Unit 2 - The Understanding of Micro-satellite Design and Manufacture

Overview

The overall focus for learning in this unit is to understand the environment and materials required to make microsatellites and to appreciate the overall purpose. It also introduces more of the design and development principles from unit 1 in a different area.

A work activity will typically be ‘straightforward or routine’ because:

The task or context will be familiar and involve few variable aspects. The techniques used will be familiar or commonly undertaken.

Example of context – making a physical or digital model f a simple microsatellite

Assessor's guide to interpreting the criteria

General Information

RQF general description for Level 1 qualifications

- Achievement at RQF level 1 (EQF Level 2) reflects the ability to use relevant knowledge, skills and procedures to complete routine tasks. It includes responsibility for completing tasks and procedures subject to direction or guidance.
- Use knowledge of facts, procedures and ideas to complete well-defined, routine tasks. Be aware of information relevant to the area of study or work
- Complete well-defined routine tasks. Use relevant skills and procedures. Select and use relevant information. Identify whether actions have been effective.
- 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.
- The work in the unit is recommended in order for candidates to have covered enough depth and breadth in the topic to successfully carry out their controlled assessment and take the external exam.

- When the candidate has covered as much of ths material as necessary to complete the controlled assessment element, they may be introduced to the topic

- This unit should take an average level 1 learner 30 hours of work to complete.

Assessment Method

Understanding of these learning objectives will be demonstrated through answering questions related to key ideas and concepts in the terminal examination as well as practical application of their understanding through the controlled assessment.

Expansion of the assessment criteria

1. Understanding why microsatellites are made and the manufacturing guidelines

1.1 I can list some of the current uses of microsatellites

Learners will show a basic understanding of the current field of microsatellites

Additional information and guidance

It should be easy enough to search for information about microsatellites that are currently in use. Learners can compile this data into some sort of table or short report for later criteria that look at other aspects of the microsatellites.

This page would be a good place to start the search:

https://sa.catapult.org.uk/services/ [1]

1.2 I can explain some of the dangers of microsatellites

Learners can investigate and document some possible issues

Additional information and guidance

The most talked about danger at present is the sheer volume of “space junk” as many satellites that have been launched and no longer function are still floating about (currently about 500,000 bits of debris ranging from 2 - several thousand kgs). These devices are orbiting at 28,000 km/h so can cause a great deal of problems to other devices, such as the ISS. Most of these satellites are too small to be a danger here on earth as they burn up on entering the atmosphere. If some “junk” hit some critical satellites used for navigation or flight control, it could have some devastating results.

Some of the other dangers relate to overdependence. If we as a people rely completely on these devices, it makes us quite vulnerable if and when they go wrong.

It is also possible that future devices might use some form of nuclear material to make them power efficient while in space, but launching these could be an issue. If they contain any substances that are poisonous in any way, then if they explode on take-off, this will dissipate the chemical across a wide area via the atmosphere.

1.3 I can list the advances in manufacturing that have helped microsatellite production

Learners will be able to show a number of key manufacturing advances

Additional information and guidance

In terms of our area of interest, microsatellites, there is the corresponding miniaturization of materials and components. Just 20 years ago, a computer would have needed to be relatively large and heavy with a large metal based hard drive for storage. The same power and storage can now be designed around an Arduino and some solid state memory. This sort of processing power and low power consumption devices makes a powerful but very small satellite devices easily achievable. Other advanced, particularly in camera and lens technology makes microsatellites a better option.

Other advances in materials and 3D printing can also be investigated.

1.4 I can list the materials used in microsatellites

Learners will understand some of the materials used.

Additional information and guidance

The devices made need to be strong, light and robust. This should give an indication of the materials required. They need to be able to withstand some of the shock and heat of getting into space and once there, be able to deal with the difference in pressure and temperature.

The following document is a great resource for assessors to find details required about materials builds and other considerations.

https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19690023854.pdf [2]

The key point, as defined above, is strength to weight ratio, but the document also talks about some of the items that are “fit for space”.

1.5 I can comment on the suitability of manufacturing materials and processes

Learners will summarise what they have found in a simple and clear way

Additional information and guidance

In this criterion, learners just need to demonstrate that they understand some of the main constraints on design so if they design their own devices they will not recommend lead as a covering for the device and explain why. They can go into a bit of detail about any manufacturing processes they have come across that are particularly interesting. One key requirement for manufacturing of these devices is they require a completely dust free environment which may be tough to achieve in most situations.

They can create a short report showing their thoughts and reflections.

2. Designing, creating and testing a microsatellites

2.1 I can create some rough sketched designs of a new microsatellite

Learners need to create their own design for a microsatellite

Additional information and guidance

Most designs in manufacturing start out as rough sketches, or “back of a napkin” designs. A very rough sketch, or series of sketches, will allow the learner to start thinking about how their design will look and start thinking about some of the elements that make it up, such as external sensors or thrusters, perhaps some simple dimensions. The better the sketches, the easier it will be to transfer to a digital format.

Assessors may need to work with learners to give them some suggestions for shape and purpose.

2.2 I can label my designs for clarity and explain their purpose

Learners need to make clear designs with functional labels

Additional information and guidance

The sketches will be used to build out designs in a digital way and the more numerous the guidance comments, the easier it will be for the designer. In most cases, a digital designer will take over from someone that made the initial sketches, so it is important to include as much detail as possible about the designs and their purpose. If possible, the learner should include details such as materials used and angles and distances. If they know, they can also include the types of instruments used, such as external cameras or other sensors.

2.3 I can turn my sketches into digital images

Learners can digitise their designs

Additional information and guidance

Learners can use a range of digital drawing tools based on their current skill and the packages available at the centre. It would be useful, from a manufacturing point of view, if they could design something on purpose built software, such as CAD/CAM software, but the key point here is that they can create a digital copy of their initial sketch.

2.4 I can explain the equipment used in my design

Learners will detail the equipment they hope to use

Additional information and guidance

This can be either as part of the original sketches or incorporated into their digital design, but learners need to show what equipment they intend to incorporate into their designs and explain why they are there. They could create a table for clarity.

Equipment	Features	Purpose
Camera	12MP small form camera	Capture images of the Earth’s cloud formations for determining weather patterns
Laser link	Laser based transmission module	Send data back to Earth as quickly and efficiently as possible. Low power use.

2.5 I can include the needs of a potential client in my designs

Learners should be able to sell their idea to a group

Additional information and guidance

Once they have a working design and have explained the various pieces of equipment and features, the final phase is to get someone to pay for the manufacture and launch etc. It would be good experience to pitch their idea to a local business entrepreneur if possible, perhaps Dragon’s Den style, though it is not necessary for this criterion as far as evidence. A simple presentation will suffice. Thy could, if they can find details, include some potential costings of the project and potential clients for the collected data, such as the UK Weather agency.

The assessor can assist the learners by giving them a specific purpose, for example to include a temperature measuring device in order to capture temperature.

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3. Explaining how and why my microsatellite will be used

3.1 I can list the main uses of microsatellites

Learners will research and produce a short list of uses

Additional information and guidance

Most learners will no doubt appreciate that the morning news is accompanied by a weather report for the day and most of the images shown on the map of the UK must have come from somewhere higher than the news centre's building. If learners have used some of the online maps of the earth they will also appreciate that these images came from satellites. However, what other uses are there for the 1,000s of satellites out in space around the planet?

http://satellites.spacesim.org/english/function/index.html [3]

Can the learners think of additional ways a satellite could be used?

3.2 I can explain the data that microsatellites can capture

Learners need to explain some of the data

Additional information and guidance

Using some of the examples from 3.1, the learners can say what kind of data would be captured. As with any computer input, it will be related to light, sound, heat, pressure, moisture etc. Other satellites might be used to detect particles, such as the bursts of particles from the sun during solar flare events. The main data used will be images of the earth, but perhaps focussing on certain key events like the cloud patterns or dryness of the land.

3.3 I can explain, with examples, the features of my microsatellite

Learners will explain their design

Additional information and guidance

Features can include examples of the weight of the device, therefore determining if it is a micro (10 - 100kg) , nano (1 - 10kg) , pico (100 - 1,000g) or femto (10 - 100g) satellite.

What sort of material is it made of and why? How is it powered and what are the advantages of this type of power?

What equipment is it carrying and how does this affect the design or weight?

3.4 I can list the uses for my design

Learners will list some of the ways their design will be used

Additional information and guidance

In simple cases, there will probably be only one main use for the learner's design, for example, they may have a nano satellite that just takes pictures of the clouds. If they have a more complex design with more measuring equipment, this will obviously affects how they explain what the device does or is capable of doing.

3.5 I can explain to a potential client the purpose of my microsatellite design

Learners will explain to an audience what their satellite is capable of

Additional information and guidance

As with all things that are on the cutting edge of design, they tend to rely on someone else to pay for it. Many investors, other than some government backed agencies, will only pay for something if they can get a good return on their investment. Learners need to practice selling their designs to an audience and justifying why it needs to be built and launched. They can prepare a presentation to summarise the main points of their design and especially how it will benefit some company, and therefore, justify the cost of manufacture and launch.

Links
[1] https://sa.catapult.org.uk/services/
[2] https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19690023854.pdf
[3] http://satellites.spacesim.org/english/function/index.html