

SQA Advanced Unit specification

General information

Unit title: CAD: 3D Surface and Solid Modelling (SCQF level 7)

Unit code: HV1K 47

Superclass: VF

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Unit purpose

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

Outcomes

On successful completion of the Unit the learner will be able to:

- 1 Create complex surface models using surface modelling tools/techniques.
- 2 Create composite solid models incorporating the use of surfaces, and extract mass properties for each model.
- 3 Display fully annotated composite models on a drawing sheet.
- 4 Explain the advantages and disadvantages of both surface and solid models.

Credit points and level

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

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Recommended entry to the Unit

Access to this Unit is at the discretion of the centre. However, learners 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

Opportunities to develop aspects of Core Skills are highlighted in the Support Notes for this Unit specification.

There is no automatic certification of Core Skills or Core Skill components in this Unit.

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. The Unit may be linked/integrated with the following Units in the SQA Advanced Certificate/Diploma in Computer Aided Draughting and Design: *Design Methodology*; *CAD: Visualisation, Rendering and Presentation*; *Computer Aided Draughting and Design Graded Unit 1*.

The Assessment Support Pack (ASP) for this Unit provides assessment and marking guidelines that exemplify the national standard for achievement. It is a valid, reliable and practicable assessment. Centres wishing to develop their own assessments should refer to the ASP to ensure a comparable standard. A list of existing ASPs is available to download from SQA's website (<http://www.sqa.org.uk/sqa/46233.2769.html>).

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: Statement of standards

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Acceptable performance in this Unit will be the satisfactory achievement of the standards set out in this part of the Unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to SQA.

Outcome 1

Create complex surface models using surface modelling tools/techniques.

Knowledge and/or Skills

- ◆ Types of surface models
- ◆ Straight and curved elements
- ◆ Combining surface tools to create composite shapes
- ◆ Viewpoints

Outcome 2

Create composite solid models incorporating the use of surfaces, and extract mass properties for each model.

Knowledge and/or Skills

- ◆ Primitives
- ◆ Solid model operations
- ◆ Conversion from surface models to solid models
- ◆ Combining tools to create composite shapes
- ◆ 3D sectioning
- ◆ Multiple viewpoints
- ◆ Extracting mass properties information

Outcome 3

Display fully annotated composite models on a drawing sheet.

Knowledge and/or Skills

- ◆ Orthographic layouts
- ◆ Display 2D orthographic layouts of composite solid models in both 1st and 3rd angle projection
- ◆ Display hidden detail of the composite solid model
- ◆ Display a 2D section view of the composite solid model
- ◆ Drawing annotation

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Outcome 4

Explain the advantages and disadvantages of both surface and solid models.

Knowledge and/or Skills

- ◆ Different types of surface modelling
- ◆ Solid model methodology
- ◆ Advantages and disadvantages of 3D surface models
- ◆ Advantages and disadvantages of 3D solid models

Evidence Requirements for this Unit

Learners will need to provide written and/or oral recorded and product based evidence to demonstrate their Knowledge and/or Skills across all Outcomes. Evidence should be generated under controlled, supervised, open-book conditions. Learners will be allowed access to course material, text books, the internet and the Help files associated to the software used. All evidence must be generated during the assessment period.

Learners will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

Outcome 1

- ◆ create a minimum of two complex surface models each consisting of at least four different surface modelling tools/techniques, straight and curved elements.
- ◆ display the complex surface models from above and below on a drawing sheet.

Outcome 2

- ◆ create composite solid models with the use of surfaces.
- ◆ create a 3D section of the solid model.
- ◆ display the composite solid model with a minimum of four 3D views on a drawing sheet including a view of the sectioned model.
- ◆ extract the mass properties information from the 3D composite solid model.

Outcome 3

- ◆ create a first angle drawing of the 3D composite solid model showing a minimum 3 orthographic views inclusive of a 2D section, a 2D detail view and a 3D isometric view. Hidden detail should not be shown.
- ◆ create a third angle drawing of the 3D composite solid model showing a minimum 3 orthographic views inclusive of a 2D section, a 2D detail view and a 3D isometric view. Hidden detail should be shown.
- ◆ fully dimension the third angle 2D drawing created from the 3D solid model.

Outcome 4

The learner should demonstrate an understanding of different types of surface modelling. They should also demonstrate an understanding of solid model methodology, ie boundary representation and CSG (Constructive solid geometry). The learner must state a minimum of three advantages and two disadvantages of both surface and solid models.

SQA Advanced Unit Support Notes

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Unit Support Notes are offered as guidance and 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 learners to develop knowledge, understanding and skills in the following areas:

- 1 Creation of complex 3D surface models.
- 2 Creation of composite solid models incorporating the use of surfaces, and display of the composite solid model in multi-view orthographic layouts, and the extraction of its mass property information.
- 3 Creation of a 2D drawing detail from a composite solid model.
- 4 The key elements of both surface modelling and solid modelling, including the different types of each and the benefits/drawbacks of each.

This Unit is at SCQF level 7 and may form part of a group award or be completed as a free-standing Unit.

In designing this Unit, the 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 Support Pack (ASP) 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 ASP so that they can get a clear indication of the standard of achievement of learners in this Unit.

Guidance on approaches to delivery of this Unit

It is intended that this Unit be delivered using the specialist CAD software available at the delivering centre.

Learners should be provided with the opportunity to gain as much 'hands on' experience as possible. Appropriate technical and support material should be available, and each learner should have access to a PC with CAD software installed.

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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:

Outcome 1

Create complex surface models using surface modelling tools/techniques. (25 hours)

- ◆ Use of a 3D reference co-ordinate system
- ◆ Use of 3D co-ordinates to draw linear and curved elements
- ◆ Types of surface model available with software
- ◆ Combining surface modelling techniques to create composite surface models
- ◆ Use of a viewpoint reference system able to display the model from above and from below

Outcome 2

Create composite solid models incorporating the use of surfaces, and extract mass properties for each model. (30 hours)

- ◆ 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, lofts.
- ◆ Creation of complex composite models using primitives, operations and surface profiles.
- ◆ Use of a viewpoint reference system able to display the model on a drawing sheet without ambiguity.
- ◆ The ability to hide, shade, render composite models
- ◆ Ability to extract mass properties to a user-defined file. These properties could include:
 - mass, volume and surface area
 - centroid and radius of gyration.

Outcome 3

Display fully annotated composite models on a drawing sheet (6 hours).

- ◆ 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.

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Outcome 4

Explain the advantages and disadvantages of both surface and solid models (5 hours).

Surface model types should include:

- ◆ Mesh
- ◆ Surface
- ◆ How these are used in industry
- ◆ Tools available in application package being used

Methodology should include:

- ◆ Types, eg CSG (Constructive Solid Geometry), Boundary representation
- ◆ How these are used in industry
- ◆ Type available in application package being used

Benefits of surfaces could include:

- ◆ No ambiguity
- ◆ Shading and rendering effect
- ◆ Surface area mass property available

Disadvantages of surfaces could include:

- ◆ Only the surface area mass properties

Benefits of solid modelling could include:

- ◆ No ambiguity.
- ◆ Shading and rendering effect.
- ◆ Ability to add materials.
- ◆ Mass properties available.
- ◆ Interference effect possible.
- ◆ Clash detection possible.

Disadvantages of solid modelling could include:

- ◆ Cost.
- ◆ Training.
- ◆ Specialist use.
- ◆ Is it actually needed.

Guidance on approaches to assessment of this Unit

Evidence can be generated using different types of assessment. The following are suggestions only. There may be other methods that would be more suitable to learners.

Centres are reminded that prior verification of centre-devised assessments would help to ensure that the national standard is being met. Where learners experience a range of assessment methods, this helps them to develop different skills that should be transferable to work or further and higher education.

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The assessments for Outcomes 1, 2 and 3 in this Unit should be practical, ie the completion of a printable/plottable drawing.

Outcome 1 could be assessed as a separate assessment. It is recommended that the assessment for Outcome 1 should last no more than three hours. The Outcome 1 3D surface model should consist of both straight and curved elements. 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. Dimensions are not required. Assessments should be conducted under controlled, supervised open-book conditions. Learners will be allowed access to course material, text books, the internet and the Help files associated to the software used. All evidence must be generated during the assessment period.

Outcomes 2 and 3 could be integrated into a single assignment. The assignment tasks should involve solid model composites, displaying these composites in multi-view format and extracting 2D drawing detail from the composite to a given specification. The Knowledge and/or Skills item 'Extracting mass properties information' may be included in the assessment of Outcome 4. The assignment should be completed in ten hours and conducted under controlled, supervised open-book conditions. Learners will be allowed access to course material, text books, the internet and the Help files associated to the software used. All evidence must be generated during the assessment period.

Outcome 4 should be carried out at the end of the delivery of the Unit. The learner could provide a written report or an oral presentation.

Recommended assessment times:

Outcome 1	Practical	3 hours
Outcome 2, 3	Practical	10 hours
Outcomes 4	Written/Oral	1 hour

It should be noted that learners 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 learner's own work. While it would be advantageous for centres to issue learners with separate models to create, this is not practical, and learners will thus be asked to create the same models for each Outcome. This is acceptable.

Opportunities for e-assessment

E-assessment may be appropriate for some assessments in this Unit. By e-assessment we mean assessment which is supported by Information and Communication Technology (ICT), such as e-testing or the use of e-portfolios or social software. Centres which wish to use e-assessment must ensure that the national standard is applied to all learner evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. The most up-to-date guidance on the use of e-assessment to support SQA's qualifications is available at www.sqa.org.uk/e-assessment.

Opportunities for developing Core and other essential skills

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

Learners 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. Learners 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, learners 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 learners 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 learners 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.

History of changes to Unit

Version	Description of change	Date

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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](#).

General information for learners

Unit title: CAD: 3D Modelling (SCQF level 7)

This section will help you decide whether this is the Unit for you by explaining what the Unit is about, what you should know or be able to do before you start, what you will need to do during the Unit and opportunities for further learning and employment.

This Unit has been designed to provide you with the knowledge and skills that will enable you to understand the basic concepts of 3D 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 correctly on a drawing sheet.

You will need to provide written and/or oral recorded and product based evidence to demonstrate your Knowledge and/or Skills. Evidence will be generated under controlled, supervised open-book conditions.

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.

There will be opportunities to develop the Core Skills of *Information and Communication Technology (ICT)*, *Problem Solving* and *Numeracy* at SCQF level 6 in this Unit, although there is no automatic certification of Core Skills or Core Skills components.