

SQA Advanced Unit Specification

General information for centres

Unit title: CAD: 3D Modelling

Unit code: HR3J 47

Unit purpose: This Unit is designed to introduce candidates to computerised 3D modelling and enable them to understand how modelling techniques can be applied in an industrial concept. The Unit allows candidates to develop the necessary knowledge and skills to allow them to understand the advantages and disadvantages of modelling types. The Unit also provides candidates with the opportunity to develop the practical skills to enable them to create different types of 3D models.

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

- 1 Create a 3D wire-frame model.
- 2 Create 3D surface models.
- 3 Create a composite solid model from primitives.
- 4 Display a composite solid model in multi-view layouts.
- 5 Extract 2D drawing detail and mass properties from a solid model composite.

Credit points and level: 2 SQA Credits at SCQF level 7: (16 SCQF credit points at SCQF level 7*)

**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: Access to this Unit is at the discretion of the centre. However, candidates should possess a basic knowledge and understanding of 2D draughting techniques. This may be evidenced by the possession of SQA Advanced Units in Computer Aided Draughting and/or a Higher in Graphical Communication or equivalent.

Core Skills: There are opportunities to develop the Core Skills of Information Technology, Problem Solving and Numeracy at SCQF level 6 in this Unit, although there is no automatic certification of core skills or core skills components.

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. This Unit was developed for the SQA Advanced Certificate/Diploma in Computer Aided Draughting and Design awards. The Unit may be linked/integrated with the following Units in the SQA Advanced Certificate/Diploma in Computer Aided Draughting and Design award(s): Design Methodology; CAD: Visualisation, Rendering and Presentation; Computer Aided Engineering (CAE) and Prototyping; Computer Aided Draughting and Design Graded Unit 1.

SQA Advanced Unit Specification

Assessment: The assessments for all Outcomes in this Unit should be practical ie the completion of a printable/plottable drawing. Outcomes 1, 2 and 3 also have a written element which could be integrated.

Outcomes 1 and 2 should be assessed as separate assessments. Both the practical and written parts of each assessment should be taken by the candidate at one single event. The assessment for Outcome 1 should last no more than two hours and Outcome 2 no more than three hours. The Outcome 1 3D wire-frame model should consist of both straight and curved elements and dimensions (both linear and circular) should be added to the model. For Outcome 2, the software being used should be capable of producing at least two types of surface model, as two separate models will be required to complete the assessment. Straight and curved elements should be included where appropriate. Dimensions are not required. The completed model(s) should be displayed as a single 3D view. Multiple viewports are not required. These assessments should be conducted under controlled, supervised conditions.

Outcomes 3, 4 and 5 may be integrated into a single assignment. The assignment tasks should involve creating a solid model composite, displaying this composite in multi-view format and extracting 2D drawing detail from the composite to a given specification. The assignment should be completed in 10 hours. Candidates should be allowed to refer to relevant course material. This assignment should be carried out at the end of the delivery of the unit.

It should be noted that candidates must achieve all the minimum evidence specified for each Outcome in order to pass the Unit.

It is essential that Centres ensure that evidence generated is the candidate's own work. While it would be advantageous for Centres to issue candidates with separate models to create, this is not practical, and candidates will thus be asked to create the same models for each outcome. This is acceptable.

An assessment exemplar is available for this Unit.

SQA Advanced Unit specification: statement of standards

Unit title: CAD: 3D Modelling

Unit code: HR3J 47

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

Create a 3D wire-frame model

Knowledge and/or skills

- ◆ Advantages and disadvantages of wire-frame models
- ◆ Straight and curved elements
- ◆ Viewpoints
- ◆ Dimensions

Evidence Requirements

A candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

- ◆ create a 3D wire-frame model from linear and curved elements, the linear elements being horizontal, vertical and inclined
- ◆ display this model from above and from below
- ◆ add four linear, two circular and two angular dimensions
- ◆ state two advantages and two disadvantages of 3D wire-frame models

Assessment guidelines

The assessment for this Outcome should take the form of a single practical exercise and a short written exercise listing two advantages and two disadvantages of 3D wire-frame modelling. The assessment can be carried out after the topic has been taught or at the end of the Unit. This is at the discretion of the presenting centre. The time allocation for the assessment, including the written part, is two hours. It is recommended that centres develop checklists to support the assessment requirements for each of the knowledge and/or skills items.

Outcome 2

Create 3D surface models

Knowledge and/or skills

- ◆ Advantages and disadvantages of surface models
- ◆ Types of surface models (this being relevant to the software package used)
- ◆ Straight and curved elements
- ◆ Viewpoints

Evidence Requirements

A candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

- ◆ create two different types of surface model having both straight and curved elements
- ◆ display these models from above and from below
- ◆ state two advantages and two disadvantages of 3D surface models

Evidence should be generated through assessment undertaken in controlled, supervised conditions. Assessment should be conducted under open book conditions.

Assessment Guidelines

The assessment for this Outcome should take the form of two practical exercises and a short written exercise listing two advantages and two disadvantages of 3D surface modelling. The assessment can be carried out after the topic has been taught or at the end of the Unit. This is at the discretion of the presenting centre. The time allocation for the assessment, including the written part, is no more than three hours. It is recommended that centres develop checklists to support the assessment requirements for each of the knowledge and/or skills items.

Outcome 3

Create a composite solid model from primitives

Knowledge and/or skills

- ◆ Advantages and disadvantages of solid models
- ◆ Solid model methodology
- ◆ Primitives
- ◆ Solid model operations

Evidence Requirements

The practical assessment for this Outcome should be combined with that from Outcomes 4 and 5 to form a single assignment. The assignment will not probably be completed at a single event. The time for the complete assignment should be no longer than 10 hours.

SQA Advanced Unit Specification

For this Outcome part of the assignment, a candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

- ◆ state three advantages and two disadvantages of solid models
- ◆ state and discuss solid model methodology
- ◆ create a solid model composite from primitives and solid model operations

Evidence should be generated through assessment undertaken in controlled, supervised conditions. Candidates may refer to textbooks, handouts or notes for this assessment.

Assessment guidelines

The assessment for this Outcome should take the form of a written paper listing the three advantages and two disadvantages of solid modelling and discussing solid model methodology ie Boundary representation and CSG (Constructive solid geometry). The practical assessment, as it is integrated with Outcomes 4 and 5, may not be able to be fully assessed at this stage, but candidates should be advised that they have met the required criteria for the outcome. The time allocation for the written assessment should be 0.5 hours. It is recommended that centres develop checklists to support the practical assessment requirements for each of the knowledge and/or skills items as this will assist with assessing the overall integrated assignment.

Outcome 4

Display a composite solid model in multi-view layouts

Knowledge and/or Skills

- ◆ Multiple viewpoints
- ◆ Different viewpoints
- ◆ Orthographic views

Evidence Requirements

The assessment for this Outcome should be combined with that from Outcomes 3 and 5 to form a single assignment. The assignment will not probably be completed at a single event. The time for the complete assignment should be no longer than 10 hours.

For this Outcome part of the assignment, a candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

- ◆ display the composite solid model in a multi-view layout at different viewpoints
- ◆ display the composite solid model in a multi-view layout with orthographic view

Evidence should be generated through assessment undertaken in controlled, supervised conditions. Candidates may refer to textbooks, handouts or notes for this assessment.

Assessment guidelines

This assessment, as it is integrated with Outcomes 3 and 5, may not be able to be fully assessed at this stage, but candidates should be advised that they have met the required criteria for the outcome. It is recommended that centres develop checklists to support the practical assessment requirements for each of the knowledge and/or skills items as this will assist with assessing the overall integrated assignment.

Outcome 5

Extract 2D drawing detail and mass properties from a solid model composite

Knowledge and/or Skills

- ◆ Extract hidden detail from the multi-view orthographic layout of the composite solid model
- ◆ Extract section detail from the multi-view orthographic layout of the composite solid model
- ◆ Extract a 2D orthographic layout in first and third angle projection from the composite solid model
- ◆ Extract mass properties from the solid model composite and create a user-defined mass properties file for export

Evidence Requirements

A candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

- ◆ extract hidden detail from a multi-view layout
- ◆ extract section detail from a multi-view layout
- ◆ extract a first angle orthographic layout to a given specification
- ◆ extract a third angle drawing layout to a given specification

Evidence should be generated through assessment undertaken in controlled, supervised conditions. Candidates may refer to textbooks, handouts or notes for this assessment.

Assessment Guidelines

This assessment is integrated with Outcomes 3 and 4. The time allocation for the complete assignment should be 10 hours. The assignment is practical and no written report is required. It is recommended that centres develop checklists to support the practical assessment requirements for each of the knowledge and/or skills items as this will assist with assessing the overall integrated assignment.

It is essential that Centres ensure that evidence generated is the candidate's own work. This could be confirmed by Centres ensuring that different elements of the solid composite being created are placed in different positions. This is at the discretion of the centres.

SQA Advanced Unit Specification

Administrative Information

Unit code: HR3J 47

Unit title: CAD: 3D Modelling

Superclass category: CH

Date of publication: August 2017

Version: 01

History of changes:

Version	Description of change	Date

Source: SQA

© Scottish Qualifications Authority 2006, 2013, 2017

This publication may be reproduced in whole or in part for educational purposes provided that no profit is derived from reproduction and that, if reproduced in part, the source is acknowledged.

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

FURTHER INFORMATION: 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

SQA Advanced Unit specification: support notes

Unit title: CAD: 3D Modelling

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 80 hours.

Guidance on the content and context for this Unit

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 80 hours.

This Unit has been written in order to allow candidates to develop knowledge, understanding and skills in the following areas:

- 1 Creation of 3D wire-frame models
- 2 Creation of 3D surface models
- 3 Creation of composite solid models
- 4 Display of a composite solid model in multi-view layouts
- 5 Extraction of a 2D drawing detail and mass properties from a composite solid model

This Unit is at SCQF level 7 and is in the framework for the SQA Advanced Certificate in Computer Aided Draughting and Design. However this does not preclude the use of the Unit in other awards where award designers feel this to be appropriate.

In designing this Unit, the unit writer has identified the range of topics that would be expected to be covered by lecturers. The writer has also given recommendations as to how much time should be spent on each outcome assessment. This has been done to help lecturers decide what depth of treatment should be given to the topics attached to each of the Outcomes. Whilst it is not mandatory for centres to use this list of topics, it is recommended that they do so as the assessment exemplar pack for this Unit is based on the knowledge and/or skills and list of topics in each of the Outcomes.

A list of topics for each Outcome is given below. Lecturers are advised to study this list in conjunction with the assessment exemplar pack so that they can get a clear indication of the standard of achievement of candidates in this Unit.

Outcome 1

Create a 3D wire-frame model (5 hours)

The following topics are generic in nature but should be put into context by reference to the CAD software application package being used at the Centre:

- ◆ Use of a 3D reference co-ordinate system
- ◆ Use of 3D co-ordinates to draw linear and curved elements
- ◆ Use of a viewpoint reference system able to display the model from above and from below
- ◆ The ambiguity effect of 3D wire-frame models
- ◆ Use of a relevant dimension style suitable to the model being created

SQA Advanced Unit Specification

- ◆ Benefits could include:
 - basic spatial representation
 - general size and overall dimensions
 - possible clashing effect
- ◆ Disadvantages could include:
 - no hide effect ie ambiguity exhibited
 - no mass properties
 - no shading or rendering

Outcome 2

Create 3D surface models (20 hours)

The following topics are generic in nature but should be put into context by reference to the CAD software application package being used at the Centre:

- ◆ Types of surface model available with software
- ◆ Use of a 3D reference co-ordinate system
- ◆ Use of 3D co-ordinates to draw linear and curved elements
- ◆ Use of a viewpoint reference system able to display the model from above and from below
- ◆ The removal of ambiguity effect with 3D surface models
- ◆ Benefits could include:
 - no ambiguity
 - shading and rendering effect
 - surface area mass property available
- ◆ Disadvantages could include:
 - only the surface area mass properties

Outcome 3

Create a composite solid model from primitives (10 hours)

The following topics are generic in nature but should be put into context by reference to the CAD software application package being used at the Centre:

- ◆ Primitives available. These could be:
 - box, cylinder, sphere, wedge, torus, cone
- ◆ Solid model operations. These could be:
 - union, subtraction, intersection
- ◆ Creation of a composite from primitives and operations
- ◆ Creation of a composite from complex 2D shapes using appropriate operations. These could be:
 - sweeps, revolutions
- ◆ Use of a viewpoint reference system able to display the model from above and from below
- ◆ The ability to hide, shade, render composite models
- ◆ Benefits could include:
 - no ambiguity
 - shading and rendering effect
 - ability to add materials
 - mass properties available
 - interference effect possible
 - clash detection possible

SQA Advanced Unit Specification

- ◆ Disadvantages could include:
 - cost
 - training
 - specialist use
 - is it actually needed
- ◆ Methodology should include:
 - types eg CSG (Constructive Solid Geometry), Boundary representation
 - how these are used in industry
 - type available in application package being used

Outcome 4

Display a composite solid model in multi-view layouts (5 hours)

The following topics are generic in nature but should be put into context by reference to the CAD software application package being used at the Centre:

- ◆ Ability to work in different drawing environments
- ◆ Multiple viewports able to display a composite model at various 3D viewpoints
- ◆ Multiple viewports able to display a composite model at various orthographic views which should include:
 - top, front, side, isometric
- ◆ Multiple viewports able to display a composite model from above and from below
- ◆ The ability to display a composite model without ambiguity effect in several viewports
- ◆ Ability to customise the layout sheet to user specifications

Outcome 5

Extract 2D drawing detail and mass properties from a solid model composite (25 hours)

The following topics are generic in nature but should be put into context by reference to the CAD software application package being used at the Centre:

- ◆ Ability to extract hidden detail from a composite model displayed in a multiple viewport layout with orthographic views
- ◆ Ability to extract section detail from a composite model displayed in a multiple viewport layout with orthographic views
- ◆ Ability to create a 2D orthographic layout from a composite solid in:
 - first angle projection with:
 - top, front, end views
 - section views
 - an auxiliary view
 - dimensions added
 - third angle projection with:
 - top, front, end views
 - section views
 - an auxiliary view
 - dimensions added
- ◆ Ability to extract mass properties to a user-defined file. These properties could include:
 - mass, volume and surface area
 - centroid and radius of gyration

SQA Advanced Unit Specification

Unit Assessment

Outcome 1	Written and practical	2 hours
Outcome 2	Written and practical	3 hours
Outcomes 3, 4, 5	Integrated assignment	10 hours

Guidance on the delivery and assessment of this Unit

It is intended that this Unit is presented at all times by using the specialist CAD software available at the Centre. Appropriate technical and support material should be available to the candidate.

In delivery of this Unit, candidates should be provided with the opportunity to gain as much ‘hands on’ experience as possible. Each candidate should have access to a PC with the CAD software installed.

Details on approaches to assessment are given under Evidence Requirements and Assessment Guidelines under each Outcome in the SQA Advanced Unit specification; Statement of Standards section. It is recommended that these sections be read carefully before proceeding with assessment of candidates.

Opportunities for developing Core Skills

Candidates are working in a context which requires that they produce original computer aided design work. Access, to and interpretation and evaluation of examples of, complex graphic design would be of value. Candidates should be able to work unaided in the selection of appropriate software and the modification or customising of applications to meet the identified needs of purpose and context. They could, however, benefit from discussions with the class group and/or assessor to reinforce an analytical approach to evaluating the effectiveness of the design process.

As they produce design solutions to a given brief, candidates will need to analyse and seek solutions to a range of theoretical and practical problems, and identify specific objectives. Identifying and considering the variables, including all potential resources, and analysing the relative significance of each before identifying and justifying an appropriate strategic approach to concept development will provide opportunities to develop critical thinking and general problem solving skills to an advanced level. Analysing and evaluating the potential and actual impact of their designs will be a critical aspect of underpinning knowledge and understanding, and candidates could be supported in identifying appropriate methods to measure achievement and progress.

Accuracy and effectiveness in the interpretation and communication of graphic information underpins the competencies developed in the Unit. Some candidates may benefit from formative opportunities to further develop skills in the analysis and application of graphic data, and the use of software packages or on-line tutorials to enhance skills may be useful.

Open learning

This Unit could be delivered by distance learning, which may incorporate some degree of on-line support. The candidate would require access to a PC with the appropriate CAD software installed. With regard 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 into place to ensure that written assessment was conducted under controlled, supervised conditions. Arrangements would also need to be made to ensure that the candidate could demonstrate that the practical assessment evidence is their own work. This could involve the candidate attending the

SQA Advanced Unit Specification

centre, utilising video conferencing or alternatively, special arrangements could be made for the candidate to demonstrate the practical assessments to a designated, responsible person local to the candidate.

For information on normal open learning arrangements, please refer to the SQA guide.

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.

SQA Advanced Unit Specification

General information for candidates

Unit title: CAD: 3D Modelling

This Unit has been designed to provide you with the knowledge and skills that will enable you to understand the basic concepts of 3D wire-frame, surface and solid modelling.

You will learn about the advantages and disadvantages of each model type.

This Unit will allow you to develop practical skills that will enable you to create these models and display them at different viewpoints, with hide and shade effects.

The formal assessment for this Unit is practical although there is a small written assessment requirement.

The actual assessment times are as follows:

Outcome 1	Written and practical	2 hours
Outcome 2	Written and practical	3 hours
Outcomes 3, 4 and 5	Integrated assignment	10 hours

Your practical skills will be assessed by your being asked to satisfactorily create 3D models. You will be presented with the basic drawing, sizes and layouts that are needed to create these models.

The Outcome 1 and 2 assessments are normally carried out after the teaching of the appropriate topics while the integrated assignment will not usually be attempted until all teaching has been completed.