Unit 15: Measurement Techniques in Construction

Delivery guidance

The procurement of a contractor cannot be undertaken without measurement of quantities, so rates can be applied and a contract sum established. Measurement is used for the valuation of variations and to provide quotations for contract instructions.

This is an optional unit and will be of interest to learners orientated towards a career pathway in quantity surveying. In this unit, learners will explore the processes and procedures involved for a client and main contractor. They will examine how quantities are extracted from the drawings produced by the designer and develop an understanding of the principles and procedures regarding budgets, pricing and estimating.

Analysis to gain information forms a large part of this unit. Therefore, learners who are interested in mathematics will engage well with this unit, along with those who have strong analytical skills. During delivery, learners will develop the following key skills:

- interpretation of drawings to define what to measure and the standard of measurements required locally to your country
- mathematical skills in quantifying dimensions
- the ability to work methodically through a sequence of operations.

Attention to detail is essential to ensure that nothing is missed that could have a financial impact on a client's project. Within this context, learners will understand why quantity surveyors are in demand and highly valued as they are essential to the financial management of a client's projects across the world.

Approaching the unit

A large majority of the content for this unit is based around taking off quantities, so it is vital that you source suitable drawings for this purpose. Obtain drawings from a local contractor in your country so learners become used to the standard of drawn information available. These will need to contain sufficient detail and dimensions so no scaling is required (as this could lead to errors). Obtaining the services of a Quantity Surveyor would provide another method of engaging learners in employer-related projects and they may be able to provide a lot of resources to assist with the delivery of the unit. Demonstrations using examples are the key focus for this unit. The internet can provide some examples to demonstrate the processes contained within this unit, but you should note that they may not use the same standards as your country.

Delivering the learning aims

Learning aim A

Learning aim A introduces the learners to the reasons for taking-off quantities and the methods used to undertake this. This is further enhanced with reference to your country's local standard method of measurement, which you will need to obtain copies of. A simple explanation would suffice for topic A1, which could then be drawn out into class discussion using a spider diagram to capture the main points. You need to explain

the local country standard method of measurement (SMM) and how this is applied to the taking-off processes and procedures. The content refers to SMM from several different organizations.

Topic A2 carries more depth and explores the standard methods of measurement used across the world. You need to draw out why we need such rules, and this can best be approached through tutor-led discussion.

The Royal Institute of Chartered Surveyors (RICS) produces the New Rules of Measurement (NRM), and the Institution of Civil Engineers (ICE) the Civil Engineering Standard Method of Measurement (CESMM). You will need to differentiate between the two standards of measurement as one is mainly for construction and the other is used for heavy civil engineering works. You will need to further explore the three separate standards (NRM 1, 2 and 3) and explain the difference between the three. NRM 2 is the one that covers the rules for taking off construction quantities.

Examination of the format of a page from a measured item needs to be undertaken so learners can see that a standard set of columns are used to give guidance, and to establish logical rules against each measured item. A similar approach needs to be taken with the Civil Engineering Standard Method of measurement so a contrast can be made. Your local standard method of measurement can be used, even if it is not included within the unit content. Learners need to be made aware of the international use of SMMs in case they consider working outside of their country.

Learning aim B

Learning aim B is the main part of the unit and covers the production of quantities using taking-off techniques and using dimension paper. Learners will do this for substructures and superstructures and for civil engineering projects. You will need to source suitable drawings for this and could obtain these from a contractor, quantity surveyor or a local planning office. The drawings should be checked for suitability to ensure they contain sufficient dimensions for the activities and are not too complex.

Topics B2 and B3 cover the production of quantities for substructure and superstructure items. Here, links to the other units, especially *Unit 1: Construction Technology*, will help learners to understand how the take-off will be built up. Each of the relevant work sections of the NRM 2 (or your local SMM) will need to be accessed so learners can see the detailed procedures for the take-off of each area covered within the unit. Access to NRM2 will provide you with a free resource to determine the unit of measurement and how this is applied along with any supplementary rules of guidance. A range of take-offs will need to be covered, as there will need to be at least three from each of the content areas witihin B2 and B3 for substructures and superstructures. Drawings will need to be provided that are specific to each, and contain dimensions and specifications where applicable.

Topic B4 covers the production of quantities using the Civil Engineering Standard Method of Measurement, using the current version, CESMM4. You will need to source suitable civil engineering drawings so that quantities can be taken off. These could be sourced from a local civil engineering firm. Remember that not all of the content has to be taught. The assessment criteria state that learners" produce quantities for a project using a recognised standard method of measurement and an appropriate layout of dimensions".

Learning aim C

Learning aim C covers the production of bills of quantities. This is the final part of quantity production after the taking-off process has been completed. The various methods related to this process will need to be explained to learners.

An actual bill example will need to be demonstrated to show how bills are formatted, as well as section summaries. A final summary should also be demonstrated so learners understand the layout of the final bill of quantities. Examples can be downloaded from the internet or provided by a local quantity surveyor.

Examples of 'direct billing' will also be needed to show how this process differs from dimension, abstraction and bills of quantities. It should be noted that the process of cut and shuffle is now obsolete and is no longer considered a viable method of producing bills of quantities. A class discussion around this topic would be useful to help learners understand the changing demands within the industry. Digitisers can now take-off quantities directly from architects scaled drawings into an electronic bill of quantities.

Assessment model

Learning aim	Key content areas	Recommended assessment approach
A Examine the measurement rules for building and civil engineering	**A1** Introduction to taking off quantities **A2** Standard methods of measurements	A guidance document for new learners to comprehend the use of quantities in construction and the standard methods of measurement available in the construction industry.
B Undertake the production of quantities for substructure and superstructure elements	**B1** Processes in the production of quantities **B2** Production of substructure quantities for a building **B3** Production of superstructure quantities for a building **B4** Production of quantities for a civil engineering project	A set of quantities from tutor-provided drawings for a building, substructure, elements of a superstructure and elements of external works. Bills of quantities for a building, substructure, elements of superstructure and elements of external works.
C Undertake the production of bills of quantities	**C1** Abstraction of quantities **C2** The production of a bill of quantities for a building or civil engineering project	

Assessment guidance

The assessment of this unit will require learners to demonstrate their knowledge of, and ability in, taking-off some quantities using a standard method of measurement. The SMM can be the one used locally within your country or an internationally recognised one taken from the unit content. The first assignment requires learners to analyse and evaluate the various standard methods of measurement used in construction in terms of the rules laid out within the standard. A written report is the recommended format.

For the second assignment, learning aims B and C are covered with one assessment activity, combining construction and civil engineering elements. Learners will need a copy of NRM 2 or CESMM4 if no local country version is used, to apply the rules of taking-off. Dimension paper will need to be prepared for this purpose, along with abstract paper, and suitable drawings will be needed for substructures and superstructures so that quantities can be taken off.

Getting started

This provides you with a starting place for one way of delivering the unit, based around the recommended assessment approach in the specification.

Unit 15: Measurement Techniques in Construction

Introduction

This unit involves the application of rules that are followed in the production of quantities. The various stages of a project, from inception, design brief, feasibility and construction, all require different methods of measurement and quantities. This is because the drawn information at the detailed design stages becomes more accurate and, therefore, so does the quantities for the bills that are taken from them. A bill of quantities contains the full project quantities taken off into the sections defined by the rules of measurement from the international or local standard.

Across all learning aims, the use of guest speakers and developing a relationship with a local Quantity Surveying practice will prove a very valuable resource. Examples of current practice could be demonstrated to learners, along with digital methods of taking-off and quantifying building elements. Employer engagement through learners may also provide opportunities for finding resources for the delivery of this unit.

Learning aim A

This topic introduces learners to the rules of measurement for building and civil engineering projects. You can download a free copy of the New Rules of Measurement and purchase a copy of The Civil Engineering Rules of Measurement (one copy will suffice). Details for both are listed in the Resources section.

Learning aim A1

- A tutor-led discussion will establish prior knowledge. Collate information in a spider diagram, recording the reasons why both approximate and accurate quantities are needed, and who would use them at different points in a construction project.
- Engaging guest speakers from a range of backgrounds would be useful in these early sessions. For example, the Estates Manager for your centre could provide information on the different uses of measurement within your centre. A quantity surveyor could demonstrate the different uses of measurement rules for the different stages of a project. An architect could cover this specifically for the design stages and budgets.
- Tutor presentation using a timeline from a case study project to summarise the reasons you would use measurements and quantities at each stage. Follow this with small group activity.
- Provide a project brief and images to small groups of learners to explore the many different stages of the project in more detail and identify where quantities would be used at each stage.

Learning aim A2

- Moving on to the standard methods of measurement, you will need to ensure learners understand why there is a rulebook for the production of quantities and what the origins of measurement are. Delivery a tutor-led review of the Standard Method of Measurement 7 (SMM7), the predecessor to the New Rules of Measurement 1, 2 and 3, or your countries local standard method of measurement. This demonstrates the

historic development of the rules of measurements along with the updating required for technological changes.

- Split the class into three groups and ask learners to go and measure a room. You will need to give each group different rules. For example, one measures to the nearest full metre, one rounds up by one additional unit and the other measures exactly. All three groups then present and discuss their results and their understanding of the reasons and need for rules of measurement.
- Ask learners to carry out detailed examination of a page from their local standard method of measurement, NRM 2 or a page from CESMM4 on the same work item so comparisons can be made between them. This should include an examination of the different columns and their meanings within each document.
- Learners to write a report summarising the status of RICS and the Institution of Civil Engineers (ICE), about how each professional body regards the rules of measurement. They should focus on what influence the rules have on each professional body and the considerations for its application within the construction and civil engineering sector. The report should also outline the International Construction Measurement Standards (ICMS) and the International Property Measurement Standards (IPMS).
- Ask learners to download NRM 1, 2 and 3 and divide the class into groups. Each group will prepare a presentation on what NRM 1, 2 and 3 means, in terms of what it covers and is used for. Presentation delivery will give you the opportunity to give learners constructive feedback in terms of important employment and development skills.

Learning aim B

Learning aim B1

- Introduce Topic B1 with a brief presentation on the 'rules' that are used for dimension paper, explaining what each column is used for. The standard format and rules when placing dimensions and how these are written should also be covered. Examples of how this is done should be provided so that learners develop a clear understanding of how the content (listed under topic B1) is applied on dimension paper.
- Further activities to demonstrate the processes in the production of quantities and the vocationally correct format to be used could include the following:
  - A template sheet with the rules of how dimensions are laid out; a copy of such a method is available within the BTEC book for Level 3 in Construction.
  - Whiteboard demonstration and learners take down the methodology onto dimension sheets to form quick reference guides.
  - Sheets from a quantity surveying practice that demonstrate the rules of taking off.
  - Forming a glossary of standard quantity surveying abbreviations.
  - Centre line activity calculation examples.
  - Practical demonstration of the centre line calculation for a cavity wall so that the centre line can be calculated for each skin and the cavity.

Learning aims B2 and B3

- Topics B2 and B3 cover quantity production for substructures and superstructures, and links with content in *Unit 1: Construction Technology* and *Unit 20: Quantity Surveying*. You may be able to share resources across this unit and make assessment more effective.

You will need to source suitable project examples to support your delivery, covering areas such as:

- excavation take-off for a mass-filled foundation
- construction of external wall to dpc level
- solid ground floor construction.

- The recommended delivery approach for both substructures and superstructures is a tutor demonstration of the method, followed by learner-centred worked examples. Tutors should give learners a change in dimensions for their starting point (e.g. perimeter dimensions for an external wall take-off could be changed). Learners should work independently throughout the exercises, with tutor support when required. Quantity surveying textbooks may provide several worked examples for this method of delivery.

Learning aim B4

- Topic B4 covers the civil engineering take-off of quantities. Drawings will need to be sourced and could be provided by a civil engineering consultant or a structural engineering practice. A simple concrete base or foundation would provide all the elements to be covered under the unit content. The drawings need to contain concrete works and reinforcement with associated earthworks. Drainage drawings could be used along with retaining structures and other details. It would be beneficial to learners to work through a simple take off so they understand the formatting required and the rules of measurement.
- It is worth noting that the recommended method of assessment crosses learning aims B and C, and therefore, elements of construction and civil engineering could be taken from one set of drawings, for example drainage or piled foundations associated with construction elements.

Learning aim C

Learning aim C1

- Introduce this learning aim with a tutor presentation on the changing nature of the production of bills of quantities in the face of technological advancements (such as BIM). For example, cut and shuffle is no longer a common method of abstraction.
- Tutor-led activity asking learners to explore when cut and shuffle is no longer a common method. This activity can be based around BIM and how it can produce quantifiable elements straight from the BIM elements. Research on this aspect would open up discussion and debate on the use of 3D modelling.
- Learners will best understand abstraction techniques through practical worked examples, and you can utilise the take-offs produced for substructures or superstructures in learning aim B in this activity. This involves a sheet of A3 paper where quantities are collected and summated, then rounded to the nearest whole unit. You will need to print off some A3 paper that has vertical lines across it spaced 25 mm apart to form abstract paper.
- There are several online sources that can be used to demonstrate the direct billing method, along with examples in quantity surveying textbooks. It may be possible to get direct billing paper from a main contractor to assist with this method. In this activity learners need to understand how direct billing enables quantities to be calculated and the rates applied straight away without abstraction and forming a bill of quantities.

Learning aim C2

- Sourcing a bill of quantities from a quantity-surveying consultancy will assist with this topic. A bill of quantities will demonstrate:
  - how a bill is written
  - how page summaries are incorporated
  - final work section summaries
  - the final summary
  - the format and layout of the document.
- The size of the bill of quantities that learners will have to produce needs to contain a range of different sections from a standard method of measurement and needs to be manageable, covering substructures, elements of superstructures and some external works.

Details of links to other BTEC units and qualifications and to other relevant units/qualifications

This unit links to:

- Unit 1: Construction Technology
- Unit 7: Graphical Detailing
- Unit 20 Quantity Surveying
- Unit 23: Construction in Civil Engineering

Resources

In addition to the resources listed below, publishers are likely to produce Pearson-endorsed textbooks that support this unit of the BTEC Internationals in Construction and the Built Environment. Check the Pearson website (http://qualifications.pearson.com/endorsed-resources) for more information as titles achieve endorsement.

Textbooks

Topliss, S. et al., *BTEC Nationals Construction Student Book + Activebook: For the 2017 specifications (BTEC Nationals Construction 2016)*, Pearson, 2017, ISBN 9781292184043 (please note that this book was written specifically for the UK market but it may be useful)

Institute of Civil Engineers, *CESMM4: Civil Engineering Standard Method of Measurement* (4th Edition), ICE Publishing, 2012, ISBN 9780727757517
The standard method of measurement for civil engineering works

Ostrowski, S.D.C. *Measurement Using the New Rules of Measurement*, Wiley-Blackwell, 2013, ISBN 9781118333013
A comprehensive guide to the application of the technical measurement skills required in construction

Websites

Go to the 'YouTube' website and search for: "An Introduction to Taking Off Building Quantities: an Irish Approach" for an introduction to taking off.

The "designing buildings" wiki website

The RICS website and search "RICS NRM: New Rules of Measurement" to download the New Rules of Measurement 1, 2 and 3

Pearson is not responsible for the content of any external internet sites. It is essential for tutors to preview each website before using it in class so as to ensure that the URL is still accurate, relevant and appropriate. We suggest that tutors bookmark useful websites and consider enabling students to access them through the school/college intranet.