SQA Advanced Unit Specification

General information for centres

Unit title: Robotics and Animatronics

Unit code: HV5C 48

Unit purpose: This unit is designed to enable candidates to extend their knowledge and understanding of robotics and animatronics as an application area within mechatronics. The unit provides candidates with the opportunity to use sensors, control and actuators to perform functions as part of a robotic or animatronic system.

On completion of the unit the candidate should be able to:

1 describe robotic and animatronic system interactivity
2 describe the advanced input, control approaches and output of a robot and animatronic system
3 construct and evaluate a fast prototype of a practical robotic/animatronic application

Credit points and level: 1 SQA Credit at SCQF level 8: (8 SCQF credit points at SCQF level 8*)

**SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the Framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from National 1 to Doctorates.*

Recommended prior knowledge and skills: It would be an advantage for candidates to have a knowledge and understanding of the basic robotic and animatronic systems, such as covered by the unit HV47 47 Robotics and Animatronics: An Introduction, plus a knowledge of the main areas of basic mechatronics. However entry requirements are at the discretion of the centre.

Core skills: There may be opportunities to gather evidence towards the following listed core skill components in this unit, although there is no automatic certification of core skills or core skills components.

Problem Solving	SCQF level 6
Using Information Technology	SCQF level 6
Numeracy	SCQF level 6
Communication	SCQF level 6
Working with Others	SCQF level 6

Context for delivery: If this unit is delivered as part of a group award, it is recommended that it should be taught and assessed within the subject area of the group award to which it contributes.

Assessment: The assessment for Outcomes 1 and 2 of this unit is combined into one assessment paper. This paper should be taken by candidates at a single assessment event which should last one hour. The assessment paper should be composed of a suitable balance of short answer, restricted response and structured questions covering the content of Outcomes 1 and 2. This assessment should be conducted under closed-book, controlled and supervised conditions.

Assessment of Outcome 3 should be carried out by means of a project involving practical analysis, solution selection, sizing and scoping, iterative design/fast prototyping, testing and evaluation. The project brings together subsystems to do a task and then candidates are required to produce a report of 1,500 words minimum which should be completed in their own time.

Centres should make every reasonable effort to ensure the assignment solution is the candidate's own work. Where copying or plagiarism is suspected candidates may be interviewed to check their knowledge and understanding of the subject matter. A checklist could be used to record evidence of the candidate's knowledge and understanding.

SQA Advanced Unit Specification: statement of standards

Unit title: Robotics and Animatronics

The sections of the unit stating the outcomes, knowledge and/or skills, and evidence requirements are mandatory.

Where evidence for outcomes is assessed on a sample basis, the whole of the content listed in the knowledge and/or skills section must be taught and available for assessment. Candidates should not know in advance the items on which they will be assessed and different items should be sampled on each assessment occasion.

Outcome 1

Describe robotic and animatronic system interactivity

Knowledge and/or skills

- Physical interactivity of a robot/animatronic system
  - feeders/conveyors and importance of position and orientation
  - mobility of robot or animatronic device
  - sensors and actuators for interacting with an environment
  - elements needed to navigate, explore or change an environment
- Informational interactivity with other robots or animatronic systems
  - methods of communication between robots
  - methods of communication with humans
  - different roles of a robot or animatronic system
- Work cell tasks
  - pick and place
  - assembly
  - packing

Evidence requirements

Each candidate will need to demonstrate that he/she can answer questions based on a sample of the items shown under the knowledge and skills items shown in the outcome. Where sampling is used, in order to ensure that the candidates will not be able to foresee what items they will be questioned on, a different sample of knowledge and/or skills items is required each time the outcome is assessed.

Candidates will need to provide evidence to demonstrate their knowledge and/or skills by showing that they can:

- describe the physical interactivities of a robot/animatronic system by showing that they can answer questions based on a sample of **two out of four** physical interactivities of a robot/animatronic system
  - feeders/conveyors and importance of position and orientation
  - mobility of robot or animatronic device
  - sensors and actuators for interacting with an environment
  - elements needed to navigate, explore or change an environment

- describe the informational interactivities of a robot/animatronic system by showing that they can answer questions based on a sample of one out of three physical interactivities of a robotic/animatronic system
  - methods of communication between robots
  - methods of communication with humans (sound, visual, gesture, behaviour)
  - different roles of a robot or animatronic system (substitution, extension/amplification, imitation)
- describe one of the work cell tasks of a robotic system by showing they can answer questions based on a sample of **one out of three** work cell tasks of a robotic/animatronic system
  - pick and place
  - assembly
  - packing

Assessment guidelines

Evidence for the knowledge and skills in Outcome 1 is combined with Outcome 2 and should be provided on a sample basis. Details of the assessment are given under Outcome 2. The evidence may be presented in response to specific questions.

This assessment should be closed book and conducted under controlled and supervised conditions.

Outcome 2

Describe the advanced input, control approaches and output of a robotic and animatronic system.

Knowledge and/or skills

- Inputs
  - sound
  - vision
  - pressure
  - heat and temperature
  - balance
- Control approaches
  - sequenced and prioritising
  - randomised
  - biased/propensity
  - fuzzy logic /neural networks
  - artificial intelligence (AI)
- Outputs
  - DC field motor

Evidence requirements

Each candidate will need to demonstrate that he/she can answer questions based on a sample of the items shown under the knowledge and skills items shown in the outcome. Where sampling is used, in order to ensure that the candidates will not be able to foresee what items they will be questioned on, a different sample of knowledge and/or skills items is required each time the outcome is assessed.

Candidates will need to provide evidence to demonstrate their knowledge and/or skills by showing that they can:

- describe advanced input types for a robotic/animatronic system by showing that they can answer questions based on a sample of **two out of five** advanced input types for a robotic/animatronic system
  - sound (command, speech),
  - vision (coded commands, recognition)
  - pressure
  - heat and temperature detection
  - balance
- describe the characteristics of control approaches for a robotic/animatronic system by showing that they can answer questions based on a sample of **two out of five** characteristics of control approaches for a robotic/animatronic system
  - sequenced and prioritised
  - randomised
  - biased/propensity
  - fuzzy logic/neural networks
  - artificial intelligence (AI)
- describe a DC field motor output within a robot/animatronic system with respect to
  - characteristics (speed, torque, connections)
  - speed control (basic description of pulse width modulation (PWM), pulse frequency modulation) (PFM)) see guidance notes

Assessment guidelines

Evidence for the knowledge and skills in Outcome 2 is combined with Outcome 1 and should be provided on a sample basis. The evidence may be presented in response to specific questions.

The assessment for Outcomes 1 and 2 should be combined to form a single assessment paper. This paper should be taken at a single assessment event lasting one hour and carried out under controlled, supervised conditions and closed book. Such a paper should compose of an appropriate balance of short answer, restricted response and structured questions.

Where sampling is used, in order to ensure that the candidates will not be able to foresee what items they will be questioned on, a different sample of knowledge and/or skills items is required each time the outcome is assessed.

Outcome 3

Construct and evaluate a fast prototype of a practical robotic/animatronic application.

Knowledge and/or skills

- Solution selection
- Sizing and scoping design
- Iterative design and build
- Test and refinement
- Reporting and documenting

Evidence requirements

In any assessment of this outcome all knowledge and/or skills items should be assessed. Candidates are to be given a sequence of tasks for a robotic/animatronic application. Candidates will need to provide evidence to demonstrate their knowledge and/or skills by showing they can:

From the basic functional requirements and task sequence

- analyse the sequence of tasks
- propose a variety of solutions and justify a selected solution
- size and scope a design
- iteratively design and build
- test and refine the design
- report and document the tested design

The robotic/animatronic application must have at least eight different subsystems with at least two input, two control and two output subsystems. (See support notes for exemplar subsystems.)

Evidence of this process will be that candidates will construct a fast prototype such that at least **six out of the eight** subsystems work correctly and complete a report of 1,500 words minimum which includes:

- analysis of sequence of tasks
- proposed solutions and justification of the selected solution
- examples of sizing and scoping of the design
- details of construction highlighting key aspects of fast prototype, build stages and iterations
- test results against given sequence of tasks and subsequent design refinements including discussion of any subsystems not working if applicable

In addition to reporting there is likely to be elements of research and experimentation which will be needed prior to the fast prototyping. The fast prototyping should have at least eight subsystems and it is important to note that the fast prototyping artefact can be considered as acceptable if six out of the eight subsystems work correctly.

Assessment guidelines

The task of carrying out an analysis, design and project build based on bringing together subsystems to do a task will result in various activities. In addition to reporting there is likely to be some research and experimentation which will be needed prior to the fast prototyping of elements. The report of 1,500 words minimum should be completed in the candidate own time.

Centres should make every reasonable effort to ensure the assignment solution is the candidate's own work. If supervisor or technician support has been provided then this should be clearly acknowledged. Where copying or plagiarism is suspected candidates may be interviewed to check their knowledge and understanding of the subject matter. A checklist could be used to record oral evidence of the candidates' knowledge and understanding.

Administrative information

Unit code:	HV5C 48
Unit title:	Robotics and Animatronics
Superclass category:	VE
Date of publication:	November 2017
Version:	01
Source:	SQA

SQA acknowledges the valuable contribution that Scotland's colleges have made to the development of SQA Advanced Qualifications.

For further information, please call SQA's Customer Contact Centre on 44 (0) 141 500 5030 or 0345 279 1000. Alternatively, complete our Centre Feedback Form.

SQA Advanced Unit Specification: support notes

Unit title: Robotics and Animatronics

This part of the unit specification is offered as guidance. The support notes are not mandatory.

While the exact time allocated to this unit is at the discretion of the centre, the notional design length is 40 hours.

Guidance on the content and context for this unit

The purpose of the unit is to develop candidates’ knowledge and understanding of robotics and animatronics as an application area within mechatronics. The unit provides candidates with the understanding of the robotic/animatronic system interactivity and advanced input, control and output stages. It includes a practical fast prototyping project to explore a robotic/animatronic application in a deeper and more robust way than in the unit Robotics and Animatronics: An Introduction.

Allocated delivery times are for guidance only.

Outcome 1 (10 hours)

The aim of this outcome is to provide an understanding of robotic and animatronic system interactivity.

Physical interactivity is the first basic element of a robotic system covered and should be explored starting with feeders/conveyors as a way to physically bring items to a robotic/animatronic system. The importance of position and orientation of presented items is included. Items may travel to a robotic/animatronic system but the robotic/animatronic system may itself be mobile and able to travel to items. The issue of mobility of robot/animatronic devices is covered by considering both wheeled and non-wheeled realisations. Examples of wheeled might include conventional wheels (free or on rails), tracked vehicles (similar to bulldozers), chain or cable systems. Example of non-wheeled might include those with legs or limbs, sledges, floating or airborne. Sensors and actuators for interacting with an environment are covered, not so much as detailed device descriptions but more as their ability to interact by responding, for example, to noise, light or temperature. Possible purposes are then discussed such as the need to navigate or explore or the need to change an environment.

Informational interactivity is covered with first interaction with other robots or animatronic devices. This leads to communication between robots which may be simple electronic signals or more complex protocols or languages. These are not covered in detail but highlighted as an aspect that needs considering. Interactivity and communication with humans is perhaps more complex and perhaps potentially more error prone. Basic sound and visual interaction can be fairly straightforward and it can be argued that complex screen/keyboard dialogue are well developed and known. If, however, the sound or visual is in some way symbolic, as a gesture or suggestion of a behaviour then this is more complex and once again open to error, particularly if signals given are unclear, ambiguous or misunderstood. Some of the more common different roles of a robot or animatronic system are discussed. Substitution (the robot or animatronic system is a substitute for a human or animal or function (toy, recreational, commercial application such as robotic lawn mower), extension/amplification (robot or animatronic system extends or amplifies a normal action (arm manipulator for handling heavy or dangerous loads, micro-keyhole surgery using robot, repetitive character model) or imitation (model answering questions, playing games, robotic footballers).

Finally work cell types are described which covers ‘pick and place’ assembly (putting assemblies together which may involve complex movement or manipulations in addition to just placing items), and packing which may involve a variety of materials and sometimes palletising actions.

Outcome 2 (9 hours)

This outcome considers some advanced input and control stages of a robotic/animatronic system and dc field motor and their speed control.

If the unit, ‘Robotics and Animatronics: An Introduction’ has been studied then candidates will have covered some basic input types for a robot/animatronic systems. Here more advanced input types are covered. The sound types include command and speech the complexity of which varies depending on the size of vocabulary, the number of potential different speakers and extent of training (if any). Again the nuances of speech recognition go well beyond the unit but simple systems to detect speech are available and potentially useable. Vision again has much variation from simple flashed code or colour codes through to complex shape or pattern recognition (not forgetting basic barcodes). Pressure (sometimes known as tactition) is covered and should include mention of both absolute and differential measurement. Heat and temperature (sometimes known as thermoception) detection while not the same are closely related with sensors giving outputs that vary from a simple contact closure through to complex analogue or digital outputs. Balance can be complex using for instance gyroscopic devices but simple pendulums and switches should not be overlooked. Some exemplar input devices or subsystems should be valuable in demonstrating the suitability of these types of advanced input devices/subsystems. When considering exemplar sensors then a ‘Fact-file’ approach could be useful. Such an approach would enable candidates to know some facts about characteristics and realisations which would enable them to identify a sensor or suggest a sensor for a particular application. By its very nature the recorded information may be incomplete, indicative and generalised but the wide range of types of devices could be usefully summarised and made more available for helping in the solution of robotic and animatronic problems. The emphasis should be on practical usage and characteristics rather than detailed technical design or principle issues which is generally beyond the scope of this unit.

Control approaches for a robot/animatronic system should prove quite interesting and best be illustrated by examples of possible applications. Sequenced and prioritised (sometimes known as subsumption) systems are quite common. Sequences abound and where certain tasks are done first or sooner than others then this may result in a delay or sometimes a non-completion of the less prioritised tasks. Candidates may initially consider randomised responses to be mainly limited to games or chance situations but their potential use for exploration and testing should be explained. The concepts covered by biased/propensity then fuzzy logic/neural networks and artificial intelligence (AI) should be discussed with practical examples though once again this is a major topic in its own right and only an introductory explanation of potential issues and characteristics can be covered in the unit. Working through some sequences with comparative decision-making on the basis of some of the above approaches could prove very useful in illustrating the topic.

The only output considered in this unit is the DC field motor.

DC field motors as used with a robot/animatronic system can provide a flexible and cost effective solution. The basic characteristics (speed, torque, connections) should be covered so that candidates learn that field and armature windings can be connected in different ways with resultant changes in speed and torque characteristics eg serial, high starting torque, poor speed regulation and potential runaway gives a good traction motor. A basic understanding of speed control using pulse width modulation (PWM) and pulse frequency modulation (PFM) should be introduced owing to the practical usefulness of these approaches. PWM and PFM should not be covered in depth, some basic practical circuits together with simple graphs and diagramming should greatly assist in communicating this topic — an example might include a basic rechargeable electric drill or screwdriver.

Outcome 3 (20 hours)

Outcome 3 is much concerned with a fast prototype. A fast prototyping here is considered as a technique of quickly producing a basic/skeletal model which demonstrates the key principles of the real thing. This model may be deficient in some aspects but is able to perform with limitations such as power, distance, smoothness, reliability, precision, repeatability, etc.

This outcome considers and practices the stages of a practical analysis and fast prototyping project based on bringing together subsystems to do a task. There should be elements of research and experimentation which will be needed prior to the fast prototyping but the time and effort limitations of the outcome and assessment must be remembered. The fast prototyping should be carried out in about 1 and a half hours so the emphasis is more likely to be on improvised constructions using material to hand or construction kits than on precision engineering, machining and assembly. The use of commercial 'engineering kits', technical toys, scientific tools or construction kits should be encouraged owing to the speed with which ideas and concepts can be proposed, built, explored, characterised and modified. The use of pre-designed or constructed modules should also be considered provided their basic function, characteristics and limitations are understood by each candidate. For learning and pragmatic reasons the use and reuse of subsystems and equipment should be explored provided the exercise does not end up as a reconnection of previous attempts or solutions but has sufficient novelty and innovation aspects.

There is the statement that 'the fast prototype should have at least eight subsystems and it is important to note that the fast prototyping artefact can be considered as acceptable if six out of the eight subsystems work correctly'. The choice of six out of eight is because there are many factors outside a candidate's (or supervisor's) control, which may impair performance. The emphasis should be on the need to concentrate on understanding what is occurring and potential issues rather than chasing elusive performance which may well be unachievable within the limitations and constraints.

The importance of the report should be emphasised as an important record, a reflective exercise and means of clear communication. Sections should be included covering the analysis of sequence of tasks (what should happen when), proposed solutions (more than one solution is required) and justification of the selected solution (reasons which might include cost, availability, performance, flexibility, etc. and may contain ranking tables, comparative tables, cost and availability data, etc.), examples of sizing and scoping of design (why a certain motor size, power source, voltage, type of detector was chosen with calculations), details of construction highlighting key aspects of fast prototype (how was the fast prototype constructed including safety considerations, key building stages, iterative activities) and test results against given sequence of task including discussion of any subsystems not working if applicable (how well the prototype performed (or didn't) and subsequent changes, improvements and enhancements).

The actual detailed topic or problem can be from a wide range of situations and scenarios. Common scenarios include exemplar systems such as line followers with variable activities, responsive animations with variations of triggers and variations of reactions, maze solvers/explorers perhaps requiring a number of different physical means of motion or detection methods, etc. may be appropriate but more diverse scenarios should not be excluded provided they provided a suitable vehicle for learning and assessment. In addition to a new problem, it may also be appropriate to consider the needs to modify or enhance an existing solution and/or to consider part of a larger project being tackled by the presenting centre or by a team of candidates. In the latter case where team participation is considered then all the expected aspects of relative individual contribution, shared work, understanding or whole and candidate's particular part, etc. should be considered and addressed.

Exemplar subsystems could include:

A system has sound detection and light detection so that it detects command and/or light conditions and produces a visual and movement response based on the command content and/or a randomised element such as a musical tune.

An exploring system moves randomly forward by means of dc motors controlling wheels using both visual and audible information sensed to select a path. Information is produced periodically to communicate progress and routing information to another robot that seeks to duplicate the movement.

Depending on other units being studied then it may be possible that more advanced aspects may be introduced or used by candidates to enhance and extend their learning and provide some element of integration of assessment.

Guidance on the delivery and assessment of this unit

This unit has two aspects to its delivery and assessment. The first aspect concerns developing knowledge and understanding which is found within all outcomes and the second is practical exercise and associated reporting which is in Outcome 3. Outcomes 1 and 2 are assessed by an appropriate balance of short answer, restricted response and structured questions. Outcome 3 is assessed by the construction a fast prototype such that at least six out of the eight subsystems work correctly and the completion of a report of 1,500 words minimum with specified content.

This unit should be delivered by a combination of lecturing, group and individual working, and demonstrations. There are important statements contained in 'Guidance on the Content and Context for this Unit – Outcome 3' that describe the role and format of the practical work.

An assessment exemplar will be available for this unit.

Opportunities for developing core skills

Candidates are working in a context which requires that they research and design original robotics and animatronics applications to a specific brief. All elements of the core skill of Problem Solving, namely planning and organising, critical thinking, and reviewing and evaluating will be naturally developed and enhanced. As they seek design solutions they must analyse the sequence of tasks and select and justify appropriate subsystems to carry out requirements while working within available resources and to timescales. Identifying and considering the variables and analysing the relative significance of each before constructing a fast prototype will provide opportunities to develop creative skills to an advanced level. A detailed analysis and evaluation of the final product and all stages of the development process will be a critical aspect of underpinning knowledge and understanding.

Accuracy in interpreting complex graphic information and the ability to calculate, apply and present complex numerical data underpins the competencies developed. Flexibility and an ability to respond to the needs and purposes of the task should be encouraged and developed as candidates undertake the unit. The emphasis of formative work should be on Numeracy as a tool to be used and applied efficiently and critically in design contexts.

Although communication skills are not formally assessed candidates will be expected to research and analyse a range of complex information before undertaking design work. They must also produce and present a 1,500 word written report which should be to standards acceptable in industry, expressing essential ideas, information accurately and coherently. Information should be formally structured, accurate, use correct spelling and punctuation and be effectively presented to meet the needs of purpose and readership. Use of current software to check technical accuracy is good practice. Candidates may benefit from awareness raising on current business communication approaches to dealing with the internal and external customer as a key element in the design process. There are practical opportunities to foster skills in co-operative working and oral communication as candidates discuss proposed solutions and:

- analyse the task and its component elements
- negotiate the nature and scope of goals, roles and responsibilities taking account of all resources including strengths and weaknesses of individuals
- negotiate rules for effective management of the group and task
- demonstrate the use of working methods consistent with available resources
- use techniques to promote communication
- demonstrate and explain methodology to others
- review and evaluate their own performance in working with others

Open learning

This unit could be delivered by distance learning, which may incorporate some degree of online support. However, with regards to assessment, planning would be required by the centre concerned to ensure the sufficiency and authenticity of candidate evidence. Arrangements would be required to be put in place to ensure that assessment, whether done at a single or multiple events, was conducted under controlled, supervised conditions.

For information on normal open learning arrangements, please refer to the SQA guide *Assessment and Quality of Open and Distance Learning* (SQA 2000).

Equality and inclusion

This unit specification has been designed to ensure that there are no unnecessary barriers to learning or assessment. The individual needs of learners should be taken into account when planning learning experiences, selecting assessment methods or considering alternative evidence.

Further advice can be found on our website www.sqa.org.uk/assessmentarrangements.

General information for candidates

Unit title: Robotics and Animatronics

This unit has been designed to help you to learn more about robotic and animatronic systems in an engineering context. The unit has been designed to be interesting, challenging and potentially fun!

The unit builds on general understanding of mechatronic systems and topics which are covered in the unit Robotics and Animatronics: An Introduction. If you have not got such a knowledge then it may be advisable to explore the possibilities of studying those topics before embarking on this unit. Discuss this with your centre’s representatives if you are unsure about this. The unit has theoretical, application and practical aspects.

The issue of interactivity is explored first. Physical interactivity covers how items can be brought to a robotic/animatronic system and this is followed by looking at how a robotic/animatronic system may itself be mobile and able to travel to items. Other aspects of interacting with an environment are next covered together with possible purposes such as the need to navigate or explore or the need to change an environment.

Robots and animatronic systems may not only interact with their environment but also with other robots or animatronic devices. Robot communication may be simple or very complex but usually it is considered as less difficult than communicating with humans, the next topic. Various aspects are considered with potential problems explored. Finally some of the different roles of robotic/animatronic systems are discussed. Many robots work as part of a work cell so some types are described in this unit.

This unit considers some advanced input and control stages of a robotic/animatronic system and a dc field motor and their speed control.

If the unit Robotics and Animatronics: An Introduction has been studied then candidates will have covered some basic input types for a robot/animatronic system. Here more advanced input types are covered, including sound command and speech and visual methods from simple flashed code or colour codes through to complex shape or pattern recognition (not forgetting basic barcodes). Other inputs such as pressure, heat, temperature and balance are briefly covered.

Different control approaches for robotic/animatronic systems are interesting so a number are described including sequenced and prioritised and fuzzy logic/neural networks.

DC field motors as used with a robot/animatronic system can provide a good solution so basic characteristics and speed control is discussed.

Towards the end of the unit there is an opportunity for some practical analysis and a fast prototyping project based on bringing together subsystems to do a task. Your centre should be able to tell you about possible examples of this. This part should be interesting, challenging and enjoyable and give you considerable scope to explore an area that interests you. You are required to produce a report to record what you have done. The fast prototyping approach means that you should be able to ‘try things out’ and ‘get something going’ quickly.

As you learn about robots then the issue of safety and safe working will be emphasised at all times and you should keep safety in mind when working with robots whether in a recreational or engineering context.

For the selection of robots to do a particular task, you will be required to analyse this information and judge its value in supporting any views you wish to put forward. Thus, another benefit of taking the unit is that you will be encouraged to develop or enhance new skills in research, analysis and critical thinking. There is no single right way to solve a particular technical issue or to solve a business problem, so you will need to develop judgement as to which may be the most appropriate in practice and for a particular situation.

During the unit, you will be provided with examples and background materials to illustrate how the various aspects are important. If you do have previous experience or knowledge in this area then your lecturer or instructor may encourage you to use this knowledge to set in context the information you receive during the teaching of the unit.

By the end of the unit you will be expected to have a clearer understanding of many factors involved in using robotic and animatronic systems in a variety of contexts and applications.

The assessment for Outcomes 1 and 2 of this unit is combined into one closed-book assessment lasting 1 hour. Assessment of Outcome 3 involves a project involving practical analysis, selection, iterative design/fast prototyping, testing and evaluation. The project brings together subsystems to do a limited task and then produce a brief report of 1,500 words minimum which should be completed in your own time. The fast prototyping should have at least eight subsystems and is considered as acceptable if six out of the eight subsystems work correctly.