L2 - Unit 3 - Working with Robotics and Artifical Intelligence

Relevant LINKS

BACK TO AMT UNITS **[1]**

Handbook home page **[2]**

Link	Comment
http://www.techrepublic.com/article/raspberry-pi-and-google-kit-transfor... [3]	Pi based kit to create an AI device to test and operate.
https://consequential.bitbucket.io/ [4]	MiRo development kit. Also has simulation software to test ideas.

Overview

Working with Robotics and Artificial Intelligence at Gold Level requires the candidate to show what AI is and how it works in a basic sense. They need to show some examples of where it is used and how effective it is in these situations, giving their own assessment. They need to look in more detail at these uses and give clear examples of the application in areas such as medicine and agriculture etc. They need to show a good understanding of the workings of robotics software and hardware and evaluate how useful to available tools are for this process. They will need to run their own tests and assessments of robotic and AI systems in order to fully understand their wider application.

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 – modifying an existing robotic device or creating their own one for a specified 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

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information that are relevant to the area of study or work.

- 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. Understanding what Artificial Intelligence is and how it works.

1.1 I can list the the main features of an artificial intelligence.

Candidates should be able to show they understand the basic aspects of AI.

Evidence: Documentation in portfolios, assessor observations.

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Additional information and guidance

The idea of AI goes back a long way in human history, but it is only recently that it has become more realistic and achievable. It is also now debatable about what AI is. For example, is the “intelligent” device that maintains the temperature in your home and gives various alerts an intelligent device?

Are the driverless cars that are now appearing on our roads any less intelligent that the drivers they have replaced? In recent news stories, another milestone has been reached with AI where a computer was able to beat the world champion Go player. Many people have said that Go is far too complex a game for machines to beat people at, though clearly that is no longer the case. Equally, a tablet device interaction system was recently able to call an ambulance and thereby save a young child’s life. Re these examples of machine intelligence or just examples of how subtle programming has now become? Most research into this area is looking at some sub-problems which define intelligence in different ways, of at least some aspects of what we feel is intelligence. These are:

Deduction, reasoning and problem solving

Most people can solve problems by taking various steps, which is relatively easy to replicate with algorithms, but people can also make judgement leaps and reach the correct conclusion even without going through the steps. AI can’t not yet achieve these and the processing power to get near is currently difficult to achieve. The ability to act on probabilities for AI devices will be a large step forward.

Knowledge Representation

Much of what people reach decisions on is based on some very subtle understandings. They understand objects and their properties, the effect of these objects and properties opn other objects etc as well as aspects of time and space. All of these are quite difficult to replicate in a machine working in logical steps. This also has some sub elements:

- Default reasoning - nothing is as simple or true as it needs to be
- Common sense - everyone has millions of little facts to draw on and use and some of these are applied in non similar situations
- Gut feelings - most art critics can spot kafe paintings without checking

Planning

Most of us can plan as we can act on external inputs and collaborate with others to achieve shared goals. Machines often work on a simple path of one action leading to one goal. Even though we don’t know the future, we can act on it. A machine might see 30% chance of rain as meaning there is no need for a coat, but most people would assume that they might be the unlucky one in that 30% zone and take a coat.

Learning

We change our behaviour through our experiences and being told by others. An AI device can not necessarily learn as effectively as it does not have that shared experience, though algorithms can be built to build upon similar experiences and actions to “learn”. Many school based VLE (Virtual Learning Environments) use simple systems to try and give students questions and support based on their wrong answers, which is a simple learning mechanism.

Communication

Many candidates will be familiar with smartphones and tablets that have devices that “talk” to you and many help centres have automated phone systems that take questions and replies and move you through various queues to get to the area you need. How much can a machine actually communicate to us naturally?

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Perception

Many machines are quite capable at speech and visual perception and can have a huge bank of images or sounds available to quickly process the data to get a good response. In many cases, they may be as good as any human. For example, if a computer had every single image of skin cancer known in its database, it may be able to decide if a patch of skin was cancerous or not long before an expert was available.

Motion and Manipulation

Machines are also good at detecting and acting on motion and being able to manipulate objects. How much of this is intelligence?

Social

Many toys these days have the seeming ability to interact with us and display what we would consider emotions. These sorts of AI devices are expected to offer a great deal of relief to elderly people who no longer have close family or friends to interact with. How effective can these be at accurately interpreting a human's state and responding correctly?

Creativity

Most people who study the history of humans cite cave paintings and other decorative objects as the turning point in our intelligence. How much can machines replicate or improve on this?

General Intelligence

Putting all the above together, you have more or less what it is to be human. Therefore, it is the overall aim of AI research to reach this point. Some would argue against this as it is going to render people, in some instances, of little or no value. This then becomes a philosophical issue.

At Level 1, students should be at least familiar with some of these areas of research and development and how they can be used, even in a small way, in their own engineering projects.

1.2 I can describe, with examples, the main uses of artificial intelligence.

Candidates should be able to describe, perhaps by creating a table, the main uses of AI.

Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

It is likely that candidates have come across a number of uses of AI in their lives, and may not even have been aware of the fact. Some have already been listed in the previous overview of AI. Candidates need to list and discuss some of the main features of a number of these applications and focus on the ones that interest them. This could be a useful criterion for inter-departmental collaboration as applications of AI cover most academic disciplines to varying degrees.

The company HireVue [5] uses AI to select people for jobs. The system works by companies giving HireVue videos of their "good" employees and these are then compard via AI with interviewees. The AI system picks up subtle posture and eye changes that interviewing people miss.

https://en.wikipedia.org/wiki/Applications_of_artificial_intelligence [6]

1.3 I can review some of the expectations of artificial intelligence.

Candidates should be able to give some clear details of their chosen examples from 1.2.

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Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

It could be useful here for candidates to put together a presentation of their examples of AI they have found. They can present this to the rest of the group for feedback as it will enhance the entire group's understanding and appreciation of the applications and uses of AI. Hopefully the group will have a wide enough range to cover all aspects. If need be, assessors can chose the areas for candidates to investigate so that the group can come back together and discuss their findings. If any companies local to the centre use any form of AI, this would be a good opportunity to get some hands on experience for the learners.

1.4 I can review the intended uses of artificial intelligence.

Candidates should be able to demonstrate a broad understanding of using AI.

Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

In order to fully appreciate the study of AI, it is useful for candidates to have an understanding of the wide range of uses and also future proposed uses. This overview will help them better evaluate the suitability of designs and uses and be able to make more informed judgements. Probably the closest to their own experience is the use of AI for education. Some companies claim to use AI in a benign way in order to help students learn better. For example, many companies offer maths tutor programs. Some claim that they use sophisticated algorithms to personalise the learning of each student and therefore maximise their results. Candidates can use some of these tools as a starting point to evaluate the use of AI. Do they help them achieve better results. What aspects of the AI make this work. How does this compare to a human teacher. These are important considerations for candidates to explore as we venture further into AI.

In a competition in the US in July 2016, contestants were set the challenge of making software that could fix security problems. The US government is investing a great deal of money in making self-healing computer systems and already Google and Apple use these types of systems to cut back on costs of employing people. When Instagram was purchased it had less than 100 employees, but made billions of dollars. Car companies making the same money 20 years earlier employed hundreds of thousands of people.

1.5 I can identify some of the strengths and weaknesses of using artificial intelligence.

Candidates should be able to demonstrate an appreciation for some of the good and bad aspects of using AI.

Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

Clearly there is a great deal to be gained from the use of AI. It would be hard to dispute the benefits of using AI for checking medical photographs for particular diseases or infections, or the use of AI machines to take away some of the monotony of jobs for people so that they can carry out more meaningful tasks. However, both of these also carry dangers. An over reliance on AI for any task will always carry a certain amount of risk that the AI is not accurate enough and might miss some nuance that a trained expert would see.

Can AI be used to hurt people?

http://www.bbc.co.uk/news/technology-36517340?ocid=socialflow_twitter [7]

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If AI is used in finance to help large companies make lots of money at the expense of others, is this a good use? If AI through Google and other large corporations controls how we get our information, do we still live in a democracy?

Clearly there is a need to understand some of the problems as well as the advantages of AI going forward and candidates need to show a reasonable awareness of the issues.

1.6 I can describe any legal and ethical issues associated with using robots.

Candidates should be able to describe the legal and ethical concerns.

Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

Many people argue that the best way to make sure that AI machines do not harm people is to make them like people. However, one thing history shows us is that humanity is more than capable of extreme cruelty to others, so why would making a machine be like us stop this effect?

There are various laws that apply to AI and perhaps the most famous is from some writing by a science fiction writer Isaac Asimov. His three laws of robotics are:

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.
3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws.

The main thing here is perhaps the intent of the designer. Anyone making a machine using AI is obviously building into the control of the machine their own interpretation of the world. If they build the AI to do harm, then that is what the machine will do, so perhaps it is here that intervention and rules need to be applied. In this instance, the development of AI needs to be open and transparent and therefore open standards and open source principles are perhaps the best to use.

Some of the legal and ethical areas that candidates can explore and discuss include (though are not limited to):

- Rights - should AI machines have the same rights as us
- Privacy - if AI can understand and report on all our conversations, what if it is used by government to control us
- Dignity - should AI devices treat the old and sick, can they be good soldiers or police
- Weapons - should AI by used in warfare
- Ethics - should AI be autonomous and make its own decisions

2. Review examples of where robotics is used.

2.1 I can describe instances of robotics in industrial places.

Candidates should be able to list, with guidance, the main industrial applications of robotics.

Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

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Robotic arms have long been used with some effect in industry. Some of the first robots were used in manufacturing as early as the 1960s, though mass deployment occurred in the 1970s, particularly in japan which today leads the world in the development and use of robotics. Candidates for this criterion need to describe a number of robot applications used in industry, such as in car manufacture or even the automation of book orders from large retail companies. There are plenty of examples to draw from.

2.2 I can review how robotics is used in medical applications.

Candidates should be able to give some examples in their own words of robots used in medicine.

Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

The use of robotics in medicine is relatively new, having first appeared in the 1980s, but it has accelerated in the last 10 years. In 2006 a robot device assisted with a successful heart surgery and was rated better than any existing surgeon. The device had a database of 10,000 operations to call upon in order to work which is more than any surgeon would have experienced. Robots have assisted across the range of surgeries and continue to evolve and improve with feedback. Candidates need to investigate some of these examples and write what they feel about the current status. They could also investigate and comment on the development of nanorobotics which are intended to be injected into patient's bloodstream and be able to fix people at the macro level.

https://en.wikipedia.org/wiki/Nanorobotics [8]

2.3 I can describe how robotics is used in agricultural environments.

Candidates should be able to list, with guidance, the agricultural application and use of robotics.

Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

The main use for robots in agriculture is in the automation of harvesting of crops, but they are also being developed to tackle weeds and other areas. In harvesting, different robotic arms are developed to deal with different fruit and vegetables. Fruit such as grapes are quite delicate and require sensitive robotic arms to cut and collect them without damage. Robotics is also used to automate things such as milking. Cows carry an identification chip in their collar which is radio enabled. As they enter the milking shed, their details are read by the milking machine. They are then cleaned and a laser pinpoints their udders to attach the milking device. According to various farmers the system has increased yields as it is less stressful than human intervention. Other uses for robotic devices are in automated tractors and watering systems. Candidates can choose their own examples and those who live in rural areas may be able to collect direct evidence of this use from their own local farms.

2.4 I can assess the wider use of robotics in society.

Candidates should be able to show other areas of robotics use.

Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

This criterion is an opportunity for candidates to explore the wide range of robotic use outside of the previous more commonly known areas. They can tie this in with other units and look at the use of robotics in space and microsatellites where a robot makes a lot of sense in terms of working in zero

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oxygen and zero gravity. Areas might include robots around the home, such as the robot vacuum cleaners in some homes. They might also explore uses in education and sports. Candidates are not expected to into a great deal of depth, but need to show that they are aware of the wide range of applications and uses of robotics. This will help inform their other areas of study and also any future progression in the field of manufacture.

Some robots are being designed to be companions [9].

2.5 I can assess and comment on the dangers associated with the reliance on robotics in society.

Candidates should be able to show that they understand some of the dangers of using and being reliant on robots.

Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

Candidates in the above criteria will have looked in some detail at the various uses of robots and can now be in a position to think and comment about some of the potential dangers. While some of the dangers may appear in the realms of science fiction, there is an important point here that as robots become more successful at solving problems for us, there is a creeping reliance on them to do that work without supervision. The most contentious developments are possibly in the field of warfare. The US are said to be developing robots to be able to go into battle in order to take away the risk from real soldiers. However, what sort of programming will they receive in terms of life and death. A famous book and film from the
1970s, Westworld (now a TV show), explored this very effectively, though there have been many others.

https://en.wikipedia.org/wiki/Westworld [10]

In this book/film, robots are used to populate a theme park. The real people can go to different worlds and interact with the robots. The most popular is a Western where people can have harmless (for them) shootouts with robot cowboys. As you might expect, the robots malfunction and start turning on their “masters”. This is played out in many books and films, but it plays on real fears of most people. At what point do we over-rely on robots and how can we turn them off when they get nasty.

Are we ready to have robots be teaching us in the classroom?

http://bit.ly/28Y2tDY [11]

Candidates might be able to explore this criterion as part of their PSRE or English lessons, or during tutorials to full appreciate the social context of these technological developments more widely. In the Summer of 2016 the first driverless car was involved in a fatal accident which makes this investigation all the more important.

3. Identify the processes of making a basic robot work.

3.1 I can review the equipment required to design and create robotic devices.

Candidates should be able to show familiarity with some of the tools available to create robots.

Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

In many cases, there will be software tools which come with devices and candidates just need to

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show an awareness of some of their more understandable features. This is an exploration of what is available and centres are free to explore as much or as little as they need in order to give learners the confidence to be able to move forward. Candidates should be aware that robots are designed with software and controlled with software, so a familiarity with a range of tools will make sure they are equipped to investigate the field in some depth at a later date as they continue their studies. Some basic robots might have a hand held controller, but candidates can still explore how this might work and some of the functions that it has and see how it relates to the movement of the robot itself.

3.2 I can assess the design tools used to create robots and use these in a basic way.

Candidates should be comfortable around the various tools used to design and create robots.

Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

Candidates do not need to demonstrate high levels of competence in the use of 3D software or programming languages, but should be able to show that they are aware of the application of these types of systems and applications in robot design and manufacture. This is also a useful point to look at other subjects that support the development of devices such as the use of smart products and design tools. If centres have access to 3D printers they can explore the functionality and usability of these devices and the software design tools that come with the devices. There are open source software and proprietary versions available that can offer either real world control and robots or virtual versions. In both cases, the candidates will gain experience of the process of design and construction. In some
instances, it might be enough to demonstrate to a group how software can be sued and some of the likely end products and as they gain confidence they can explore on their own. Software such as EZ-Builder (https://www.ez-robot.com/EZ-Builder/ [12]) may be a useful starting point, but there are plenty of packages on the market to explore.

3.3 I can work with various components of robot design and appreciate their features.

Candidates should be able to understand the main components and separate parts of a robotic device.

Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

This criterion is deliberately open so that centres can use whatever materials they are comfortable with and have access to. In some cases, centres will have staff experienced with robot design and construction, but in most cases it will be using pre-made kits of devices such as the following or similar:

https://www.intorobotics.com/47-programmable-robotic-kits/ [13]

http://www.robotshop.com/uk/ [14]

These types of systems can be purchased with varying levels of complexity and numbers of elements. Candidates should be able to appreciate that robots are designed to mimic human functions (for the most part) so it would also be useful to see the human equivalent so some overlap with biological sciences and physics would be useful. How does the hip joint work, how do muscles and bones work together to lift weights etc. Understanding these will help candidates better understand what is required in a robot design to make it do similar, but also to see some potential limitations. Most materials that robots are constructed from are not the same as human equivalents so there will always be limitations in something like flexibility and endurance. Understanding these will help students make better quality design decisions in their engineering projects.

3.4 I can build a basic robot for testing.

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Candidates should be able to participate in building a basic robot system.

Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

Many engineering projects involve a great deal of teamwork and people working on their own specific areas of specialism. However, it is only in being involved in the entire process do people really appreciate the project. Therefore, it is good for candidates to be involved in constructing and controlling a robot as part of a team or on their own. Centres should either build a working robot a a class based project, or as small teams, but not discourage students who are confident of their own abilities to work alone. This will ensure that candidates can appreciate all aspects of robot construction, even if they are not involved in individual aspects.
Candidates should also be shown, or have the opportunity, to be able to test out some ideas about a robot's functionality. What changes can they make to the device or the control software and what effect might it have? Did the change have the expected effect? If not, what more needs to be done and what improvements can be made.

4. Appreciate and test the issues and challenges of robotics.

4.1 I can test the build quality of an assembled robot against a specification.

Candidates should be able to appreciate quality control issues in engineering.

Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

In most cases, unless it is an open source project, candidates will not necessarily have a detailed specification about how a device is built. There are open source projects available which are good starting points.

http://www.turtlebot.com [15]

Some of the design features might be protected by intellectual copyright, but they can still see enough details about some of the specifications to discuss and understand with support some of the design features. It may be something relatively easy to see, for example a robot built using a 1st generation Raspberry Pi, as that was available at the time, may be far more effective with a 3rd generation board due to the improvements in processing power and control software. The rate of development in technology is very rapid and many companies will need to move on their designs even though they may find them unsuitable by the time they are ready for market. In this case, their design skills will hopefully win out. The key thing is for candidates to be able to compare and contrast finished products with their understanding of what was intended. They should be shown how to look for design details and match them to available hardware and software, even if at this point in their journey they don't fully understand the intricacies.

4.2 I can test the main features of a built robot in terms of hardware and software.

Candidates should be able to appreciate some of the main features of hardware and software used in robotic products.

Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

Robotic devices, as determined in earlier criteria, are built for specific purposes and usually to

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emulate some aspect of human action. This means that they are quite specific in what they can do and how they can do it. In manufacturing systems, there are multiple robotic arms and each one carries out one small part of the entire process. They can do this with great precision and at great speed, but they can do little else. In looking in detail at some robotic project, for example the TurtleBot listed in the last criterion, candidates can investigate how well the tools are matched. Does the hardware work in all types of conditions, or are there some obvious limitations. If the candidates want the device to do X, can it actually do it with the given hardware. Many people these days use the popular robotic
vacuum cleaning devices. These can be left at home during the day to potter about and clean the house, but they can't clean the stairs or clean the cobwebs lurking in the ceiling corners. What kind of device can be used for this set of tasks? Equally, most robotic devices come with some proprietary software or with an SDK (Software Development Kit). How much knowledge is required to take full advantage of the SDK version? Is the software easy to change and understand? Many robots now use an Open Source Linux based operating systems called Robot Operating System or ROS. This has all the basic functions required to run any robot device, but is open source and community supported which allows people to build the functions they need on top of it easily and cheaply. At this level, it is enough for candidates to be shown some of the answers to these questions and show some sense that they can ask their own questions relating to the equipment available.

4.3 I can make adjustments to a robot build or control system to improve its functioning.

Candidates should be able to list a number of basic changes to a design.

Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

As with 4.2 above, candidates will not be expected to have the sophisticated manufacturing and development skills to be able to recommend precise adjustments, though this should be encouraged, but they will need to show an appreciation that these are possible. It may be enough at this level to work with existing examples in development kits which allow candidates to explore the ideas and see the results for themselves. This will hopefully lead them to begin thinking of their
own adjustments as they start to appreciate how the hardware and software interact and what they can do to modify them.

4.4 I can recommend additional features to existing designs based on usage.

Candidates should be able to identify possible improvements.

Evidence: Documentation in portfolios, assessor observations.

Additional information and guidance

Most of us are sold on the surface features of products and it is only after some time that we realise they might not be as good as we thought in our own situations. For example, some smartphones are made as thin as possible for carrying convenience and lightweight feel, but this means that the structural integrity is compromised and they end up having cracked screens when people sit down with them in their back pockets and they bend. This is probably an acceptable compromise as people value the convenience over the small(ish) chance of the screen damage. It is likely that the designers of this product did not think that users would put them in their back pocket and sit down on them. This is the sort of understanding that only comes about because of usage. Candidates here need to consider some of their own observations that come about in usage and try to formulate some design improvements to try and overcome or at least minimise this. It may be something quite basic or something fundamental, the point is that they think about how they could improve some features. This type of thinking will help them in the future to design better products for manufacture.

Moderation/verification

The assessor should keep a record of assessment judgements made for each candidate guided by

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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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