initial flights, many of the lessons will be combined during longer 'multi-purpose' flights. However, you should continue to brief on various specific elements of each flight as often as possible. Aimless flying around with no goals will do very little to improve piloting ability.

Do instil into your student that **HEIGHT IS SAFETY** and watch his flying whenever possible after he has qualified to ensure that he does not develop any bad habits.

AND FINALLY

When you take on the role of instructor you are taking on a rewarding and responsible position within your club. Good instruction is never wasted and the results of your efforts to instil good flying habits in the people you teach will always make a difference in the long term. Not only will the general standard of flying within your club improve as properly taught pilots begin to show their paces on the field but the person you teach today might very well be your club's ace pilot or a club examiner or instructor in a few years time.

Good luck to you all - and safe flying.