PREPARATION FOR FIXED-WING FLYING

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Insights into the challenges and solutions of operating commercial fixed wing drones.
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INTRODUCTION

With the huge advances that have come about in recent years in micro technology and unmanned control systems, it can now be a simple and easy process to get a fixed wing drone into the sky and get it to act with a high degree of intelligence.

The challenge however is not to be the pilot that successfully launches and controls the UAV - that is a relatively simple task. The challenge instead is to be able to make the myriad of important decision that will ensure that the UAV will conduct a safe and efficient flight that ticks a series of varied and demanding boxes. Flight Safety, Human Performance, Legal, Airspace, Battery Management, Flight Planning, Documentation, Endurance, Crew Training and Currency are just a few of the subjects that have an direct impact on success.

As a result QuestUAV has spent eight years perfecting the products and procedures that help just one type of small Unmanned Aircraft become a safe and effective tool for surveyors, agronomists, researchers and other end users.

Often good practices are just simple common sense, and easily put into practise, but like so many other professions, it is not until the simple stuff is pointed out that it becomes obvious. This booklet is one of those “How To” guides packed with good advice that will make so many decisions easier, as well as providing good operating practices for current QuestUAV Users.

What has set QuestUAV historically apart from other manufacturers is the application of military grade checklists and procedures for every stage of the end users operations. In particular our “Flying Checklists” are a perfect example of how the primary pre flight operations should be carried out in a professional organisation. There is nothing left to chance. Every active component is checked through a 1-2-3 sequential system and each check builds on the knowledge that the previously checked system is working.

Other manufacturers are following our lead but we have been the industry leader and expect to remains so. Our intention with this book is to continue this philosophy of safety through procedure by extending best practise to anyone who is interested in reading it.

For our trainees, this handbook can be read alongside the many other documents that QuestUAV uses to bring the multidisciplinary aspects of UAV operations to its customers. Other assets available are:

- The QuestUAV Online Support Site
- QuestUAV User Manual
- QuestUAV Operations Manuals
The QuestUAV Website, with its Expertise Articles
A range of residential training courses in UK and abroad
Online training

In summary, this booklet is meant to bring together as many of the tips, and sound advice that will make life easier and safer for the UAV operator. It is not only meant as a guideline for QuestUAV Operators, but is also aimed at any operator that is interested in advancing his or her knowledge of fixed wing drone / UAV / RPA systems.

Nigel King
Director
QuestUAV Ltd
THE ARTICLES AND BEST PRACTISE

UAVs, when put to the right applications, can achieve astounding results and improve productivity in no small measure. Remote sensing bringing increased crop yield through improved agricultural knowledge, awareness of the spread of tree disease, accurate and timely measurement of mining stockpiles and just a few of the many applications that new airborne technology can be used for. The range and capability grows every month, and the media spreads the word every day about drones and their growing presence.

But what doesn’t really come out in all this blur of growth and media presence is the need for best management in a fast growing industry that has many concerns over safety. And my message in this booklet is to get across not only the need for the training to help safety issues but how we, as a company focused on bringing this about.

So let's start of with best practice. Just like good accounting best practice and best practice for internet security, there is also such a thing as best practice for commercial drone operations. What is first perceived as a simple activity that just requires the purchase of some self flying drone equipment soon becomes a more complex activity as the search for solutions and best product deepens. With this search should come the awareness of the necessity for procedures and disciplines that are not too far removed from our big brothers that pilot manned aircraft and share the same airspace as us.

The two biggest detractors to best practice are over confidence and lack of awareness. We tend meet them in our dealings to a greater or lesser degree and with a wide variety of end users. Lack of awareness is easily overcome, and that is one of the reasons why invest effort in offering top quality training - the effort to learn always pays dividends and results in a more competent operations with fewer hurdles.

But over confidence is harder to deal with. Mostly it is a confidence borne of misleading advertising that intimates that a drone is easy to fly and that’s it. To a degree the sentiment is right right, drones can make some tasks incredibly easy, but there is something missing. It is when things go wrong; and when they go wrong, they go wrong quickly and mostly with destructive, and costly, results. Over confidence can be balanced with awareness and good practice, and that is hopefully what the rest of this document will help
with.

So here we are, ready to provide the best of what we have learned as a UAV manufacturer, and provider of training over the last decade. In this document are some of the top tips, the golden nuggets that have been learned by man others on their route to success.

What follows is a series of articles, with no particular connection between them. Articles that have been written following the analysis of recurring issue or problem that seems to keep bugging us or our trainees at various stages of the learning process. The solutions and general advice are what have come from a close analysis of the issues and the best are presented here.
Article 1: THE PURCHASING CHECKLIST

This is a simple checklist for those who are considering the purchase of a UAV.

This checklist will take you step by step through the complex decision and action processes, moving from investigation into UAV’s through the consultancy and purchasing phases, through training and into the final “We can now operate commercially” phase. Tick them off as you proceed.

☐ Read this book “Preparation for Fixed Wing Flying” Start a list or write down a needs requirement – help it define what you or your business needs are.

☐ Ensure you understand what can be achieved and understand ways to minimise risks. Refer to the chapters “It’s all about Flight Safety” and “Chains of Events”. Develop a culture of drone safety awareness right from the start.

☐ Think about Spares, Support and Maintenance Options. You are dealing with drones. You will need it eventually. Add it to your list to consider.

☐ Examine the options for employing a good crew. Read the chapters entitled “How to Choose a Good UAV Crew”, “Crew Constitution” and “Crew Currency”.

☐ Examine the quality and variety of training. More advanced operations will require more advanced training. Can we deliver what you need when you have gone beyond the basics? See the end of this book for details of our global training schedules.

☐ If you haven’t already, make an appointment with us to start a pre sales consultancy phase (no cost option).

☐ Examine the Sensors, resolutions and accuracies required to achieve the end results you want.

☐ Examine the Post Processing options. What support will you have to get up and running? What IT and computer requirements will you need?

☐ Complete our Online Survey (email us for this). It will look at a range of important factors that you need to work out before purchasing.
☐ Examine the environmental conditions, and weather conditions the UAV will be required to work under. If necessary refer to the chapters “Working in the Cold...” and “Care of UAV in High Temperatures”

☐ Examine the need for spares and redundancy. Refer to the chapter “Redundancy Pays Dividends”.

☐ Examine realistic costs and potential for profit (A brief business plan?)

☐ Understand the Legal Requirements in the chosen area of Operations. Refer to the Chapter “How to get a UAV Licence”

☐ Examine RPAS Training and Civil Aviation Authority requirements, costs and Schedules.

☐ Examine Insurance options.

☐ Confirm that the UAV can be legally shipped to country of use. We can help you with this.

☐ Examined training field requirements (if a training field is needed). Refer to the chapter “Choosing a Good Training Site”

With all these in place you will be able to make much better decisions as to whether one of our drones, combined with the right training, will be a fit for you.
Article 2: POST TRAINING: THE OPERATIONAL WORKUP

This phase is a time when trainees take their UAV back home and commence their operational work-up phase. Quite simply this phase can be a wonderful success or a bit of a failure depending on the attitude, approach and discipline of the trainee(s).

In order to keep this period the most productive we are going to provide 10 of the best tips we have come up with to get successfully through this period.


Remember that you are likely to encounter difficulties as you, or your team, faces unknown challenges.

We are prepared for this. However most clients aren’t and disappointment and frustration often follow the initial training period. Don’t give up or get upset. Things will be solved bit by bit, the little things become obvious and your experience will grow.

2. Assign plenty of time to your WorkUp.

No one knows how long this will take. Twenty flights or three months is a good start. The more you pay attention to good advice, the quicker you will get through this period.

3. Don’t book any important flights during the WorkUp.

Booking surveys or demonstrations early on is a big mistake. It puts huge pressure on the team to perform and rush through this essential training period. The result is disappointment, embarrassment at having to cancel appointment or worse still having things go wrong in front of clients.

4. Beware of taking advice from others.

A typical mistake comes from RC (remote control) fliers with a lot of flying experience telling you (and us) that the UAV is underpowered and needs a bigger engine or bigger propeller. If you don’t want to annoy the QuestUAV
support staff, then beware of taking this advice and sending the recommendations to us. If the UAV seems underpowered there will be reasons. A classic mistake is putting the propeller on the wrong way round. The result can destroy the whole motor train and cause the UAV to fail a couple of minutes into flight!

5. Video Every Take Off.

When things go wrong we all need the evidence. A video will instantly show up any launch issues. Make sure that the windsock is at the end of the line and in sight!

6. Send your Flight Plans to us.

We will be able to instantly spot the glaring mistakes that newbies make, over and over again. Doing downwind turns. Waypoints far too close together. Too many waypoints. ERP outside the circle. Over ambitious and complex plans. Zero height waypoints. We have seen it all!

7. Get the extra kit before you fly.

If you have been advised to buy important kit before flying, then we suggest do it. It is advice for your benefit, not ours. A typical fault is operating in hot climates without a tent to protect the UAV and crew. As a result the UAV, avionics and ESC become intolerably hot, causing failures.

8. Re-read “First Flights With a QuestUAV”.

You read it during your pre-reading. We suggest that you read it again and consider what is important for your training area and your operation.

9. Write up the debriefs after a flight.

If this isn’t done then the changes and improvements you need to make will not happen, despite having the best of intentions. Analyse and improve your own processes and methods. We will be able to provide much better support with when there are good debriefs available.

10. Work out your Resupply / Export Methods

You may well need spares/replacements and will no doubt need a rapid response from staff at QuestUAV. Work out how your whole chain of supply and information workflow will happen, especially if working outside of the UK or Europe.
Finally, be patient. It is all about paying attention to detail and giving everyone time to absorb new information in a safe environment.
Article 3: ITS ALL ABOUT FLIGHT SAFETY

The whole purpose for using UAVs is to achieve success, either commercially or in research, in the gathering data from a viewpoint above the ground. This data would classically be gained through manned aviation, where experienced pilots would be in control of an aircraft.

Now, because many people who enter the UAV arena are doing so from a non-aviation background, there are dangers lurking in the corners caused simply by an under exposure to a new set of Laws of Nature. Once understood, these new “Aviation Laws of Nature” generally make perfect sense and assist greatly in the success of every UAV operation, flight or campaign.

So, if you can get this bit of advice right, then your operations will have the highest chances of success simply because your approach to risk assessment is a healthy one.

Let us delve a little deeper and find out why.

Anyone who has gone through our QuestUAV training knows that we clearly define two objectives:

1. Flight Safety

We also define the priority of each and the relationship that one has with the other.

This article will assist explain this concept.

(Before I start, please note that this article doesn’t lessen the importance of road safety, vehicle maintenance and driver competence but it does try to put into perspective the scale and requirement for safety that we generally accept as the “norm” or the “benchmark” or the “Standard to Achieve” for adults going about their everyday life. This article is about the dangers of expecting this “norm” to apply to aviation.)

Here we go...

Most things on the ground are naturally stable (cars, buses, trains, boats etc). This means that they can rely on gravity and contact with
the earth, both for movement and for safety. So if, for example, a car’s engine starts becoming troublesome, or a wheel punctures, it is more likely to be an inconvenience rather than a disaster. Most of the time the driver of a car can slow down, come to a stop and sort the problem out. We as a nation have a pretty set response to such incidents and it’s normally an emotional one involving frustration, fear or anger. Indeed we can generally afford to have such emotions because situations are relatively contained by the presence of good old Mother Nature, natural stability, being on terra firma etc.

As we grow up we develop a mindset based on what we learn and what we are taught about safety in the home, safety at the workplace and safety on the road, unknowing that it is a mindset based on a set of rules regarding “things” that rely on having the ground or a solid surface close by that aids stability and minimises falls.

Aircraft however (including UAV’s) are naturally unstable and have to balance very carefully on a dynamic, changing and unpredictable body of air. They have to have a good flow of air over the wings at all times and an aircraft can’t stop in the air to sort a problem out.

A minor problem on the ground can become a major problem in the air. For example failing to close a door properly on a car doesn’t normally have dire consequences, but on an airborne passenger aircraft it can and has resulted in the deaths of many people.

Thankfully with UAVs there are no persons on board, but still the implications of minor mistakes are much greater. For example a poorly made electrical connection on the ground might just cause erratic behaviour, but in the air could quickly cause a crash.

So aircraft (UAV included), because of their natural instability in the sky, WILL expose the smallest of mistakes, whether mechanical or human, quicker than you can blink an eye. Similar mistakes might never show up on the ground.

As a result of all this inherent instability, every pilot, aviation company, government, aircraft manufacturer willingly adheres to a NEW mindset of awareness, safety and discipline that protects aircraft, people, property, jobs and whole industries. This mindset is often referred to as “Flight Safety”.

Flight Safety is therefore that special mindset, that whole cultural shift, that not only knows that things can and will go wrong quickly in the air, but also has the discipline to (A) always have preventative measures in place and (B) not take risks that will jeopardise safety.

As we develop this concept further we discover that one of the greatest risks to Flight Safety is the pressure to succeed. The pressure that something HAS
to happen, that a flight HAS to take place. That a delivery or appointment HAS to be met. This pressure is an emotional pressure that is blind to the mechanical risks that, if ignored, can (and therefore WILL sometimes) result in an air accident. It is a truth. It is a fact. It does happen all the time. It will happen over and over again.

For example If you HAVE to get from one end of your country in an old, unreliable car then you will probably manage it, even though it breaks down many times. People of our age have managed to get through all sorts of problems in life simply because we HAVE TO. However if you HAVE to get from one end of the country to another but this time you are flying in an old, unreliable aircraft you will probably only have one break-down, and that break-down may kill or seriously injure you and your companions. Both situations, in mechanical terms, might involve a similar problem (e.g. dirty spark plugs, flat battery, dirty fuel) but the result of the imperative “we HAVE TO get to Edinburgh (in this vehicle/aircraft)” can have a completely different outcome

Developing this further, when an air accident has happened involving this kind of emotional pressure and the concept of Flight Safety is missing, it is human nature to want to blame something else, rather than taking responsibility for the faulty thinking that fails to put the Laws of Physics before human desire.

So people in the aviation industry eventually come to the conclusion that the first priority is SAFETY and the second priority is SUCCESS. And if these priorities are changed around then SUCCESS quickly (and logically because of the laws of physics), becomes FAILURE.

Most people never have to make this understanding and unknowingly rely on others (pilots, air staff and aviation companies) having a deep understanding of it all when it comes to air travel. However when it comes to operating UAV’s you are thrown right into the middle of this, with no escape.

If there is a pressure to succeed, for whatever reason, then unless you are disciplined and knowledgeable, you will be blind to the myriad of tiny decisions and emotions that push you gently into the risky area of choosing SUCCESS over FLIGHT SAFETY, with it’s inevitable consequences.

So the messages are simple.

Putting FLIGHT SAFETY first will lead to SUCCESS

Putting SUCCESS FIRST is likely to lead to FAILURE

Mechanical failures and poor decisions have rapid implications
Any air accident investigation looks closely at the chain of events that lead up to a particular accident. For example, its surprising how something like an engine failure can stem from the birth of a child, but random events when all strung together will, one in a million times, result in something drastic happening. There are actually chains of events naturally occurring all the time, but generally intervention such as procedures, training and skills transfer, manages to break a chain before it has disastrous consequences.

In normal everyday life we still experience the effect that chains or events have in car accidents, domestic accidents and work accidents have. However the analysis and soul searching tend to quickly stop when “bad luck” or “blame” or “accident” can be assigned. It saves us looking too closely at things we inevitably don’t want to look at and this avoidance of the truth, sometimes combined with naivety, prevents some really good research being done that will most likely help prevent us having future “accidents”.

Insurance also acts as a buffer to protect our property and our fragile egos. We do know that the safer person is the one who is likely to have lower premiums, because this person can, through experience and attention to safety, break chains of events that others might not be able to succeed in.

When it comes to aviation, (you and I are firmly and squarely in that field when operating sUAV), chains of events build much more quickly and have more drastic results.

For example a lack of understanding of meteorology, of wind shear, when combined with a wooded area, wind from a particular direction, haste in completing checks, pressure to achieve a task, lack of knowledge of a UAV system capability and lack of experience could all build a sequential chain of events that leads to the total loss of a UAV. Such events wouldn’t have any effect on the ground, but in the air it’s a different story - events build much more quickly and therefore have to be kept in check through knowledge and procedure, and not through luck.

You are probably picking up by now that my recommendation is that we work at breaking chains of events rather than saying “oooh, bad luck” (or something worse!) after a crash. sUAV cost a lot of money - there is no denying that - and we all want to keep them as safe and productive as possible as well as the people and property that comes into contact with us.

So I’m just going to give a short list of factors that are known to assist breaking such chains and I will allow you to think more on them and how they fit your UAV scenario.
1. **Know your UAV.**

Get to know it well. Know how all the equipment works. Have a training field that you can regularly attend that you, and your crew, know well. Do all this even before you take to the sky.

2. **Having a good training schedule.**

There is a lot more to training than flying. Regularly work through the checklists and manuals. Practice on the simulator. Define clearly the roles for your pilot and your UA Commander. Find out more about the legal side, Flight Safety in general, operating UAVs. You will be surprised how quickly you forget stuff and how much there is to learn in becoming an experienced and safe crew member.

3. **Get the right training in the first place.**

Getting the right training will be the single best investment you make. There is a lot to learn and no matter what anyone will tell you it cant be learned in one go over just a couple of days. Examine our schedules and ask “what can I do without”. The answer often is “not very much”.

4. **Do things one at a time.**

Only change one thing (if possible) at a time. New camera, new flight path, new GCS setting, new location etc. try and introduce just one thing at a time. If you can’t and there is a lot of new stuff going on then make sure you do the next thing well;

5. **Be Patient.**

There is always lots of time after a crash to think over the factors that you should have thought about before. Its far better to put the patience in before and find out the little thing that will break the chain of events before it gets too far. Think, talk, discuss, analyse. Run whole flights and scenarios in your head lots of times before flying. And after you have flown do the same thing with your new knowledge.

6. **Document.**

Write it all down. Commit your learning, your flights and your failings
(however little) to a manual or diary that you can go back to. Fail to do this and I guarantee you will fail to break so many nasty events that could be avoided with some good and honest report writing.

7. **Share.**

Network, email, Skype, call, whatever. Especially with your crew, but also with other operators. We are in a new world with this technology and there isn’t much to go on. Some may want to keep their knowledge secret, but most don’t. Helping break other operator’s chains will help break yours too.
Article 5: CREW CONSTITUTION AND CREW TRAINING

“A well trained crew is the best safety device in any aircraft. “

This is exactly the same for a UAV.

The more competent the crew, the greater are the layers of safety surrounding the flight and the operation, and with that the integrity of whole organization.

The tempting message from some UAV advertising is that zero to hero takes no more than a few days and a flight can be planned and executed in a few minutes by just one person.

Certainly, a flight can be planned and executed in a few minutes if the task is a simple one and the crew (or pilot) is suitably skilled and experienced. A typical example is a simple repeat survey where nothing has changed from the previous survey (UAV, crew, weather, wind etc). Unfortunately this is a rare experience and one is more likely to have new problems to solve rather than find a re-run of a previous survey.

However there are an ever-growing number of new UAV operators who will testify to the fact that it takes more time and effort than anticipated to achieve success.

Two are Better than One

The first big jump in safety (and potential success) comes from having a crew present, not just a pilot. With two trained persons present the risks are more than halved.

The training of the second person doesn’t have to be onerous and he/she doesn’t have to be present throughout the time that the pilot is training. However, during a flight, it’s a huge bonus to have the presence of another set of eyes and a brain that isn’t tied up in the detail of flight preparation. This person (commander) can be focussed on the bigger picture and our experience shows that this persons need to have no flying skills or coordination at all. Normally this person will be in charge of the laptop and will provide up to date information to the pilot during flight. This person will also have an awareness of the bigger picture and what is going on at the flying site and what might be about to change.

With this person present the Pilot can the focus on the UAV and safe flying operations, will be able to predict UAV performance in advance and take swift action if anything starts to go wrong.
It is a great help if the Pilot and Commander can work together in the early days. With a little time together, a well-constituted crew will soon develop a rapport and an ability to think and operate as one. Not only does this expand the safety margins, it is also a rewarding and enjoyable experience for the crew.

What If ...........

With a crew it is also possible to run through scenarios and emergencies and the way to deal with them in the comfort of a crew room (or office/garage/study/coffee bar etc). All the “How” and “What If” scenarios. Things like:

- What if a herd of sheep/cows/bison arrived unexpectedly on the site?
- How do you know if there is turbulence?
- What if the wind changes direction before landing?
- How do you know if the wind has changed?
- What if the laptop battery fails, or it gets accidentally dropped?
- What if an angry farmer turns up
- What if the UAV gets flown into a tree, or forest, or lands in water or on the roof of a farmhouse?
- What if it lands in a field of long crops and we lose it?

All these scenarios can be talked through in a calm manner within a crew. The results are always beneficial and bring about timely changes, simple equipment purchases that make a difference, and incident procedures that would never otherwise have been thought about.
Article 6: CREW CURRENCY

It is definitely not a case of having operated a UAV you will then remember the skills for life. It is NOT like riding a bike.

Riding a bike is about developing natural and unconscious skills combined with a small amount of decision-making.

Operating a UAV requires continual decision-making and conscious awareness combined with a small degree of unconscious (but important) coordination skills.

The problem is that conscious awareness and good decision-making are skills are easily forgotten. It is recognised that pilot capability and reactions drop approximately 40% after a month and 60% after two months. Skills quickly return within an hour or so of fresh training, but for a significant period of time a pilot (or crew) will be working at reduced capacity.

For a UAV crew that needs top performance during its first half hour, the fact is that if it hasn’t practiced properly in the last month then that performance just isn’t going to be there. It will be worse of two or more months have elapsed.

The good news is that with QuestUAV there are methods to keep skills current without always having to fly. This is especially important in bad weather or times when other work has priority. QuestUAV recommends that its clients follow the times, entries and advice in its Pilot/Commander logbook to maintain currency.
Article 7: HOW TO CHOOSE A GOOD UAV CREW

There is a lot more to creating an effective UAV operation or survey than meets the eye.

We have taught many crews both in UK and around the world, from one man crews aiming to run simple surveys to indigenous multiple team crews on plantations in the Far East. Each operation has its own challenges to overcome, but there are themes that play out again and again about making the correct investment prior to engaging in training.

The success of running an effective survey comes from a lot more skill and effort than just having a pilot launch or land an aircraft well. A survey will invariably involve less obvious skills such as map reading, team cooperation, understanding local weather, problem solving, public liaison, cross-country driving, IT skills and first aid training.

1. Do your finances.

Bearing in mind that a crew will most likely be a larger investment than the equipment, it makes sense to get this part right from the start. A system, with training, might cost from $10k to $30k. The cost of running a two man team for a couple of years, including all the hidden costs of transport, supervision, licensing, might be $100k or more depending where in the world you intend to operate.

Have a good plan as to where your income and expenses are likely to come from and how long it will take to become profitable.

2. Plan for longevity.

It takes time for a crew to become skilled. Plan for at least a year for a crew to train and operate together on a regular basis otherwise there will be a big skills gap that will take some filling, especially if a pilot leaves prior to any kind of succession plan.

Take good advice. Work out who you need to speak to and make an appointment for a skype, call, face to face or email.

4. Work out the skills list.

What skills will you need in the team? What has come out of your investigation so far? There are many roles to fulfil when it comes to having a competent crew. See the list below.

5. Go for Diversity versus Crossover.

When training aim to have each person trained well in their roles rather than try a have everyone trained on everything. This allows a higher level of ability to be reached during training, rather than mediocrity.


Language is also a huge bonus or barrier to progress; a team that has English as a first language will progress much faster than a team that has a member with a different native language. We have a rule of thumb that for a different language, even though English is spoken well, the length of time to assimilate the necessary information will be at least doubled, and possibly trebled.

7. Find a Leader.

Good decision maker, confident not arrogant. Likeable, invested in the whole team and the purpose of the operation. Someone who has the lasting power to overcome the challenges and disappointment. Someone capable of taking responsibility when things go wrong rather than blaming others.

8. Get Advice and Book the right training.

Don’t skimp on training. Avoid arrogance and ignorance. Spend time talking to us and we will honestly tell you what we think you need. We can even do a pre training assessment that will help you decide what you really need.

9. Know the Legals.

Will you need certification? How will you get insurance? Do you know what documents to read?
What I now write is a list of the human skills that we think are important when looking to create a good UAV team.

**Captain (Compulsory Position)**
(This is the person who is in overall charge of the mission. It could be the Pilot, The Laptop Commander, a team Supervisor, or someone else).
- Good decision maker
- Reliable and trustworthy
- Clear speaker, good at giving orders
- Leader type
- Good motivator
- Good public liaison skills
- Good problem Solver
- Driving license?
- Knowledgeable in the host business structure (can act as middleman or advisor between the flying team and any middle or upper management team).

**Pilot (Compulsory Position)**
- Good hand/eye coordination
- Practical, problem solver
- Good eyesight
- Listens and will take commands from others
- Fit, healthy
- Must speak good English
- Driving License?

**Laptop Commander (Compulsory unless one man team)**
- Good clear communicator, does not need the coordination skills of the pilot, but knows the difference between left/right
- Can issue commands, make good decisions and lead a team
- Good with software and Mission Planning
- Good with documentation and keeping administration up to date.
- GIS skills possibly
- Driving License?

**Spotter (Optional unless long range routes are planned)**
- Good eyesight
- Good span of attention (will keep track of wind changes)
- Can take commands

**ROLES THAT NEED TO BE ASSIGNED**

Who will be Pilot?
Who will be Commander
Who will be Launcher?
Who will be Spotter?
Who will do the Risk Assessment?
Who will be in charge of Maintenance and Repairs?
Who will liaise with QuestUAV?
Who will be in charge of Cameras and Camera preparation?
Who will be in charge of Parachute Packing?
Who will be in charge of Documentation and Report Writing?
Who will be in charge of vehicles and vehicle preparation?
Who will be in charge of the legal side?
Who will do Post Processing?
Who will run the training program?
Who will be in charge of inventory?
Who will be in charge of customer liaison?
Article 8: MAINTENANCE AND THE SHADOW BOARD

This next subject is one of those simple, practical, easily introduced bits of kit that will repay its simple investment many times over. It is about BEING PREPARED.

There is so much kit and batteries and clothing and checks and radios and SD Cards to remember that it’s a wonder a single flight ever happens. It’s a single-minded attitude towards preparation that will help get all the required gear to the flying site.

At QuestUAV we have designed what we call the “Shadow Board”. It’s a 4ft by 2ft chipboard/mdf board with painted outlines of the equipment that is needed to get together before a flight. Check our website for pictures of this.

With this board it is instantly noticeable if something is missing. There is no need to go down a checklist (and easily miss something) – its there on the board and if its not there, there is a hole, an empty space saying “me, me, me….. find me and don’t forget me”.

The board should be at the physical location where you pack your kit/equipment at base. Just before departure there is a final check of everything and then the contents of the shadow board go into a rucksack that will not be unpacked until it arrives at the flying site.

We have a duplicate of this system in our van so that equipment can stay in the van. Its half size and laid out on two shelves.
Article 9: WIND CHANGES EVERYTHING

Anyone who has flown in a wind above 15mph ((24kph) will have noticed a number of changes that affect the performance of a drone. QuestUAV aircraft can fly in winds up to 40 mph (64 kph) and at these speeds the impact of the wind has considerable on flight performance is considerable.

As the wind increases, first things that become noticed are the annoying things on the ground. It becomes more difficult to manage the flying site. Paper and lists get blown around, chairs get blown over, the drone might get blown off its stand. Wind-chill will reduce performance in cold temperatures. Each of these can be catered for, provided that preparations and planning has been made for the event.

More serious are the effects come when the drone is airborne. Wind generates turbulence, wind shear and rotors. The effect of these will be especially noticeable around trees, buildings, and anything with steep or sloping sides.

Next, flight planning becomes more critical. It is harder for the drone to penetrate into wind. This means that a camera triggering leg on a set time will end up with a lot of pictures into wind. That isn’t a problem, it is when the drone turns downwind and has a much higher groundspeed that the lack of pictures can pose a problem. As a result QuestUAV recommends flying across the wind on imaging routes and this generally solves the problem.

As wind increases further, the UAV will be seen significantly “crabbing” along track in order to stay on track. QuestUAV are very good at managing this. However, when there is more “Crab” than along track, the flight time required to complete a flight will increase significantly and may prevent a
full route being flown.

As the wind increases, the ground-track from flying an orbit (a loiter) becomes more distorted with the UAV being pushed downwind and then struggling back into wind to get back on track. A point eventually comes with wind strength when the UAV just can’t penetrate fast enough into wind and it will seem to almost stop in the air.

To help, we use a simple formula. For the wind strength on the ground, double it and that will give a reasonable estimate for the wind strength at 400ft. So if the wind is 15mph on the ground, expect it to be close to 30mph at 400ft.
Article 10: NEWBIE OVER CONFIDENCE

It is surprising just how much we can seduce ourselves into thinking that a new mission should be easy, and that everything should go really well from the moment the vehicle drives away in the morning with the crew and drone onboard.

There are just so many things to be ready for and the best mental attitude is one of caution and good general awareness.

If your first assessment of a site was to go look Google Earth (which is a good approach) the land will look flat, the trees will look unthreatening, the occasional lake can be easily ignored and the power lines might not be seen. When you actually turn up the road accesses may be very different, there might be a forest where there was not one on Google, a whole field can be blocked off due to livestock and walk-in routes may require military grade waterproofs.

The wind might pose significant problems with a landing (or take off) route and acres of land that you expected to see (just where the UAV will be operating) might be invisible due to tree coverage.

Now add in the presence of the customers you are doing the survey for and the stress ramps up. Film crews might be present too, watching your every move. Like it or not, you will want to impress and will dread something going wrong.

Of course there might be a new piece of equipment, or a new procedure that you want to try out that should be really easy to integrate into the day. Are you absolutely sure that it won’t be just one of those things that helps create some new chains that I spoke about earlier?

The answer to all this is to minimise the risks by being as prepared as possible. Here are just a few things to help improve success;

- Do a good risk assessment and look at all the angles, if possible including turning up at the site the day before the planned flight.
- Remember that Google Earth will show topography - use it to get a better understanding of how the land lies and where dead spots will
be with visibility and possibly with reduced transmitter range. But
don’t rely on it 100%.

Get photographs of the area. DO NOT rely on others assessment of
the area and suitability for flight (unless of course they are already
UAV operators). They will invariably be looking at it optimistically
and with inexperienced eyes.

Be wary of the involvement spectators and film crews. They are not
a risk in themselves; it is the subtle emotional changes within the
flight crew in the response to their presence that can distract the
focus from the task in hand - which should be flying the UAV in a
new scenario whilst retaining a full focus on Flight Safety.
Article 11: ENDURANCE IS NOT EVERYTHING

The call for unmanned aircraft to fly longer mapping surveys is understandable.

An operator wisely wants the longest time possible to ensure that all areas are covered correctly and with time to spare before coming in for a landing. Without sufficient time then risks might be taken to complete a job with the worry of the aircraft running out of power before it has time to come home.

We have experienced clients wanting to complete remote surveys of 1000 plus Hectares. This requires some serious battery power and careful consideration over payload compromises.

In worst case scenarios, some multirotors taking 2 or 3 minutes to setup and requiring 20% reserve to prepare for landing, it can leave just 5 minutes or less for a survey. Not a nice place to be when things don’t go exactly as planned and those shots take a little longer to get in the bag.

So quite rightly, new customers have been crying out for more endurance from their providers. More of a safety factor, more time to complete a survey, more time to complete larger surveys. And the manufacturers have been responding, albeit sometimes with overly optimistic quotes, but they have been responding. 40 Minutes, 60 minutes, sometime over an hour. We provide different Q-Pods that go from 35 minute power packs to 1 hour 15 minute power packs.

With this greater capability comes comfort and the knowledge that there is a reliable, juicy, power train pushing or pulling the drone through the sky and the operator doesn’t need to worry about picking their expensive survey tool out of a tree or a pond or a cowpat after it has gone down unexpectedly.

But is this the whole story?

With endurance comes comfort, but also with endurance comes compromise.

And the real question should be “how much endurance do I really need”, so that the inevitable compromises made for the extra battery power don’t have a significant impact on other things, like increased weight, limited climb rate, poorer image quality and so on.
We optimize our basic flight planning package for a user to work within the 500m radius that many authorities impose. It may not sound a great distance, but when a new user sees just how far half a kilometer is in terms of UAV visibility, then the 500m range soon becomes seen as a friend that should not be dismissed easily! This area is covered in nine imaging legs plus one climb and one descent.

The interesting fact is that with good overlap (70% to 80%) and good sidelap (50%) the whole 70Ha area bounded by the 500m radius is covered in around 12 minutes from launch to land.

Just 12 minutes. 15 minutes if windy.

Where in this case, is the need to drag around batteries that will land with over 80% unused?

Why fly with a heavier aircraft, with a higher landing weight and poorer performance, for the sake of misplaced comfort?

Surely 25 to 30 minutes endurance would be a fair expectation for an expected 12 minute flight?

And instead benefit from a lighter aircraft less likely to landing damage, more likely to have a better climb rate, that can manage turbulence better and possibly even carry a better camera?

We aim to fulfill customer expectations as far as possible, but there are times when a little clarity can bring the space for better decisions. And so we introduce our customers to the difference between desired endurance and required endurance. Once this hurdle is overcome, we can equip our customers with better options and better training, especially during the first months of UAV operations.

When operations become more demanding, then certainly the need for greater endurance becomes a factor. As experience increases then safety factors can be relaxed a little and a larger stack of batteries can be hauled around the skies. Foreign operations may require a transit to 3km or 4km distance outside of line of sight, and the same flight may require a 1000ha survey. Two batteries increase to five batteries and endurance climbs proportionally. This range is well without the scope of normal UK or European operations, but is still a capability that requires a much larger battery capacity and resultant higher operating weight.

The message is to know what limits you are really likely to be working in, and judging your requirements accordingly. For basic UK or European operations, stay within the 30 minute endurance, and with a QuestUAV within the two battery layout. For long range operations, or surveillance operations, yes go for the longest endurance possible but know what is being sacrificed for the extra time. You might not need to compromise!
Article 12: BATTERY ENDURANCE - TEST RESULTS

As already stated we know that customers want reliable battery endurance times that they can trust.

QuestUAV endurance tests are therefore factual tests completed under real-time conditions. Every attempt is made to optimize the results through the use of parameters that an end user can repeat (e.g., fully charged batteries). No attempt is made to falsely improve results (e.g., flying in updraughting air).

A single reliable time of endurance cannot ever be stated with confidence unless the end user is always going to operate under very similar conditions. In reality this is an impossibility and in most conditions the actual endurance time will be less and sometimes considerably less. Equally, under the right conditions the endurance time could be considerably more.

This condition is similar to the difference between the mileage claims that a car manufacturer makes and the mileage results that a car driver reports in his findings. Mileage figures are reported in various parameters (e.g., Optimal and Urban Cycle and Combined). Taking the combined mileage (mpg) figure from a highly reputable car manufacturer (e.g., Audi A1) with an official mileage of 55.4 mpg, drivers report a real mileage of 33-60 mpg with an average of 43 mpg. This tells the car driver that the mileage figures one of the most reputable car manufacturers has a variance of up to 40% over what drivers report. This is not a criticism of Audi, but a reflection of the difficulties in bringing figures that mean something to the public.

Unlike car manufacturers, UAV manufacturers have no official benchmark to work to. The range of in-flight variables are considerably more than on-road variables, making such a benchmark hard to achieve. Also the sUAV industry is not mature enough to have set an agreed standard and hence UAV manufacturers can make any claims they wish.

The result is that it is hard for a manufacturer to show competitive figures against other manufacturers without being tempted to over-inflate realistic figures. We resist this and instead prefer to publish our reports and share what our customers feedback to us. The truth is that we know that published endurance times can experience up to 60% variance depending on what the end user is putting the UAV through.

A further explanation is required for large variance in flight endurance times;

The biggest variables come from temperature, updraught/downdraught and turbulence.
Taking just one of these (updraught/downdraught), the simplest analogy is if a UAV is in dowdraughting air this is similar to a car “coasting” downhill with a 200+ mpg figure. It is incredibly efficient.

If however the UAV is in updraughting air (or having to climb a lot) then this is similar to a car trying to drive full speed up a steep hill in first or second gear. It is incredibly inefficient and may only return 12 mpg, possibly even less.

Unlike a car, a UAV can conduct its whole flight under climbing conditions just in order to stay level. This effect, along with many others, can cause a large variance in flight times for an aircraft.

QuestUAV therefore now provide endurance reports that show optimal times under neutral test conditions and refer to this as the TOP (Typical Optimal Performance) rating. We now also provide a percentage variance that can have an effect on this TOP figure.

Under this specification we are going to quote two different results from a QuestUAV with two different Q-Pods attached, to demonstrate this variance

<table>
<thead>
<tr>
<th>Q-Pod Configuration</th>
<th>Flight Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Surveyor Q-Pod with 10000MAH Battery</td>
<td>36 mins (worst 22 mins, best 50 mins)</td>
</tr>
<tr>
<td>Long Range, Long Endurance Q-Pod</td>
<td>90 mins (worst 54 mins, best 126 mins)</td>
</tr>
</tbody>
</table>
Article 13: THINGS THAT WANT TO DESTROY YOUR FIXED WING

There are many dangers to consider when planning a UAV flight, but here I want to focus on what we find as the main environmental dangers (rather than human factors).

Trees.

Tall trees, small trees, single trees, in forests, bushy trees, bare trees; whatever, they pose one of the greatest dangers.

Firstly, they tend to be the tallest thing around and it’s the tallest thing that acts as a fishnet for a low flying UAV.

This statistically means that it is the upper part of a tree that a UAV is likely to get entangled in rather than the lower branches. This is not the normal situation that is imagined – normally it is the imagined as stuck in the side of a tree, and visible to an onlooker. Recovering a formerly low flying UAV from the canopy of a tall tree can be a tricky thing.

The first problem is trying to locate a lost UAV in a stand of trees, even a small stand. The simplest answer might be to launch another UAV to find it but that is likely to be a task of a day or more. Then IF it has been located, how is it removed? How many trees need to be cut down and can they be cut down safely? Surely you wouldn’t expect to climb …..

There is something else about trees that is vitally important to know. Woods / forests / lines of trees generate their own weather and turbulence. You wont see it until your UAV is overhead or downwind, getting thrown around by invisible air currents. Even on a calm day if it is warm, trees can still generate strong, vertically rising vortices that rise a hundred feet or more above the canopy.

Plan your routes accordingly and be especially cautious of take off or landing near trees. Work out how wind and turbulence might occur around them. Plan for the worst and anything better is a bonus!

Large Scale Topography

This means big features like mountains, hills, valleys, cliffs etc. They each can direct winds into unexpected directions and strengths and create exceptionally strong turbulence.

If a large body of air has got to find its way in over and around a mountain,
then that body of air is going to get pushed left and right and up and down as it tries to find the path of least resistance through the terrain. Put a low flying UAV in this body of air and it can suffer to the point that it just can’t climb fast enough to battle downdraughts or has no hope of returning any worthwhile imagery in rapidly changing and unpredictable turbulence. Updraughting can be so strong that it can be very hard to get a UAV under control.

**Turbulence**

Turbulence can throw a UAV around so violently that it can tear it apart and this turbulence might not be immediately visible from the ground. Also winds over topography can be strong enough to cause rotors that could flip a UAV or put it into an unexpected stall. Windshear close to the canopy of a forest or on a valley can create a sudden stall too. Even though the UAV may have been operating safely at cruise speed for some time a sudden change in wind speed or direction can cause the essential airflow over a wing to be reduced below stall speed. This can happen during an approach to land as the UAV’s altitude decreases.

**Water (Especially Salt Water)**

With fresh water immersion it is can be possible to recover components without too much of a loss. The ESC and servos may be written off. Our Lumix cameras can be recoverable and the motor is unaffected. However in order to achieve this the UAV has to be recovered first and this isn’t always possible.

However, salt water is very different. A quick dunk in the sea will write off virtually everything electrical or electronic.

**Crocodiles**

Or so we are told. If someone’s QuestUAV gets eaten by a crocodile we promise a major discount on the replacement. We will need the pictures first though!
Redundancy is finding ways to ensure that a mission does come to a halt because a single piece of equipment fails.

It is also referred to as Single Point of Failure (SPOF) and the less SPOF there are in an operation/system the more likelihood there is of mission success.

That spare transmitter, the extra laptop battery, the extra airframe, the spare camera, the extra SD cards, the spare gimbal. Just some of the “what if” bits of equipment that a crew may think that they are most unlikely to need. Well, they are indeed unlikely to need it especially if the planning and prep has been done well. However as each flight and each landing occurs new chains are being set up, each with entirely unpredictable outcomes.

Lets just take the transmitter. What if it accidentally gets dropped in a puddle, or left in the rain, or left in a warm damp atmosphere and the screen fogs over for 2 days? What if a low battery wasn’t noticed, or the mode switch gets broken off. Or the aerial pulls away, or it fails a low power range test. Or a stick gimbal fails. We have had all of those. Having a spare is the difference between the problem being an irritation or ending up in “game over” for the whole mission.

For a successful operation it is worth looking at each item that is on the shadow board and asking “does this need a backup”. Only the crew will be able to work that out in the knowledge of what lies ahead. For a training mission to a local field, the outcome of a broken transmitter is annoying. For a mission to Antarctica, a broken transmitter with no available backup is devastating.

What mission do you hope to run and what could be the outcomes if you did not have certain replacements to hand?

Something extra to think about. Redundancy goes further than equipment and right into crew skills. Can any of the essential skills (piloting, setup, laptop, planning, risk assessment etc) be fulfilled by another crew member?

having a spare is the difference between the problem being an irritation or ending up in “game over” for the whole mission.
The statement that working in the cold is tough must seem obvious however when it comes to UAV ops there are special things to think about.

The biggest risk of all is the reduction in human performance that the cold and the wind bring. Each member of the crew needs to have a raised awareness and be able to fight the debilitating effects of the cold. Wind chill can soon affect crew performance at a time when it needs to be at its peak. Having to stand around for up to an hour or more at a site will quickly bring on cold feet, cold hands.

Unless a person is ready for the degradation in performance, it normally isn’t noticed as a risk. Cold is certainly experienced as discomfort and an annoyance, but rarely as a significant factor that decreases the ability to think clearly, make good decisions and give 100% to a task in hand. There can be a rush to get things done, a desire to minimise checks and a reluctance to stop and examine any issues that need sorting.

QuestUAV advise is to prevent the fall in human performance in the cold before it has a detrimental affect on Flight Safety by being prepared long before setting up the flight launch area.

Proper clothing layers, crew briefing, weather forecasts, effective decision points (go/no go), mobile shelter (e.g. storm shelters), hot drinks etc. all need to be prepared in advance.

Here is a good rule: Below 5 Deg C, every 5 deg C drop requires a doubling of effort.

So operating at 0 deg C will take twice the effort to run a full survey than it would at 5 deg C. And operating at -5 deg C will take four times the effort to run a full survey.

Effort involves the things we have discussed above (preparation etc) but it also involves the concentration required, the increased time taken to setup fly and pack up, and the little things such as the hindrance from clothes, dealing with others complaints and low morale.

The cold also takes a toll on battery performance. A battery at 0 deg C can have only 25% of the performance of a battery at 15 deg C.
Article 16: SOME MORE TIPS

CAMERAS

- On an imagery flight make sure the lens is clean and extended before launch - it is very easy to launch with a dirty lens

- Never fly with SD cards that have un-backed up imagery on them.

- Carry a light meter with you. Any subjects less than 4000 lumens (ground view not sky view) are going to be dull and lacking detail

ROUTES

- On long range, high risk routes aim to have spotters positioned so the UAV is visible at all times by 2 persons, but who aren’t co-located. This will provide you a triangulation method if the UAV goes down. Have each take GPS position and heading.

- Memorise your route well, if possible on the day before flying it. It will pay dividends in stress reduction and better decision-making.

- Turbulence and wind shear can make a UAV stall. Most times the UAV will recover from a stall if there is sufficient height, but if there is high wing loading or insufficient ground clearance the result could be an inadvertent and unexpected early landing.

- Know that on the long routes you will only have telemetry (and therefore voltage information) in the sections where the UAV is within 500m.

CAPTAINCY and AIRMANSHIP

- Faithfully hold a pre flight brief and a post flight brief.

- If it all starts to go wrong...STOP... and take time out. Break the chains.

- Write good notes after each flight. Pay attention to the signs - things that
came “Close”. You will forget surprisingly quickly things that were “Close” until you are airborne again and it all comes rushing back!

- If it is difficult to write notes, take a handheld dictation machine or a mobile phone to speak notes into.

- Be true to the flying checks - but be prepared to alter them.

**PREPARATION**

- Always have a baseball hat and sunglasses to hand.

- If you have two or more transmitters, use one as a master with all the model memories in it. Regularly make a backup onto the SD card and keep the SD card in the backup/spare transmitter.

- Separate ground prep from flying by an overnight sleep. In UK this would be prep everything the day before and do your flight planning and execution plan then. Then go to bed knowing that everything is ready - your mind will switch from engineer thoughts to pilot thoughts overnight and you and your unconscious, and therefore you and your crew will be a lot more prepared for flight.

- If you have recovery poles use them, fully extended, as turbulence masts, with tape to show wind direction. Place them approx 70m away from the launch point, 25m apart. Understand what the tapes are telling you re turbulence / wind direction / strength.

Be true to the flying checks… but be prepared to alter them

Don’t forget that you can use the "GOTO" button to go to different waypoints that might not be showing on screen.

Avoid doing too many training landings - do overshoots but ensure that you give full power to execute the overshoot.

Voltages. Experience has told us that you can fly until 10.5 volts. The telemetry will show the voltage dropping to the region of 11.1 to 10.9 volts and spending ages there (ten minutes at least). Once it starts dropping below the 10.7 it is definitely time to start the approach to land - you might need to do an overshoot so 10.7 leaves a little bit of spare.

Landings are all important - this is when any damage is likely to occur. Plan your landing areas carefully.
Article 17: CHOOSING A GOOD TRAINING SITE

Having a good training site is crucial for your Post-Training Workup and for general training and airtesting. We cannot say how important this is. If you don’t have a site, you won’t be able to train and no matter how good you think you are, you will quickly suffer skills fade and run much higher risk of accidents when you do start to fly. Let’s look at some of the basics requirements for choosing a good site.

Requirement 1. The training site should fulfil legal and airspace requirements for UAV flight, and protect the public at all times.

The aircraft will at no times be closer than 150 metres to any built up area during its flight.
The training area is not in airspace that prevents unmanned flight (even though it may permit Remote Control flight). In UK and most European countries the UAV should only operate in type G airspace.
The pilot must at all times be satisfied that the UAV would be able to stay within these parameters during flight (particularly important with new or inexperienced fliers and during airtests).

Ideally the training site should not be situated in a built up area (ie within the boundary of a town or city unless there is at least 750m clearance in all directions from the pilot).

Requirement 2. The training site is free of dangers that would risk the UAV or persons in its path.

Check for things like the following and consider “what would happen if the UAV got close to, or landed unexpectedly here”. Dangers become more significant the closer they are to the proposed landing site. (ie within 150m of the landing site). Consider risks from the following:

Woods and trees
Pylons and wires
Railways, motorways, roads and tall hedges
Houses, villages, farms and barnyards
Rivers, ponds, lakes, areas of water
Fields with livestock (cattle, bulls, sheep etc)
Crops that would “Swallow” the UAV and make it invisible after landing

Requirement 3. (Visibility of the UAV at all times throughout the flight).
The training site is a large open area where there is a clear view of the sky and of a UAV flying at a minimum of 200 feet, unobstructed by objects.

This can be harder to achieve than expected and indeed might not be fully possible. But consider that if your previously planned flight track has to be changed because of wind and if your UAV has to turn the “opposite” way to that expected at a waypoint then where is it likely to go and will you see it, especially when it is on it’s landing circuit.

It’s easy to say to yourself “it’s not a problem if it dips behind a row of trees; I won’t worry”. In reality when this happens it is very worrying and the pilot has effectively lost his control of the aircraft - he would not be able to fly it out of any dangers if he wants to.

Trees and buildings are typical objects prevent good VLOS. Please take time to understand the following:

**Obstacle Clearance angle.** The angle measured from the pilot’s position that an obstacle must be below, in order to guarantee safe passage past it by a UAV.

**UAV LOS Angle.** The angle measured from the pilots position that the UAV is planned to take.

**Adjusted Minimum UAV LOS Angle.** The angle measured from the pilots position that the UAV could possibly take during its planned (or unplanned) route, including dips after altitude changes and air-current induced altitude changes.

In the following diagram each of the angles is explained. A UAV (at 400ft height and 500metres range) is planned to be on the “UAV LOS Angle”. However it could be as low as the “Adjusted Minimum UAV LOS Angle”. However the UAV is always visible and well above the “Obstacle Clearance Angle” for an 80ft tree at 500metres from the pilot.

However a tree that is 100 metres from the pilot has a much larger perspective and might block visibility of the UAV.
In the next diagram it is assumed that a QuestUAV is flying at 200ft on an approach to land. The pilot is conducting the “Standard Landing Circuit.” Whereby the UAV is brought in on a finals approach at 200ft.

It now becomes clear that at this lower height that visibility of the UAV could be obstructed by a tree 250 metres away from the pilot, and will definitely be obstructed by trees within 100 metres of the pilot.

Here is a schematic diagram of eighty foot trees at a range of 100metres and 500 metres from a pilot, shown to the perspective of what the pilot would see.

It is clear that the closer the obstacle the more it will block the visibility of a UAV from the pilot.

So it is possible to deduce a rule as follows. “Knowing that a UAV has clearance for safe flight above an obstacle does not mean that the UAV can be seen behind the obstacle, if the object is closer to the pilot”. 
REQUIREMENT 4. (Freedom from the UAV hitting obstructions throughout its flight). The Training Site should ideally have a 600m radius from the pilot where the UAV can fly clear and above obstacles/terrain and practise landings in a safe and suitably large area.

Remember that visibility is not the same as obstacle clearance. Just because the UAV is visible it does not necessarily mean that it will have obstacle clearance as it flies around the training site.

It is important to look at the whole area you expect to fly over, and further. Work out the following:

- Will the UAV always be visible, even if it takes a different turn to that expected?
- Will the UAV always have ground and obstacle clearance? Even if it doesn’t follow the expected track?
- Will the UAV have good visibility and obstacle clearance right through its landing circuit?

A UAV starts its approach at, typically, 200 feet and then descends in a forward motion through 150 feet, 100 feet, 50 feet until it lands and if any objects are in the way of that approach the UAV might become invisible to the pilot or the UAV might crash into it. So it is really important to choose a training field that does not have such obstacles (trees, buildings, people, vehicles, pylons, high ground etc) in the approach and landing area.

Changes in terrain height, even if small (two or three degrees as a result of gently rising ground) can have a significant effect on ground and obstacle clearance at distance. Such changes can be difficult to spot by an inexperienced pilot, but they mean that a UAV could be closer to the ground than expected. If there are trees or buildings on the approach path then clearance is reduced further and could cause reduction in UAV visibility or even impact with that object.

USE OF PARACHUTE DEPLOYMENT

Many QuestUAV systems have a parachute landing capability. Whilst this removes the need for obstacle clearance during landing, good operating skills needs the clearances described above for normal landings to be practised.

Requirement 5. The training site is reasonable close to the area/building/business/university that you will normally operate from.

This means that a training site that is ten minutes drive away is much better than a site that is two hours drive away.
Article 18: USING REMOTE CONTROL (RC) PILOTS

Whilst we stipulate that for the warranty to be valid, only manufacturer trained pilots and commanders must fly QuestUAV aircraft, in some situations and on foreign operations, it is not always possible to use a fully UAV trained pilot for a mission involving a typical two crew setup (Pilot and Commander). Provided an operator is willing to accept the warranty limitation then an alternative is to use a person who has good remote control flying experience for this temporary job. This pilot, if chosen well, should have been a member of a flying club, possibly for years, and have built up a large number of flying hours on a variety of different aircraft.

We do recommend that having an RC pilot on hand can bring a wealth of much needed experience to a new UAV crew, developing general flight awareness and maintenance procedures. There is a caution though. Flying a fixed wing UAV is different to flying an RC aircraft and the RC pilot might not spot this. There are a number of points to be aware of when placing an RC person in charge of piloting a UAV for the first time.

Firstly a UAV, such as a QuestUAV, has high wing loading and is designed for optimum endurance and safety rather than the manoeuvring or the aerobatics that an RC pilot aims to master. As a result a UAV is generally operating in a very small area of the flight envelope and is optimized for its performance in this area. An RC aircraft is normally different in design, with a lower wing loading, making it more forgiving than a UAV of high speed, low speed and high angles of bank. As a result an RC pilot is naturally predisposed to expect a UAV to have a greater performance than he is used to, and this can cause trouble. It is not unusual to hear a pilot say “wow this UAV handles really well” and then run into difficulties!

Furthermore due to the nature of an RC aircraft providing enjoyment (rather than safe payload carrying for a UAV) this also predisposes an RC pilot towards displaying skills and expertise over a different set of operating criteria that a UAV requires. A UAV requires more planning, an awareness of the new systems in the flying operation, and a greater awareness for contingency planning rather than the skill of an RC pilot flying an aircraft out of a potential problem.
If there is a mode change required (on the transmitter; which stick has throttle and which stick has roll) then the pilot may feel that learning a new mode will risk the whole fleet of his own aircraft if his brain accidentally latches on to the new setup when he returns to fly his own aircraft. He will also be very aware that his skills in Mode 2 will be slow and limited, and be reluctant to receive the assurance that this is not a problem when flying a UAV (in fact the UAV does most of the work and an autopilot keeps the aircraft stable rather than the pilot).

An experienced RC pilot normally exudes an air of confidence. He is, quite rightly, the master of his skill in front of a crowd of other fliers and used to receiving the respect he is due as a result of his long term investment in his hobby. However, when he no longer has control of a UAV because it is operating in automatic, and it is a little speck on the sky at a distance he has never operated to, and it is a very expensive aircraft, and he is flying in a different mode, unsure of how correct his natural reactions will be, and feeling very aware of how he will be viewed by onlookers if this aircraft crashes whilst under his control, his confidence will most likely suffer and possibly suffer quite a lot. The natural reactions will be to bring things back into his comfort zone by wanting to change to Mode 1, or wanting to fly the aircraft in his “style” and or wanting to make suggestions as to how to improve the aircraft and its performance. It needs careful handling.

Finally, an experienced RC pilot is used to flying at a regular flying site where almost all the dangers are known and there are strict operating procedures in place. There is a hierarchy of skills and egos and rules, both written and unwritten, to protect the flyers, the public and the club. On a typical UAV mission none of this support network exists, leaving the experienced RC pilot less assured of what should and should not happen, and what risk can and cant be taken in an area that has not been passed with such care as his normal flying site.

In short, the UAV experience may de-skill him in the sense that he feels like a novice all over again (which he isn’t, by any means), and this sense of insecurity can cause significant problems for a crew that have to be dealt with through careful choice and discussion rather than knee-jerk reactions that demand changes to the UAV, transmitter/controller or operating systems. A simple awareness of the challenges brought to the pilot through a document like this can invariably prepares a pilot for a successful changeover to UAV operations.

Here are five primary issues to overcome;
1. Expecting an experienced RC flier to willingly understand that flying a UAV is different to flying an RC aircraft.

Okay, slightly tongue in cheek here, but experienced RC pilots have been doing their stuff for years on remote control aircraft and are generally unwilling to accept that flying a UAV should be any different to any other unusual aircraft they have flown. However the UAV scenario is different though and it requires a little humility, a little time and plenty of talking with the Commander to understand and respect the differences. Without this knowledge the whole UAV system could be at risk. Sharing this document should help.

2. Letting an experienced RC flyer become the person in charge.

As the Commander, you need to keep in charge. Hold a good preflight brief, listen to the RC pilot’s advise, but keep it framed in your UAV knowledge. Don’t be bullied. Don’t let the Pilot deviate from the plan without good cause and ensure that the dialogue Commander-Pilot-Commander keeps up. An experienced RC pilot is used to ALWAYS being the person in charge, so this might cause friction. Be ready for it.

3. Letting an experienced RC convince you that changing away from Mode 2 is the only solution.

It isn’t and can cause many problems in the future. Analyse why the pilot is reluctant to do this and suggest a simple training flight to find out that it is okay to fly this way with a UAV.

4. Letting an experienced RC flyer demonstrate his flying skills on the UAV.

This WILL end in disaster. The UAV needs to be flown very gently, smoothly and considerately. The fact that it flies well does not mean that a relatively heavy aircraft can be put through its paces, in any way. Many aircraft have been badly damaged through this assumption, especially at the end of a mission when everyone has relaxed a little, the aircraft has yet to be landed, and the pilot wants to demonstrate his skills, if only just a little. Reserve Manual mode for later missions when the piloting skills really are there.

5. Letting the experienced RC Flyer convince you that the UAV is underpowered.
This is a regular scenario that we end up with. A new customer has taken his UAV home and has (wisely) called on the assistance of an experienced RC pilot. This pilot then looks at the UAV and says “that is underpowered, the motor is too small and the propeller is too small”. This is especially the case if there are launch issues or climb issues that are not related to power. The customer now thinks that we aren’t as experienced as we would like to show and starts to try and educate us with performance programs that can be found on the internet. The answer is that in comparison the UAV is, size for size, less powerful and the reason is simply for greater endurance. A UAV does not need the kind of performance that a RC aircraft does and so is finely tuned to the minimum power requirement.

Having taken these points on board an experienced RC pilot can be a huge asset. With all this in place, and if of course it is legal to allow an unlicensed pilot to fly your UAV, then all should be well and you will benefit from the wealth of experience this person has.
Article 19: How To Get A UAV (RPAS) Operators Licence in the UK

In order to operate a UAV (or Drone or RPA) in many countries around the world, a UAV operator must possess a valid UAV operator licence to prove that they have the required level of competence to operate a UAV correctly.

For the purpose of this article we are focusing on the general overview of what is involved in obtaining a UAV operator licence in the United Kingdom, including what subject matters they cover (and should cover) and why it is important to be fully proficient in these areas before conducting full flying operations. Whilst there are many phases to the whole process (listed below) the main ones we will deal with here are from Initial Training (including Manufacturer Training) right through to eventual issue of a license from the Aviation Authority.

Note that the Aviation Authority (eg CAA) is a different body to the test Centre (eg Resources group)

The full list of phases from “Zero” to “Hero” are as follows:

- Decision to purchase UAV, including likely method of Certification (NQE) to be used
- Purchase/delivery of UAV
- Initial UAV orientation / Initial Training / Manufacturer Training
- Initial Application to NQE
- “Work-Up” Training (Training done on candidates own grounds)
- Theory Exam
- Practical Exam
- Receipt of Test Centre Pass
- Application to Aviation Authority
- Issue of “Approval to Operate” by Aviation Authority (valid one year)

Initial Training
Prior to even applying for a licence it is important that a candidate has initial training to become competent and safe with their UAV. This is similar to a new car driver going through their pre-test driving experience. This could be through formal training, similar to QuestUAV training, or through the assistance of other UAV fliers who already have a good understanding of the skills and requirements for passing the formal license. We recommend a tailor-made manufacturer training course which is specifically designed to their operational UAV as this is a process that has been carefully prepared with a view to address the majority of the challenges that a rookie pilot will come across. A good training courses should cover preparatory work where crew member undergo training in flying preparation, flying, maintenance, air law, flight planning and basic post processing. A good course will conclude with a flight test, issue of certificate and the completion of a logbook that will provide evidence of the hours and the competencies that a pilot has completed.

QuestUAV currently offer 2, 3, 5 and 10 day training courses which is specifically tailored to the operations of our UAVs. We ensure that every aspect of being fully operational is covered in our courses. We also offer advanced training in foreign countries for candidates wishing to take their operations to the next level. More information on our training courses can be found here or please email info@questuav.com or call +44 1665 479 042 to discuss requirements.

Undergoing A UAV Licence

Once initial training is in process the candidates should do their own research into choosing an appropriate testing centre. Most test centres should cover a wide range of subject areas in their curriculum to ensure all operators have a firm grasp of what is involved in operating a UAV safely. In the UK study areas tend not to vary greatly from test centre to test centre as they are controlled by the government aviation regulators called the Civil Aviation Authority (CAA) (in the United States it is the Federal Aviation Administration (FAA)). So when researching into which test centre you wish to undergo, make sure it ticks the following boxes:

1. The centre is a reputable test centre that works alongside an aviation regulator such as the the CAA or FAA.
2. The licence you will gain is a recognised document to these aviation regulators.
3. The centre provides all study aids and/or references to study aids to their candidates.
4. The course covers both theory and practical assessments.
Optional benefits may be as follows:

5. The licence you gain has a potential to be recognised globally (not essential but worth having).
6. The centre can approve and certify your chosen operational airframe of airworthiness if this is required in your country.*Please note - we recommend you look into your own country’s requirements for certification of airframe airworthiness. Currently this is NOT a requirement in the UK for sub-7kg UAV’s.

The purpose of assessment is to ensure that the operator can demonstrate the required competency to operate a specific UAV. The reason that the licence needs to be specific is that there are currently so many different UAVs available on the market offering a wide range of differences in operation and design.

**UAV Theory Assessment**

The theory part of the assessment should be designed to give the candidate a firm grasp of UAV operation fundamentals, this should include subject area such as aviation safety (Flight Safety), Air Law, aircraft and operational planning, communications, meteorology, navigation and map reading and operational procedures.

This part of the test is normally a multiple test paper where each of these subject areas are covered in the exam. All this information should be provided in your study aids, and through documents easily accessible on the internet.

**UAV Practical Assessment**

Normally once the candidate passes their theory assessment they are then allowed to proceed onto the practical assessment. This may happen immediately after or a number of weeks or months after the Theory Assessment.

The practical assessment usually consists of 2 parts, an Operations Manual submission and a practical flying exam. The candidate needs to submit an Operations Manual prior to any flight exam, this then needs to be approved by the examiner before any practical exam can be carried out.
The Operations Manual is a specific document written by the candidate in accordance with the layout chosen by the test centre or national operating authority (like the CAA or FAA) guidelines. The Operations Manual describes in detail how the operator will conduct their flying operation from storage, UAV maintenance, battery maintenance and charging right through flying operations, pre-flights and accident/incident management.

The Operations Manual will be examined and commented on by the test centre and may require a degree of re-writing prior to approval. Once the Operations Manual has been approved, the candidate will then book and undergo a practical exam. Due to the wide variety of aircraft types, the examination of either fixed or rotary wing aircraft tends to be generic where the examiner will vary the content of the exam to suit the type of aircraft that is being used. Subjects such as aircraft preparation, pre flight checks, take off, documentation, flight operations and emergencies will be tested. For operations regarding teams of two to operate (ie Pilot and Laptop Commander) an assistant should be allowed to participate in the exam.

The practical exam is designed to ensure that key elements required to operate a UAV are understood and demonstrated in a safe manner. This also includes covering aspects of the theory test in a practical manner.

**UAV Airworthiness Assessment**

An airworthiness assessment is not essential in many countries (including UK for UAV/RPA below 7kg weight). However it might be a consideration if you want to operate in a country that requires an Airworthiness Certificate (such as the Netherlands) then a test centre that provides this assessment will help you achieve these more rigorous requirements. This step also helps educate the operator in understanding what an “airworthy condition” aircraft looks like.

An Airworthiness Certificate may also come from a manufacturer that has carried out a specific assessment on the individual UAV in question. QuestUAV can provide such a document on request.

So for general operations in UK an Airworthiness Certificate is not necessary, however for some foreign countries where it is mandatory, and or for tasks where Flight Safety carries an especially high requirement, an operator should seriously considers whether this part of a licensing scheme is appropriate.
Completion Of UAV Assessments

Once the candidate successfully completes and passes all assessments they now have the official documents to prove that they are competent in UAV operations, and can apply to the countries aviation authority (eg CAA or FAA) for a “permission to Operate”. This process will require submission of the license provided by the test centre, evidence of adequate insurance and a fee to cover administration costs. Once sent off, the process can take up to two months to complete and finally receive a “Permission to Operate a UAV”. This will be valid for one year.

As part of operating as an UAV, the operator it is required to keep and maintain a UAV logbook of all flights they have undertaken including flight hours as evidence of their operations. These logs are usually also stored with the awarding body so that the operator can be subjected to re-examination if they are not attaining enough operational hours to ensure they maintain their operating skills and knowledge.

As well as on going flight logging, the operator may need to prove that their UAV remains airworthy (if their country of operation requires this). If required this is usually done on annual basis where the operator undergoes the Operations Manual resubmission again. If an Airworthiness Certificate has been awarded by a test centre, then a new Airworthiness Certificate must be undergone if the UAV has been modified from the original Operations Manual (which is most likely) and an updated Operations Manual must be submitted too. Note that this can be a costly and lengthy process if it is not really required. As a Manufacturer we can issue a Manufacturers Certificate of Airworthiness that is generally a simpler process, though you will need to check as to whether this is an acceptable level of documentation for the Approval centre.

QuestUAV have years of training and assessment experience, for more information on our training and testing services please email info@questuav.com or call +44 1665 479 042 to discuss your requirements.

Some Words Of Wisdom.

1. The whole process takes longer than is normally anticipated. We suggest from first inquiry as to “I want to fly a UAV and become Certified” the average time is at least six to eight months from inquiry, through purchase, manufacturer training, own training and experience building, Test Centre application and Testing, then CAA approval. Beware of advertising that alludes to “Operational within two days” or similar.
2. Don’t always take the test centre’s advice as hard truth. A test centre wants to achieve the highest standards and maximise their income. What they claim is essential may not always be required by the final approving authority. Check with the likes of the CAA as to what is really required.

3. Do not underestimate the requirements for pre test centre training. Would you go straight for a car driving license without driving a car first? Definitely not. Work out how you are going to do your “Work-Up” in a safe manner and who, if anyone, will be your guide during this period.

4. One of the big issues that candidates come across is the issue of insurance. Invariably insurance will not be issued until a Test Centre pass has been achieved. It takes careful planning as to how you achieve your “Work-Up” phase without this insurance. Sometimes the Manufacturer Training (and pass at this level) is sufficient to gain insurance.

5. A Work-Up phase requires a safe area to practise at clear from as many dangers, people and property as possible. QuestUAV takes its customers through risk assessments for such areas.

6. Training may be “crew training” rather than just “pilot training”. For example QuestUAV recommend that a minimum of 2 persons are used for safe operations - a pilot and a laptop commander. Don’t let this become a surprise during the initial stages of an application! Again, manufacturers will allude to minimal requirements (ie single operator), but years of UAV experience testifies to the fact that a 2 man crew is much safer than a one man crew for anything other than the most basic of operations.
Formal Training with QuestUAV

Our training happens in two formats. The first is training at our location in Northumberland in UK. The second is training in the clients country, wherever that may be in the world.

All clients that undergo QuestUAV training will prepare themselves by doing the Training Work Packages (also called pre-reading).

Training in Northumberland, UK.

Typically we run a two day, three day or four day course depending on client requirements and language skills. For courses where there is a language barrier, we may request that the course be extended by one day to help with a slower knowledge transfer. The spoken language will always be English.

We are fairly simple to get to by car, train or air. Newcastle airport is 30 minutes away from us and Alnmouth train station is 15 minutes away. The A1 is also 15 minutes drive from us. More details are on our website.

We also have a good range of accommodation in the area and there are plenty of restaurants for an evening meal.

Training Abroad

It is possible to receive training in your home country. Following suitable discussions with QuestUAV staff, This will depend on staff availability and security within your home country. Such a course will always consist of five or more days, excluding travelling time for the instructor(s).

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