L2 - Unit 4 - The Development and Deployment of Unmanned Vehicles

Relevant LINKS

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Overview

The Development and Deployment of Unmanned Vehicles at Gold Level requires the candidate to research and report on the number and variety of these vehicles (land, sea and air etc) and the range of different types and functions. Once they have researched these different types, they can then evaluate the different designs and materials used and discuss any issues that result from this. The candidates can investigate and comment on design issues of unmanned vehicles and offer possible solutions and modifications. The candidates also need to show a good understanding of the many legal, moral and ethical issues that surround the use and development of this technology.

A work activity will typically be 'non-routine or unfamiliar' because the task or context is likely to require some preparation, clarification or research to separate the components and to identify what factors need to be considered. For example, time available, audience needs, accessibility of source, types of content, message and meaning, before an approach can be planned; and the techniques required will involve a number of steps and at times be non-routine or unfamiliar.

Example of context – using some design software and hardware (i.e. a 3D printer) to design and / or build a an unmanned vehicle for testing. The final design could be a series of drawings and not necessarily be built, but with detailed guidance of what each part is made from and its purpose.

Example of work at this level (coming soon)

Assessor's guide to interpreting the criteria

General Information

RQF general description for Level 2 qualifications

- Achievement at RQF level 2 (EQF Level 3) reflects the ability to select and use relevant knowledge, ideas, skills and procedures to complete well-defined tasks and address straightforward problems. It includes taking responsibility for completing tasks and procedures and exercising autonomy and judgement subject to overall direction or guidance.
- Use understanding of facts, procedures and ideas to complete well-defined tasks and address straightforward problems. Interpret relevant information and ideas. Be aware of the types of information that are relevant to the area of study or work.

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- Complete well-defined, generally routine tasks and address straightforward problems. Select and use relevant skills and procedures. Identify, gather and use relevant information to inform actions. Identify how effective actions have been.

- Take responsibility for completing tasks and procedures subject to direction or guidance as needed.

Requirements

- Standards must be confirmed by a trained Gold Level Assessor or higher

- Assessors must at a minimum record assessment judgements as entries in the on-line mark book on the INGOTs.org certification site.

- Routine evidence of work used for judging assessment outcomes in the candidates' records of their day to day work will be available from their e-portfolios and on-line work. Assessors should ensure that relevant web pages are available to their Account Manager on request by supply of the URL.

- When the candidate provides evidence of matching all the criteria to the specification subject to the guidance below, the assessor can request the award using the link on the certification site. The Account Manager will request a random sample of evidence from candidates' work that verifies the assessor's judgement.

- When the Account Manager is satisfied that the evidence is sufficient to safely make an award, the candidate's success will be confirmed and the unit certificate will be printable from the web site.

- This unit should take an average level 2 learner 40 hours of work to complete.

Assessment Method

Assessors can score each of the criteria N, L, S or H. N indicates no evidence. L indicates some capability but some help still required. S indicates that the candidate can match the criterion to its required specification. H indicates performance that goes beyond the expected in at least some aspects. Candidates are required to achieve at least a S on all the criteria to achieve the full award.

Expansion of the assessment criteria

1. Understand the history and range of uses of UVs

1.1 I can research the history of UVs and list the key milestones.

Candidates should be able to show an appreciation of the development of UV over time.

Evidence: Documentation in portfolios, assessor observations.

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Additional information and guidance

The majority of UV are called “drones” and this is the popular perception of these devices. The term itself is rather loaded and emotional and most people would associate this with weapons that are used in war. Though the majority of UV are used in a military setting, it is not the only use.

Various starting points are cited for UV, with the earliest being the use of hot air balloons filled with explosive being sent by the Austrian army against Italy. Using that example, the same could be cited for the flaming ships which were launched against enemy fleets in various wars from ancient Greece onwards. In the 1930s, something more akin to what we would understand as a UV was used by the British Navy. They had radio controlled planes that were used by the military for target practice, a system that was copied by the US military around the same time. These were more like the UV that we would understand in today’s marketplace. These target vehicles continued to evolve but by the time of the 1970s they were beginning to carry surveillance equipment and be used to gathering intelligence in battle zones. These intelligence gathering UAV are widely used to this day.

Since the early 2000s, many UAV have been developed to be weapons to either be delivered as bombs or to deliver bombs and missiles.

The history of Unmanned Ground Vehicles (UGV) has a similar timeline as it has a similar technological need. Remote controlled cars were developed as early as the 1920s. As with UAV, the main developments have been in terms of military use, though there are also radio controlled tractors in agriculture. The latest developments are for unmanned cars and buses which is being explored by a number of countries.

Water based vehicles are relatively new as the technology required, relating to the pressure in the sea, has been harder to overcome. The earliest versions were for underwater recovery in the 1970s and this technology as taken up by commercial companies. The most high profile of these would be in the recovery of resources or for historical interest, such as the Remotely Operated underwater Vehicles (ROV) used to film and document the Titanic wreck or other famous shipwrecks.

Other uses are for science and education as they can be controlled remotely to dive to great depths to collect specimens or in places that are difficult for people, such as under ice sheets.

Candidates can document the history in their own words and give examples of what they think were the major milestones.

1.2 I can list the primary uses of UVs currently in operation.

Candidates should be able to show the most widely used areas of UV usage.

Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

Clearly the military is the biggest user of UV as they tend to be the organisation with the largest budget to be able to afford to research and develop the devices as well as use them. According to this web site: https://www.nationalpriorities.org/cost-of/drones/ [4], the cost of “drones” for the US tax payers are $116,063 per hour! Clearly there are not many companies that can afford that sort of outlay.

Other than the military, the largest user of UV, at least in the US, is for construction purposes.

http://www.devoredesign.com/2015/07/31/for-the-first-time-ever-commercia... [5]

UAV are used first of all to find good land to build houses on, so the land is surveyed and images are taken to look at the layout and the available resources such as water and other elements. Once the buildings are made, they will need to be inspected from the air to make sure they are properly

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constructed. The UAV will also explore the surrounding area to give precise measurements for marketing materials, “only 2km away from the nearest train station” or something similar. The aerial maps can be used in brochures to sell the housing.

UAV are increasingly used in monitoring wildlife. The devices are used as they do not tend to disturb the wildlife as much as people or other vehicles. In the BBC programme Springwatch in 2016, a UAV was used to check the numbers of seabirds on a cliff face for the first time. It was easier to send in the UAV from a boat below the cliffs than to let someone climb down and scare all of the birds away, which would have made counting them almost impossible. UAV are also used to try and track down poachers in Africa who are killing Elephants and Rhinoceroses for their tusks and horns, or even to stop poaching of Orang Utans. The devices can be operated from a remote location so are much more flexible and cause less disruption to other species. UAV are widely used in New Zealand where they are replacements for sheep dogs and they can monitor and herd the millions of sheep that live there.

Even construction is helped by unmanned vehicles. https://www3.nhk.or.jp/nhkworld/en/vod/jtech/2031030/ [6]

Candidates can document the areas that they are interested in and have the most information they can understand.

1.3 I can explore the extended range of uses of UVs.

Candidates should be able to show they understand the most current state of the market for unmanned vehicles.

Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

The usage of UAV, either on land, in the air or in the seas by the military, is probably more developed, but might not get as much coverage due to the emotional impact of their use in war. Here is a list of areas where UV are used extensively, though it is not an exhaustive list.

- Agriculture
- Search and Rescue
- Films and Commercials
- Sports
- Wildlife Management
- Science/Environment
- New reporting
- Real estate
- Mapping
- Delivery
- Monitoring
- Communications

List from: http://diydrones.com/profiles/blogs/examples-of-non-military-non-police-... [7]

Candidates can explore and document some of these areas depending on their interest and career preferences.

1.4 I can describe the use of UVs in civil and military situations and give examples of each.

Candidates should be able to describe in some detail some specific uses.

Evidence: Documentation in portfolios, assessor observations.

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Additional information and guidance

This criterion is an extension of the earlier criteria and allows candidates to go into some detail about the information they have found. If they are interested in the use of UV for wildlife management, can they give some detailed strengths and weaknesses of the use of the device to support their choice. They can provide images to show the devices in operation and perhaps label some of the ways they are used effectively, while also showing some of the limitations.

The military use is obviously a sensitive one because the statistics for their use obviously involve the loss of life. This is unfortunately a reality of this technology which candidates need to come to terms with.

2. Appreciate the design and development issues related to UVs.

2.1 I can describe the range of designs currently in use.

Candidates should be able to show some of the designs currently available.

Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

Candidates can produce a table or a report to list and define some of the main designs used today. The main areas will be related to sea, land and air and if they wish they can cover all of these or some detailed examples of one particular area, for example all of the different designs for unmanned submarines. This criterion will be in conjunction with the next one which looks at the designs in terms of their intended use.

The main aerial designs tend to be either small plane or helicopter based formats, though some of these can have multiple propellers. They can vary in size depending on the range required and what they will carry, which is something addressed in a later criterion.

Most of the land based devices tend to be like small tanks, presumably since this is the most efficient and effective way to travel across any terrain. This is also useful on other plants as devices like the Mars Rover show. Some military devices are experimenting with insect like forms as the multiple legs are less likely to get stuck on small inclines.

The main underwater designs generally tend to be small version of the others. Water can sustain all types of shapes and weights so they are less restricted in their designs, though pressure is a key factor.

It would be useful for students to create a presentation or report of the different designs perhaps showing as wide a range of types as possible for examples. This will help inform them for their own ideas and possible designs.

2.2 I can assess the designs in terms of their use.

Candidates should be able to show they understand the relationship between design and purpose.

Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

In manufacturing terms, devices have to be made for their intended purpose and this will vary greatly. If the designs are for underwater work, then making them from flimsy plastic will be unsuitable due to the immense pressures. Equally, the use of dense metal might make a UAV very strong, but might make it impossible to get off the ground. In some cases, such as with the mars

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Rover, some amount of assumption would need to be made. Although there have been missions to Mars and various probes, there is no way of knowing exactly how the device would respond when actually on the planet and how well the internal devices would work.

In most cases, the designs and materials can be tested with simulation software or through the use of practice environments. This will be easier for land based devices, though it would be difficult to replicate the deep sea pressures that ROVs might face. Air based devices can be tested in wind tunnels for aerodynamics.

Candidates need to pick a variety of devices they have found through their investigations and discuss how they think they work in their intended situations. Do they work well in terms of payload, distance for travel, on-board equipment and other factors? Is there a point where the device needs to be compromised as it can’t carry enough or can’t maneuver well enough? How do you decide what to leave out. Could candidates suggest improvements to a design and justify why they have done this?

2.3 I can assess the main materials used in the construction of UVs and list their strengths and weaknesses.

Candidates should be able to explore devices specifications and look for ways to improve them.

Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

This is tied in with the above criterion. What materials have been used and what properties do they have which make them most suitable. Could other materials be used? If so, why weren’t they used instead. Candidates can investigate some of the material properties, where possible, such as strength to weight rations or cost. Some materials might be difficult to obtain or in short supply, so alternative are used. They may not be as good, but are available.

Even aluminium used in aircraft is considered too heavy for UAV as the weight would greatly reduce their operational range. Therefore, most of them are constructed with composite materials. These are generally some form of Fibre Reinforced Plastic (FRP), though early versions were Glass Fibre-Reinforced Polymers (GFRP). As the technology of materials advances, so does the use in UV increase. The most advanced, currently, is Carbon Fibre-Reinforced Polymers (CFRP). These devices are 5 times stronger than the same element made from metal. This does come at a cost however and they would be 20 times more expensive than using glass fibre based elements.

http://www.azom.com/article.aspx?ArticleID=12234 [8]

The above page has some useful links exploring the future of UV and the materials that make them.

A table listing materials and describing their relative strengths and weaknesses would be useful here.

2.4 I can describe the main forms of UVs based on their use and required characteristics such as range, height, speed and payload.

Candidates should be able to demonstrate a clear understanding of the range of characteristics of UVs.

Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

This criterion could be an extension of earlier ones since it is elaborating on the detail of information about specific types and forms of UVs. Candidates can fill out a report or table listing some of the attributes of the UVs they are exploring in other sections of this unit. The following is an overview

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of areas they can explore.

UAV

For UAV, candidates can explore what the different ranges are and how these are affected by conditions such as temperature and altitude. What can the devices carry, and how does this affect their range, speed and possible altitude. What sort of speeds can they obtain and what are the various ranges of speed. Does the speed affect their functionality so that the faster they go the less they can do. If they are too slow, does it minimise what uses they have, or is this a positive attributes. Part of this is looking at the way technology is moving. Other sections are looking at improvements in build materials, power plants and instruments. All of these should have an impact on their speed and range.

Facebook are currently developing a new UAV called Aquila which is designed to give remote parts of the world access to the Internet. The UAV will fly at an altitude of 20,000m and can stay up via solar power for 3 months at a time.

http://www.bbc.co.uk/news/technology-36855166 [9]

ROV

Are there any restrictions to the depth that the devices can submerge to. If they are attached to a mother ship, this will give them more operational time, but will it limit how deep or how far they can dive. What restrictions are there in terms of pressure they can withstand. The deeper they go, the more need there is for lighting. Lighting requires a great deal of energy, which means they will have to carry more and more or be tethered to a power supply, which will limit their range and depth. What speed can they travel at and how much flexibility do they have. Do they need to be able to travel at great speed.

Some recent developments in underwater UV are based on swarming techniques and are designed for search and rescue in deep water. The devices work like a carpet that scours across the seafloor looking for debris or materials from shipwrecks and plane crashes, as well as resources for mining. The main issue with them is with communication, as discussed in later criteria.

UV

What are the restrictions on speed that are determined by the terrain they need to move across. Are there any restrictions to environment as far as operation. Do they work well in extremes of cold and heat, or can these be adjusted for. If they carry a great deal of equipment, what impact will this have on their range and ability to move effectively.

Candidates can answer some of these questions and their own questions to make sure they have a good understanding of the way that devices can be used in different settings as this information will help inform any designs they might have to make in the future.

2.5 I can describe the software and hardware used in UVs.

Candidates should be able to describe the control systems for UVs.

Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

The hardware used for different UVs is going to either be with someone close to the device or very far away, but the hardware will be similar in what it is trying to achieve. If it is a UAV, there will need to be some sort of hardware system with levers for speeding up and slowing down, as well as moving in different directions. For basic UAV, the overall control will likely be via a visual operation with the control person in sight of the device. More long range devices, especially if they are in dangerous places, will be controlled via an onboard camera which will relay film back to the operation panel for

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action. These devices may well have sophisticated sensors onboard for height and operating temperatures, as well as for control of attached equipment. All devices will have software programs running via embedded circuitry to relay the instructions and carry them out. They will have other hardware such as servos to move wing parts or other attachments.

The explosion, especially in terms of cost of commercial devices, has been helped by the revolution in open source hardware and software. It is now easy to get control software and use powerful embedded systems to carry out sophisticated maneuvers even on hobby based UVs.

The latest UAVs have a sophisticated software called Hydra Fusion which uses a system of simultaneous localisation and mapping. Sme ground based devices have a similar system. In UAV, it works by the device stitching together the video images as they are taken to create a 3D map of the surroundings in real time. This can happen at relatively high speeds and means that the UAV can determine how to navigate complex and unknown surroundings quickly. This is made possible using the same GPU (Graphics Processing Unit) technology that game developers use.

Some UVs can now “think for themselves”. The devices use learning software which allows it to make its own decisions about the correct speed, height and direction etc. The software is also being developed in order to avoid collisions and be able to track specific items such as people or animals.

Further developments are being undertaken in using swarm based simulations. Many people are familiar with how birds and other animals manage to swarm in great numbers and not bump into each other. Tests are currently underway to allow UAV to work together and follow the lead of one UAV for guidance. Tests have been effective with several UAV navigating a wood together.

The Mars Rover has been allowed to “do as it wants” on mars by the team in control of the project. Some software on the device has been enabled which allow it to go wherever it pleases and to use its laser tools to gather data about any rocks that it “thinks” would be useful.

Devices are currently being developed to search in deep ocean places. The main problems here are with maintaining communications. The best option at present is with the use of blue light as this passes through water relatively easily. Radio communications used in other UV does not work in the density of water so well and sound would not work due to the sounds in the sea such as mammals like whales. One solution would be for one of the devices to surface to get information and location information and then re-submerge and transit this information to the rest of the swarm.

3. Explore the problems and solutions of UV usage.

3.1 I can describe the main control methods used with UVs.

Candidates should be able to show the methods of controlling various UVs.

Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

Different types of device will be controlled in different ways. In some cases, they will be controlled with some hand-held device sending radio signals to the device. In other instances, the control will be built in via software to the device itself and a control panel will be set u remotely to control the movements and actions. As with all elements here, a certain amount will be determined by the purpose of the device. For example, in a recent geological survey a small radio controlled helicopter was used to survey a newly forming island in the seas off the coast of Japan. The small helicopter was sent to the volcano in order to photograph and sample the eruption. The survey ship, for safety reasons, was not allowed any closer than 4 km which made it very difficult to see the device to control it, though the control system on the ship was not sensitive enough to deal with landing and takeoff from a rocking ship. The solution was to have a skilled person deal with takeoff and landing using a hand-held controller. Once in the air, the onboard camera was used in order to control the helicopter through seeing what it was doing, as well as other sensors looking at speed, height and

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temperature.

What other types of systems can be used. What are the basic characteristics of control software. Candidates can explore and document some features of control, again depending on devices, and show that they understand that the control needed for an ROV will have some similarities with a UAV, but also some stark differences.

3.2 I can assess the development constraints that apply in building UVs.

Candidates should be able to have an appreciation of some of the manufacturing constraints in their projects or the projects of others.

Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

Most of the constraints that candidates will face wit their own designs are likely to be related to size. Even if they use smart technology such as 3D printers to make their designs, they will be restricted by how big they can make the device and this, as they will know from earlier criteria, may affect the functionality of the device. Looking more broadly, what other constraints might be general to this type of advanced manufacture?

One high profile company used $3.5 million of kickstarter funds to develop and sell a hand sized UAV but eventually had to close before going into production. The main problems they had were buying too much stock and the failure of the hardware and software combination to “scale”. The hardware and software worked well on prototypes but the tolerances used in mass production made them fail.

https://www.kickstarter.com/projects/torquing/zano-autonomous-intelligen... [10]

Are there lessons to be learned from this failure? If so, what might they be.

One other major development constraint, which is addressed in other criterion, is the issue of privacy and safety. While these are more moral and legal concerns, they also impact on the manufacture and design stages of the process. The devices must have some systems to prevent accidents. If the UAV goes out of “line of site” of a controller, it is effectively out of control. If it then ventures outside of safe airspace, the controller is unaware and can’t stop it from becoming dangerous to other aircraft. What mechanisms can be built in to prevent these issues. How can the devices be prevented from snooping on people who have not given permissions. Should there be some way to prevent them taking images without prior authorisation? How would this be achievable?

Other development constraints are related to cost and materials. The latest and greatest technologies are not always available to companies other than government agencies that can afford it and some of the testing required can be costly, especially if it results in many broken prototypes.

There are also considerations to key components such as the propellers and motors used in designs of UAV. What sort of opower will they use, how stable are they, what sort of stress can they withstand for example.

http://www.robotshop.com/blog/en/make-uav-lesson-3-propulsion-14785 [11]

Candidates are not expected to come up with their own conclusions, but are encouraged to read around this topic and offer some sensible suggestions based on their understanding, no matter how basic that might be.

3.3 I can describe the key requirements of endurance and reliability of UVs .

Candidates should be able to describe what features aide endurance and reliability.

Evidence: Documentation in portfolios, assessor observations.

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Additional information and guidance

Any device that is manufactured requires a great deal of precisions, especially with moving parts that create large amounts of friction or resistance. If a propeller on a UAV is out by a tiny amount it will not work well enough and will create wobble and wear, as well as affect the overall performance. Some of the main considerations for UAV are likely to be related to the following, though there will be an overlap with ROV and water based UV

Motors

Most motors used in UV are based on coils and magnets. The magnets are pushed around the inside of a casing as they jump from one magnetic field to the next. This rotation is then transferred to a wheel or a propeller etc. There are different type and sizes of motors available and in designing a UV, these would need to be considered carefully. One very important consideration is how fast the motor will rotate with the amount of voltage available. For UAV, it is preferable to have a lower KV rating of 500-1,000 as this will make the device more stable and easier to control. KV is the rpm per volt. In manufacturing the device, the voltage can be regulated to get the desired spin speed based on this KV rating, so for example:

A voltage of 6.5V with a KV rating of 550 would result in a spin speed of 3,575rpm. Increasing the voltage to 8.5V would be 4,675rpm.

A similar calculation can be made for thrust. Some motors would be rated by saying that a certain size propeller on the motor would be able to lift 400 grams. When designing and manufacturing your devices, you need to make sure that there is enough thrust to get into the air or move across the ground. One thing to bear in mind is that this value is the **maximum** thrust. Therefore, if you build a device that weighs 1.5kg, you really need to have about 3kg of thrust, or the ability to life 3kg, otherwise your motors will be flat out all of the time and will probably burn up quickly.

Propellers

Propellers required are generally two blades and light and small so that they can spin faster and slower quickly and therefore be easier to adjust. This will be useful in trying to fly in confined spaces where precision of placement is important. There is a great deal of complex physics involved in propeller design, but candidates just need to know some of the basic elements, such as the angle of attack, which is how much the propeller is angled down compared to where it is attached to the motor rotor arm. This helps push the air down as it spins. The other important measure is the efficiency. Most propellers are no more than 80% efficient, which means they can’t use all of the power given to them to produce thrust.

The propeller material will be chosen based on how much weight reduction is needed as plastics will be lighter. Some vehicles require more rigid propellers, so wood is used as it will not flex as much. As the propellers spin at very high speeds, it is important to make sure they are properly balanced as they could easily ping away from their mounting and damage the device or people nearby.

Speed Controllers

Mose UV are used in very controlled ways, such as an ROV trying to collect samples of animals in a deep ravine or a UAV flying close to a cliff edge to film a particular bird. In most cases this requires very precise and fine controls of the device. This control is made possible by the connectors which attach the batteries to the powerplant (propeller, tracks etc). The regulation of the power to a device is important, but especially so with a multi-propeller device as a slight variation in the speed of one rotor will dramatically alter the way the device operates. Most UV will have an onboard ESC (Electronic Speed Controller) in order to carry out these precise controls of power to each propeller or wheel etc.

Batteries

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Most UV that are operated at a distance from their operator, or remotely from a far away location, will tend to use batteries for their power. Some can have solar cells, but these are not always practical and possibly unlikely to be used by most students in their designs and use. The majority of UV batteries are made from a Lithium base. These batteries are light but powerful, so perfect for this task. Older batteries were made from Lead or Nickel.

Batteries will be measured in the amount of output voltage they generate and also the overall capacity which is measured in amp-hours (Ah). Most UAV will be able to fly for about 20-30 minutes before the battery runs out. The design consideration here is the more capacity, the heavier the battery pack will be.

Some useful details can be found on this website:

http://www.robotshop.com/blog/en/make-uav-lesson-3-propulsion-14785 [11]

3.4 I can design my own basic UV based on my understanding.

Candidates should be able to show they understand the key aspects of UV by designing one with labels.

Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

It is not expected that all candidates will have the facilities to build their own UV, though this would be beneficial for their future studies. As a very minimum, it would be useful for candidates to design their device, whether on papers or with CAD software, so that they can show they have incorporated some of the understanding from other criteria in the unit.

Their design should show some consideration of the purpose of the device and what it is intended to do, perhaps related to some of the candidate’s research on other similar devices.

3.5 I can describe the features and use of my UV.

Candidates should be able to describe their design’s features.

Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

This is an extension of the previous criterion. There should be some labelling about what the power source will be and what characteristics this will give the device. There should be some idea of the control mechanisms and also some of the limitations of these. The main features should be related to some of the equipment or materials on the design. They might have a multi-propeller design as it will be much easier to control in small spaces as they intend to use it to film in a cave or similar closed environment. They might label and show the specifications of onboard equipment, such as an X megapixel camera to get high definition video of events at the school’s sports day etc.

4. Understand the legal, moral and ethical issues related to UV use.

4.1 I can describe the legal issues relating to UVs.

Candidates should be able to list a number of key legal issues and their main features in relation to UV.

Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

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The legal issue relating to drones mostly relate to the fact that they are able to go almost anywhere. The most obvious example here is that people with small UAV with cameras onboard can easily fly the device around where they live and film their neighbours. This may all be quite harmless, but it is unlikely the neighbours have given their permissions so it is a breach of their privacy. In recent years, as UAV have become cheaper, people have been flying them more and more and going higher. For people that live near busy airports, such as Heathrow or Gatwick, this means going into space reserved for commercial aircraft. There have been increasing numbers of incidents where UAV have been close to or in some cases hit aircraft that have been landing or taking off. The developments of UAV have been so rapid that it is difficult to get laws passed in response to them as the legal process if very slow. Most property law was designed to protect people’s privacy on the ground around their property, but never dealt with the air above their property.

Anyone who takes pictures of people and places will be subject to the Data Protection Act which is designed to protect people from harm. It is fine to film your own family, but you can’t just film anyone. Candidates should be aware of the DPA from other subjects.

If UV are used to film public places, they might also be in violation of copyright laws. If they film a company and do not get the permissions from the company to use the image, they will be breaking this law.

Health and Safety

Other legal issues relate to personal injury. Some of these devices are quite heavy with powerful propellers. They do crash and if they crashed into someone, they could cause serious injuries. One operator of a medium sized helicopter was killed when it crashed into them. How do companies offer insurance to deal with issues such as this?

Another health related issue is that the power cells on UV are quite toxic. If the UV is operated in a publicly accessible water venue and breaks up, it will leach all sorts of poisons into the environment. How can this be regulated and controlled.

4.2 I can assess the main laws and regulations that affect UVs use.

Candidates should be able to show they understand the need for regulation.

Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

This criterion is an extension of the previous one and allows candidates to explore their understanding of the wider issues. Given their understanding of the laws they cited above and some of the health and safety concerns, are the laws good enough to prevent too many issues. What other laws need to be in place to limit some of the potential for damage. Who should be allowed to build and use UV and should they be available to anyone? Candidates should be able to give some examples of how the laws they identified in the previous section can be used to protect people and property, but also examples of where they can be broken, either deliberately or by accident.

4.3 I can review the ethical concerns relating to UVs in a commercial setting.

Candidates should be able to show they understand some of the ethical issues of UV usage.

Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

As with some of the legal issues above, some of the ethical issues revolve around the fact that UVs can go to places where it was difficult to go previously and they can go to these areas carrying cameras. The most obvious moral issue here is with the privacy of individuals. Some UAV are so

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small and quiet that people being observed would have no indication of the fact. Since anyone can obtain these UAV and they are relatively cheap, this means that anyone could use them to spy on other people.

Other ethical concerns could be in relation to ROV as they explore shipwrecks. Most shipwrecks involve the loss of life and usually require permission from the families of those who died before they are observed, but with ROV it is easy for people to visit these sites without anyone really knowing about it.

In the news recently there was an incident with a gunman shooting people indiscriminately in the US. It was almost impossible to stop him and talk to him to try and stop him, so the police sent in a UV device with explosives and blew it up next to him. Many people were upset that there was no chance to find out why he did it or to punish him though the due process of law. Others would argue that he was taking other people’s lives so it was the right thing to do. Was it the right thing?

Candidates can offer examples of their own to illustrate their understanding of some of the moral issues surrounding the use of these devices in a commercial setting.

4.4 I can review the ethical and legal concerns relating to UVs in a military setting.

Candidates should be able to show they understand the main issue around the use of UV in the military.

Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

The use of UV in a military setting is the most widely known and has the longest history. As noted at the beginning of this unit, UV, in this case balloons full of explosives, were used as early as the 19th Century for warfare. Warfare is a messy and dangerous business, and nations have always looked at ways of making the death of their own personnel as low as possible. However, given that war is about killing people, is there a moral case for not using machines to do it for you. If you are desensitized from the output of war, death, does this make more warfare inevitable?

One of the main concerns about the use of UV is their inaccuracy. Despite the claims of the military that they are “precision weapons”, the number of civilians killed by these devices by accident is very high. As with the police example above, is there a need to capture people and make them pay for their crimes in a more just way, such as through prison time, rather than death.

Most international organisations try to protect civilians by laws which state that nations need to be at war in order to carry out any attacks and therefore cause death. However, with the use of UV, most of the targets are in countries which are not at war with the combatants and therefore not “legitimate” targets for attack. What is the legal position in this instance.

One key moral issue is in relation to the gamification of war. In many cases, the soldiers that operate the UV are people that are good at playing games as this is effectively what is happening. They are watching their computer screens and controlling a device many thousands of miles away and “taking out” the enemy. It all seems like a big computer game and has many of the same features. This is probably better than many people dying in a battle, but is it ethically or morally OK?

The cost of using UV compared to a full army on the ground is significant and as more and more of these devices are built, it is more of a temptation for people in government to use them to save money. It takes away a lot of the cost of war but also the impact as there are no deaths on the side of the people doing it.

There are probably other issues that candidates will come across and they just need to explore them and comment on what they feel is the moral or ethical case.

Moderation/verification

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The assessor should keep a record of assessment judgements made for each candidate guided by the above guidance. Criteria should be interpreted in the context of the general descriptors of QCF Level 1 qualifications. They should make notes of any significant issues for any candidate and be in a position to advise candidates on suitable routes for progression. They must be prepared to enter into dialogue with their Account Manager and provide their assessment records to the Account Manager through the on-line mark book. They should be prepared to provide evidence as a basis for their judgements through reference to candidate e-portfolios. Before authorising certification, the Account Manager must be satisfied that the assessors judgements are sound. In the event of missing evidence, the assessor will be requested to gather appropriate information before the award can be made.

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[11] http://www.robotshop.com/blog/en/make-uav-lesson-3-propulsion-14785

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