Unit 23: Spatial Data Techniques in Construction and Civil Engineering

NQF Level 3: **BTEC National**

Guided learning hours: 60

Unit abstract

The use of spatial data is an essential aspect of any construction development, from the initial feasibility study, through the site survey, the design stages (including planning applications) production of the working drawings and the final as-built surveys for the records.

The unit will provide the learner with an understanding of the methods used to map land-based and spatial information, both using conventional cartography and in Geographic Information Systems (GI). The variety of data sources available to those working in Construction and the Built Environment is considered, including their respective data formats. These will include remote sensing, satellite and aerial imagery, photogrammetry, laser-scans, GPS, socio-economic surveys, statistics, and topographic and measured building surveys. The variety of purposes that spatial data can be put to are addressed, such as CAD, GIS, Surveying and Cartography. Cartographic design is a fundamental part of the unit.

The techniques and principles are critically compared and the learner will have the opportunity to demonstrate evidence of achieving that understanding by producing a range of maps and designs.

Learning outcomes

On completion of this unit a learner should:

1 Understand the use of different projections, graticules and grids for a variety of purposes and the referencing of spatial data using conventional cartography and GIS (Geographic Information Systems) techniques

2 Be able to collect and process data from various sources including remote sensing, photogrammetry, socio-economic surveys, statistics and physical surveys

3 Know how to critically analyse the components, properties and design of existing map series at different scales from various sources and review their effectiveness in presenting survey information

4 Be able to draft effective maps and design aesthetically pleasing layouts using symbols, text and colour suitable for reproduction, using both conventional printing and electronic methods.

Unit content

1 **Understand the use of different projections, graticules and grids for a variety of purposes and the referencing of spatial data using conventional cartography and GIS (Geographic Information Systems) techniques**

Map projections: properties required in maps; the construction of basic projections and their classification according to property; mathematical and geometric origin; distortion to be found in the main projections and their practical application especially in relation to the Ordnance Survey

Spherical co-ordinates: the origin and characteristics of lines of latitude and longitude and their application to providing a world reference system; relationship to Ordnance Survey national grid

Rectangular co-ordinates: the nature and characteristics of rectangular coordinates and their application to the national grid of the Ordnance Survey in providing a framework for survey work, a national reference system and the co-ordination of all map series

2 **Be able to collect and process data from various sources including remote sensing, photogrammetry, socio-economic surveys, statistics and physical surveys**

Properties and applications: of remote sensing, satellite imagery, conventional terrestrial photogrammetry

Processing of data: sources of socio-economic surveys and other statistics; their presentation in a variety of statistical diagrams and maps using statistical grouping techniques such as scatter diagrams

Presentation of data: simplification and generalisation of data from physical surveys suitable for maps of all scales

3 **Know how to critically analyse the components, properties and design of existing map series at different scales from various sources and review their effectiveness in presenting survey information**

Analysis: of conventional and digital Ordnance Survey mapping; commercial maps and examples of foreign cartography at all scales with regard to presentation techniques of physical and socio-economic data

Measurement: of areas, graphically, mathematically, mechanically, digitally

Analysis: presentation of three-dimensional land form

4 **Be able to draft effective maps and design aesthetically pleasing layouts using symbols, text and colour suitable for reproduction, using both conventional printing and electronic methods**

Effective and visually aesthetic design: importance of defining objectives; manipulation of irregular geographic areas and regular components of the map to achieve stated objectives

Map reproduction: methods suitable for conventional map printing by offset litho and through electronic display in GIS

Design: of statistical diagrams and thematic maps using a wide variety of techniques including point symbols, choropleths and isolines; use of symbols, text, colour and scale

Grading grid

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all of the learning outcomes for the unit. The criteria for a pass grade describes the level of achievement required to pass this unit.

Grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	**To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:**	**To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:**
P1 identify and draw a range of simple map projections for a variety of purposes P2 link the various co-ordinate systems used as a basis for geographical information P3 compile data from socio-economic surveys and statistics into a suitable form for presentation in thematic maps and diagrams	M1 process data from a variety of sources into a form suitable for mapping	D1 analyse the output from the graphical representations of the data to produce a report for discussion by a committee
P4 identify geographic features from satellite images and air photographs	M2 quantify data including determination of areas and distances using a variety of methods and compare their effectiveness	
P5 identify the main elements of map design including symbols, text, colour and scale.	M3 apply a range of techniques for the presentation of data, with the emphasis on suitability regarding the context of the data.	D2 evaluate techniques used for presenting data, including suitability, adequacy of detail, aesthetics, design and output (digital vs printed).

Essential guidance for tutors

Delivery

Tutors delivering this unit have opportunities to use a wide range of techniques. Lectures, discussions, seminar presentations, site visits, supervised practicals, research using the internet and/or library resources and the use of personal and/or industrial experience are all suitable. Delivery should stimulate, motivate, educate and enthuse learners. Visiting expert speakers could add to the relevance of the subject.

This unit is intended to give learners practical skills and an understanding of the principles of data analysis and presentation. Wherever possible, the unit should be delivered with regard to individual programmes so that assignment work which involves mainly graphic communication can complement specialist work.

All the learning outcomes are linked and form a logical, consistent and progressive structure, starting by looking at the variety of data available and how they are combined into a coherent and consistent data set suitable for analysis. The unit builds on this through analysis techniques and presentation methods, with the emphasis being on the application of the most suitable.

Teaching and learning strategies should take an integrated learner-centred approach. This involves learners in collecting data, developing consistent data sets, carrying out analysis and presenting the data accordingly. Data could be from existing databases, extracted from maps (such as land use maps), from the internet or collected (as part of the Survey Technology or Town Planning Procedures units, if taken).

Examples should be used continually to support the delivery process and should always reflect real-life and standard practice. For example, the thematic maps used to support the local Unitary Development Plan (UDP) and planning policy guidance are a prime example of the use of such maps and associated data.

Wherever possible links should be forged with relevant employers and, in particular, with the learner's employer, as this will provide an opportunity for learners to relate to areas with which they are familiar. They can use this to supply suitable data and thus inform their study of the selection and design of the most suitable presentation techniques.

Group activities are permissible, but tutors will need to ensure that individual learners are provided with equal experiential and assessment opportunities.

Health, safety and welfare issues are paramount and should be strictly reinforced through close supervision of all workshops and activity areas, and risk assessments must be undertaken prior to practical activities. Centres are advised to read the *Delivery approach* section on page 24, and *Annexe G: Provision and Use of Work Equipment Regulations 1998 (PUWER)*.

Assessment

Evidence for this unit may be gathered from a variety of sources, including well-planned investigative assignments, case studies or reports of practical assignments.

There are many suitable forms of assessment that could be employed, and tutors are encouraged to consider and adopt these where appropriate. Some examples of possible assessment approaches are suggested below. However, these are not intended to be prescriptive or restrictive, and are provided as an illustration of the alternative forms of assessment evidence that would be acceptable. General guidance on the design of suitable assignments is available on page 19 of this specification.

Some criteria can be assessed directly by the tutor during practical activities. If this approach is used suitable evidence would be observation records or witness statements. Guidance on the use of these is provided on the Edexcel website.

Evidence can be produced through well-planned assignments and projects. These will usually be undertaken individually but it is possible to introduce elements of teamwork in the collection or collation of data or simulations. Where available, evidence from the workplace can be incorporated to enhance the learning outcomes. This evidence must be appropriate and authenticated as the learner's own work. Integrative assignments will help to link this unit with other units, especially Town Planning Procedures and Surveying Processes. The volume of evidence required for each assessment should take into account the overall number of assessments being contemplated within this unit and the design of the overall teaching programme.

The structure of the unit suggests that the grading criteria may be fully addressed by using three assignments. The first of these would cover data collection and preparation, (P1, P2, P3, M1 and D1), the second would cover quantitative analysis of the data, (P4 and M2) and the third would cover data presentation (P5, M3 and D2).

To achieve a pass grade learners must meet the five pass criteria listed in the grading grid.

For P1, learners must be able to identify and draw a range of simple map projections for a variety of purposes. They must select these from basic projection types.

For P2, learners must be able to link the various co-ordinate systems used as a basis for geographical information. They must convert data from one projection to another using suitable conversion software available commercially and online.

For P3, learners must be able to compile data from socio-economic surveys and statistics into a suitable form for presentation in thematic maps and diagrams. They must link data sets to form a consistent coherent data set suitable for analysis.

For P4, learners must be able to identify geographic features from satellite images and air photographs. They must carry out basic interpretation of imagery, both satellite and aerial (and may include infra-red and thermal).

The third assignment will provide evidence for the data presentation aspects of this unit. Therefore for P5, learners must be able to identify the main elements of map design including symbols, text, colour and scale. This must be done through the compilation of a basic map.

To achieve a merit grade learners must meet all of the pass grade criteria **and** the three merit grade criteria.

For M1, learners must be able to process data from a variety of sources into a form suitable for mapping. They must select items, allocate symbols and base details and thus produce a basic map from the data.

For M2, learners must be able to quantify data including determination of areas and distances using a variety of methods and compare their effectiveness. This interpretation can be extended to include measurements for the determination of area and distances, with the necessity to adjust for scale and other imagery distortions.

For M3, learners could extend P5 to apply a range of techniques for the presentation of data, with the emphasis on suitability regarding the context of the data. They must show an application of various presentation techniques, including computer (screen) based (animated) and a variety of thematic maps and graphics.

To achieve a distinction grade learners must meet all of the pass and merit grade criteria **and** the two distinction grade criteria.

For D1, learners must be able to analyse the output from the graphical representations of the data to produce a report for discussion by a committee. This must be of a professional standard and should follow on from M1.

To achieve D2, learners must be able to evaluate techniques used for presenting data, including suitability, adequacy of detail, aesthetics, design and output (digital vs printed). This should follow on from M3.

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

The learning outcomes in this unit are closely linked with, for example, *Unit 27: Surveying Technology in Construction and Civil Engineering*, together with similar units at Higher National and degree level.

The unit has links with 2005 CIC Occupational Standards at Level 3 in B22 (Collect, analyse and present measured survey data) and B23 (Select, plan and commission spatial data).

This unit may have links to the Edexcel Level 3 Technical and Professional NVQs for Construction and the Built Environment. Updated information on this, and a summary mapping of the unit to the CIC Occupational Standards, is available from Edexcel. See *Annexe D: National Occupational Standards/mapping with NVQs.*

The unit provides opportunities to gain Level 3 key skills in application of number and information and communication technology. Opportunities for satisfying requirements for Wider Curriculum Mapping are summarised in *Annexe F: Wider curriculum mapping*.

Essential resources

Resources should include access to data sets in a variety of formats, including electronic databases, sample data sets, existing maps and plans, atlases and socio-economic and census data. As much of this information is now available through local and national government websites, access to the internet is essential. There are many websites offering sample data and completed maps (especially www.esra.com, www.arcinfo.com, www.ordnancesurvey.gov.uk and other similar sites for companies dealing with geographical information systems). In addition, official publications such

as PPGs (from www.odpm.gov.uk), Unitary Development Plans (UDPs), local and structure plans from the relevant local authorities.

The use of industry-recognised software would be advantageous, such as AutoCAD, a proprietary GIS such as Arc-Info, Mappoint, AutoMAP, although there are many 'free' mapping applications available as demonstrations, which would be adequate.

Spreadsheets, for example Microsoft Map (part of Office/Excel) will be useful, although not essential, in the teaching and learning strategies and this implies the need for learner access to an ICT resource.

Indicative reading for learners

Textbooks

Delaney J — *Geographical Information Systems: An Introduction* (OUP Australia and New Zealand, 2000) ISBN 0195507894

Huxhold and Levinsohn — *Managing Geographic Information System Projects* (Oxford University Press Inc, USA, 1995) ISBN 0195078691

Jones C B — *Geographical Information Systems and Computer Cartography* (Prentice Hall, 1996) ISBN 0582044391

Kraak and Ormeling — *Visualization of Spatial Data* (Prentice Hall, 2002) ISBN 0130888907

Mather P — *Geographical Information Handling: Research and Handling* (John Wiley and Sons Ltd, 1993) ISBN 0471940607

Robinson, Muehrche, Guptill and Kimberling — *Elements of Cartography* (John Wiley and Sons (WIE), 1993) ISBN 0471555797

Key skills

Achievement of key skills is not a requirement of this qualification but it is encouraged. Suggestions of opportunities for the generation of Level 3 key skill evidence are given here. Tutors should check that learners have produced all the evidence required by part B of the key skills specifications when assessing this evidence. Learners may need to develop additional evidence elsewhere to fully meet the requirements of the key skills specifications.

Application of number Level 3	
When learners are:	**They should be able to develop the following key skills evidence:**
• collecting and analysing data sets • analysing data sets • presenting findings.	N3.1 Plan an activity and get relevant information from relevant sources. N3.2 Use your information to carry out multi-stage calculations to do with: a amounts or sizes b scales or proportion c handling statistics d using formulae. N3.3 Interpret the results of your calculations, present your findings and justify your methods.
Information and communication technology Level 3	
When learners are:	**They should be able to develop the following key skills evidence:**
• collecting and compiling data sets • linking the various data sets together • presenting their data.	ICT3.1 Search for information using different sources, and multiple search criteria in at least one case. ICT3.2 Enter and develop the information and derive new information. ICT3.3 Present combined information such as text with image, text with number, image with number.