Themata 5 E-learning Archaeology, the Heritage Handbook

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E-learning Archaeology

the Heritage Handbook

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SCO Project planning and authorities

Project planning, and authorities.
Archaeological investigations should be carried out early in the planning process, to make it possible to take the results into consideration before approval of Plans – which are legally binding for spatial dispositions and building activities. If this is not done, both archaeological interests and construction projects may suffer.

Planning processes

The planning hierarchy for spatial development is different from country to country. But normally, the National level provides guidelines for the spatial planning, while the regional and local levels provide comprehensive plans – and all these types of plans are normally a public responsibility, even if private companies may produce parts of the plans on behalf of the planning authorities. In addition, at the local level there are 'Local Plans' (even if they may be nominated differently), which provides the legal basis for building activities by giving utility requirements and design criteria. The Local Plans may be produced by local planning authorities or by private developers/clients, but all plans must be approved by the Planning Authorities.

Since the spatial utilization in the Local Plans are legally binding for building activities, archaeological investigations should be carried out prior to production of Local Plans – and thus important input regarding possible protection of sites can be taken into consideration. The Local Plans normally also comprise instructions or recommendations on the extent of archaeological investigations.

Interface between planning and building processes

In most countries, the Local Plans should be approved before detailed design of a construction project starts – and the project should comply with the criteria given by the Local Plan. And in many countries, there are formal or informal procedures to ensure that the intentions of a plan are carried out in the project, and such interpretation levels may consist of visualization plans, mandatory early conferences, two-step applications for building permits or other tools.

However, this is not the case in all countries, and practice can change due to changes in procurement routes. Now, parallel processes for planning (Local Plans) and design are more and more common, and amongst other aspects, this may lead to planning process challenges and neglect of the integration of results from archaeological investigations (as the design processes may be developed too far to fully take results from these investigations into consideration).

Significance of building permits

In many countries a Building Permit is mandatory for all construction works. To obtain this, compliance with an approved Local Plan must be demonstrated, and the client must pay a fee which may be relatively high. The Building Permit may be considered as a 'contract' between the authorities and the client regarding content and design for the project. Changing the design after this point may be both formally complicated, cause significant delays, and be very costly.

Authorities for planning and building

Often there are different authorities for planning and for building activities. The authorities for planning and spatial development are normally delegated from Central Government Ministries.

The authorities for building activities are more diverse, and derived from different ministries in different countries: they may be primarily related to the purpose of the constructions (connected to housing policy etc.) or to the construction sector (economy), or to other aspects. The structures regarding mandates for the Building Control Offices are also diverse: from all activities including issuing of building permits according to approved Local Plans, to merely inspectorates for the construction activities.

> Exercises

SCO Who's who in a construction project

The members of the project team and their role in the project.
The members of the project team and their role in the project will not be the same for all projects, but will depend on the chosen procurement route, and the type, scope and size of the project. Their responsibilities may even change within a project at different stages.

> ***Animation***

Client

The Client (promoter) establishes the project, and is responsible for providing or arranging funding. Clients may be public bodies, limited liability companies, partnerships, sole traders, or developers. Under Health and Safety laws clients have a number of important responsibilities.

Project management

The project manager will normally be appointed by the client to take responsibility for managing the project. National legislation may also add other tasks. Large projects may have several project managers, each responsible for specific sections of the work. In some procurement routes he may be appointed by the contractor. Project Managers will normally be assisted by other specialists.

Controllers and supervisors

Controllers and Supervisors handle different construction issues in different countries (Quality, costs, environmental and health & safety etc.).

Designers

The designers may be hired as a team, or separately. They may be hired directly by the client – with or without a design competition – or by the contractor (or a combination of both). The design team may comprise architects, structural engineers, M&E engineers, specialist consultants, landscape architects and more. For most building projects the architect will act as lead consultant, and co-ordinate the design work.

Contractors

Normally, there will be a principal contractor responsible for ensuring the design is constructed safely and correctly, and will coordinate the work of sub-contractors and specialists where required. Sub-contractors for specialist works, may be hired by the principal contractor or by the client.

For further more detailed information see Handbook.

Additional elements

> Chart 1: Typical construction team format. (see handbook)

> Exercises

SCO Procurement routes & Types of contracts

> ***Animation***

Procurement routes and contracts

Procurement routes and Contracts set the basic principles for managing the project: who has the lead administrative responsibility, takes decisions for what, assumes the economical risk etc. Combinations of the mentioned procurement routes may occur.

Design procurement

Designers may be hired directly by the client, with or without a competition on design. They may also be hired by the contractor, for competitions also on price. Design and price competition may be arranged in several ways.

Contract procurement

Client management: The client enters into separate contracts with a number of contractors. Basically, the client performs the real management, both of design team and contractors. Principal contractor: The client is responsible for design works – the principal contractor is responsible for construction works, with some variations. Turnkey contractor: The contractor is responsible for both design and construction works.

Collaboration agreements

Agreements developed from turnkey contracts, to give the client greater impact on design and project development. The costs are not concluded when the contracts are signed. Public-private partnership (PPP)/lifetime contracts. PPP is sometimes used by public clients, where a company will finance, design, build, manage and maintain large projects - and the public client participates in the process and pays through leasing. 'Lifetime contracts' are similar, but only between private parties.

Development agreements

These are agreements between developers and planning authorities where the developer will do the planning work to suit his project, and agrees to cover more infrastructure costs than normal according to law. The plan will be approved through normal procedures.

Financial arrangements

Money can be paid as fixed amounts (contractor has the risk), unit prices/performed work (client has the risk), or by 'incentive contracts' where both parties share benefits and risks.

For further more detailed information see Handbook.

Additional elements

> Chart 2: Typical format for split contracts/ client management

> Chart 3: Typical format for Principal (Master) Contractor
> Chart 4: Typical format for General Contractor
> Chart 5: Typical format for Turnkey Contractor
> Exercises

SCO Public clients – Contractual/financial issues

> *Animation*

Public clients obligations

Public clients build infrastructure projects and buildings for public facilities. They are obliged by law to have competitive procurement systems. They spend public money granted by politicians and are committed to include the finance needed to cover the costs of archaeological activities.

Laws on public procurement

EU/EEA legislation requires public clients to have competitions on all public procurements to ensure that public money is spent efficiently, and to give all parties an equal chance to obtain public contracts. These principles are part of national legislation, for projects over certain sizes (thresholds).

Competitions

Competitions on design concepts are used in early stages for obtaining the best concept, and for the engagement of designers. Evaluations are performed by a jury. Competitions on price are most often used for contractors, when the projects are already defined ('lowest bidder'). Competitions with more complex evaluation criteria – as design, price, quality and other elements – are aimed at getting the 'best bidder'.

Funding

Public clients spend public money – using funding granted by politicians. When money is granted, costs for archaeological activities may easily be included – but exceeding budgets may cause problems.

Impact on archaeological activities

Competition may impact on the continuity of parties on the construction site, and more. Continuity can not be ensured unless the chosen procurement route is based on a model where the same parties participate in a competition for the whole project from the beginning.

For further more detailed information see Handbook.

> Exercises

SCO Private clients – Contractual/financial issues

> *Animation*

Private clients

Private clients commission commercial buildings and housing projects, for sale or rent. In addition, in Public-private partnerships, the contractors may even act as private clients on behalf of public interests. They are very sensitive to 'additional' costs caused by archaeological activities.

Types of private client

Private clients represent a wide range in terms of size and type: Some private clients are large professional developers or companies, others may be non-professional companies or private persons just building 'once in their lifetime' – and they may be financially more or less vulnerable.

Contractual issues

Private clients are not obliged by law to have competition on procurements, but they often choose to because they may obtain cheaper prices. Private clients may also hire companies they know by positive earlier experiences. However, they will also sign contracts based on business practice in accordance with the procurement route adopted.

The real estate market part 1

Private clients depend upon sale/renting of the completed project in a market where they compete with projects which do not have any 'additional' costs for archaeology. The knowledge of existing archaeology prior to the planning process will then be very important, as the estimated costs for excavations may determine whether the client can afford to invest in the project or not. Additional costs due to 'surprises' may be critical.

The real estate market part 2

with 'additional costs' which will not give the customer 'added value' (speaking of the 'built product'), unless the report from the archaeologists could be used in the promotion of the project as 'virtual added value'. When these reports are delayed, such promotion is not possible, which causes the client problems. The cyclical nature of the construction market is an economical challenge regarding sale/renting: when the market is 'down' clients will suffer loss of profit.

For further more detailed information see Handbook.

> Exercises

→ LU Technological aspects *by Kenneth Aitchison*

SCO Engineering Soils

> ***Animation***

Definition

Construction soil he top layer of the earth's surface, consisting of rock and mineral particles mixed with organic matter, which is located under the building object foundations.

Standards and Eurocode

The last EU soil classificationis made to recent 'Eurocode 7 related modifications'. The full recommendations of the Eurocode are being implemented in EU countries, meanwhile readers are advised to be aware that published text books are likely to make little reference to the Eurocode 7 (ie. EN 1997) and there are some major differences in the way that soils are described. British reader should be aware that the final National Annex to BS EN 1997 was due to be published on 31st March 2009 and that sections of BS1377 and BS5930 are currently being re-written so that they comply fully with the Eurocode). Purpose of soil classification: Provides a concise and systematic method for designating various types of soil. Enables useful engineering conclusions to be made about soil properties. Provides a common language for the transmission of information. Permits the precise presentation of boring records and test results.

Practical soil classification

Table below show categories of soil – division depends on the easiness of excavation performance.
Types V and VI– loesses and clays with more stones. Higher categories: hundreds of different types of rocks: from lime stone to granite and basalt, as well diamonds.

Chosen soil properties

Chosen soil properties (to be investigated by geological and geotechnical specialist prior the construction started)

> Exercises

SCO Plant and equipment

European clasification of machines and equipment for earthworks.

> ***Animation***

Standard ISO/TR 12603 provides the European classification of construction machines according to their use within the framework of individual work groups:

100 Earth-moving machines and equipment:
preliminary earthworks and wide excavations: 110 bulldozers: wheel, caterpillar, 120 loaders; wheel, caterpillar, 130 digger-loaders; wheel, caterpillar; 140 diggers; hydraulic, drag line excavators, bucket wheel diggers, bucket chain excavators, demolition equipment, transport of soil: 150 articulated dump trucks, tipper trucks earthworks, finishing: 160 scrapers, 170 graders, narrow and pit excavations: 180 ditch diggers, 190 pipe-laying machines.

200 Foundation and compacting machinery and equipment:
piling and gaps: 210 ramming and removal of piles (pile drivers), extracting equipment, probing equipment, pile forming equipment, 220 boring rigs and equipment for performing gaps, soil compacting: 230 rollers, plain-bodied rollers, rubber-wheeled rollers, other rollers, 240 compacting equipment: rammers, vibratory plates.

The range of plant used for various purposes will include general earth moving equipment, lifting and transport machinery, compaction plant and also other specialist equipment such as piling rigs.

> Diagrams of different construction plant are shown in figure 1

Use and costs of the machinery

Commonly plant on site during the early stages of a project, when archaeological investigation is being undertaken, will be related to earth moving and foundation installation such as piling rigs. An indication of the costs of plant and machinery is given in the Handbook.

Further reading

The following list of websites contains manufacturer's information for a wide range of construction plant.
http://www.aarsleff.co.uk/rigs/ (Examples of piling rigs)
http://www.liebherr.com/lh/en/default_lh.asp (Manufacturer of mobile cranes, excavators and telescopic handlers)
http://www.craneit.com/ (Directory of links to crane related information)
http://unitedkingdom.cat.com/cda/layout?m=234301&x=7 (Manufacturer of wide range of construction machines)
http://www.bobcat.com/ (Manufacturer of excavators and other construction plant)
http://www.jcb.com/products/machinerange.aspx?tabID=4 (Manufacturer of wide range of construction plant)
Basic information concerning plant and machinery is contained in Handbook.

> Exercises

sco In ground structures in Rural areas

Typical in ground structures in rural areas

Typical in ground structures in rural areas are Highways, Bridges, Railway-Transportation Lines, Tunnels, Foundations, Water Resources, Electrical and Telecommunication Lines, Environmental, Coastal and Port Engineering structures.

> *Animation*

Highway structures

Highway structures are road formations, banquette, curbs, side walks, traffic barriers, surfacing, surface-drainage systems, pavements, traffic control and safety systems and intersections.

Bridges

Bridges can be grouped as highway or railway bridges and viaducts, canal bridges and aqueducts, culverts, pedestrian or cattle crossings, material-handling bridges, pipeline bridges, bridges over highways and railways, river bridges, bay-, lake-, slough- and valley-crossings.

Railways

Railway-Transportation structures involve roadbeds, tracks, bridges, trestles, culverts, yards, terminals, stations, office buildings, locomotive fueling facilities, environmental protection facilities, signals and communications, track-side protection devices, and railroad-car, locomotive, and transit-vehicle maintenance facilities.

Tunnel

Tunnel structures can be classified as railroad tunnels, rapid-transit tunnels, highway tunnels, water tunnels, sewer and drainage tunnels, cut- and cover-tunnels, immersed tunnels.

Water resource structures

Water resource structures primarily deal with collection, flow control, transmission, storage, and distribution; piping, culverts, open channels, well construction, reservoirs, water treatment plants and dams.

Major environmental structures

Major environmental structures are sewage networks, collecting systems, storm water collecting networks, solid waste and waste water treatment plants.

Coastal and port engineering structures

Coastal and port engineering works in the coastal environment are harbours and marina developments, shoreline protection, beach nourishment, and other constructed systems in the coastal wave and tidal environments.

For further more detailed information see Handbook.

> Exercises

sco In ground structures in Urban areas

> *Animation*

Typical in ground structures in urban areas

Typical in ground structures in urban areas are the same as defined in rural areas, except that, airports can be defined to be belonging to urban area. Highways, Bridges, Railway-Transportation Lines, Tunnels, Foundations, Water Resources, Electrical, Telecommunication Lines, Environmental, Coastal and Port Engineering structures are also constructed in urban areas.

Important differences between urban and rural areas structures

The difference between rural and urban areas is the higher density of construction which exists in the urban environment. As most construction is related to the population of the area, the construction parametres and characteristics differ from rural areas.

Water distribution systems feature larger pipes in urban areas and tunnels are used for infrastructure solutions in major cities whereas in the towns, the pipes and infrastructure are directly buried under the ground without tunnels. Areas of denser population need wider streets, roads and highways with more lanes whereas in rural areas narrower roads are constructed according to the needs of the low population.

For further more detailed information see Handbook.

> Exercises

→ LU Health, safety and environment protection

by Kenneth Aitchison

sco Health & Safety

> *Animation*

Importance of health and safety issues

Health and Safety is a key consideration on Construction Sites and is often regulated by Local or National control authorities. These regulations require certain members of the Design and Construction team, including Archaeologists, to take appropriate actions and take responsibility for the health and safety of those involved in the construction, maintenance and eventual demolition of a construction.

Archaeologists are involved in site activity and this is controlled by the regulations which means that they should have an input into designing the Archaeological works such that the works are carried out safely.

Construction employees duties in terms of h&s

All workers on site including Archaeologists, as a minimum must:

> Co-operate with others and co-ordinate works so as to ensure health and safety of all on site,
> Co-operate with others and co-ordinate works so as to ensure health and safety of all on site,
> Make others working on site aware of their presence,
> Check on their own competence to carry out the tasks required of them,
> Immediately report obvious risks,
> Give feedback to their employer via an agreed consultation method,
> Provide input to risk assessments and the development of task specific method statements,
> Work to the agreed method statements,
> Use welfare facilities with respect,
> Make full use of personal protection equipment,
> Look after tools and personal protection equipment,
> Be aware of the actions to be taken when dangerous situations arise.

For more detailed information see Handbook.
> Exercises

SCO Contaminated land

Risks c onnected with contaminated land

Archaeologists need to make themselves aware of any risks associated with contaminated land. This is done by inspecting all survey information which has been prepared by the Engineering team for the project. The risk of contamination has to be addressed by the design team during the planning phase of a project and this evidence must be provided to all who are likely to be working on the site.

Definition of contaminated land

A definition of contaminated land is: Land or rivers where poisonous substances exist in a form which can, upon contact, be harmful to crops, livestock, fish or humans.

Archaeologists should be aware, that in the case of a site being deemed to be contaminated, they must be in possession of an up to date risk assessment of the site and the corresponding health and safety plan which addresses these risks.

Source-pathway-receptor model

A competent risk assessment will describe the level of risk which exists in terms of the source-pathway-receptor model. It must describe the actions which are necessary to remove the risk or at least mitigate it to a safe level.

A competent health and safety plan will describe the precautions which must be taken to eliminate exposure to contamination.

For further information see Handbook.
> Exercises

→ LU Running the construction investment project *by Kenneth Aitchison*

SCO Stages in the building project – including timescales

History and presence of in the construction projects' stages. In the past the stages in a building project were clearly defined, and one stage ended before the next stage started. Now, due to increased speed, the stages overlap, and are defined differently for different procurement routes.

The stages in 'classical' terms

> *Initial phase.* Identification of the functional needs, visions, goals, timescales, economical and technical possibilities/ limitations, and choice of procurement route.
> *Design phase.* Defining the project, development of concept design and final technical solutions.
> *Construction phase.* Detailed design, construction works.

Guarantee period, Facility management (FM) phase. Correction of defects, evaluations, use and maintenance.

Building projects start during the initial phase and end within the FM-phase, shortly after the completion of construction works.

Overlaps and milestones

Depending on the chosen procurement route, there will be overlaps of stages in different ways – and the distinctions between the stages may then be less important. But where competitions are to be carried out, approvals to be sent, or contracts to be started or ended, there will be milestones which must be kept on schedule, these milestones are important for both practical, economical and formal reasons.

Timescales

Co-ordination of those involved in construction projects represents a complicated puzzle and needs meticulous planning. All actions for those involved must be plotted into the project programme – both main activities and detailed activities and milestones clearly identified

Timescales are the most important management tool for complicated building project, and should include archaeological works. It is vital that all the work is kept on schedule.

For further more detailed information see Handbook.

Additional elements

> Chart 6: Typical format for simplified stages in a construction project
> Chart 7: Typical format for stages in traditional procurement routes
> Chart 8: Typical format for more complex picture of stages, and for several procurement routes
> Chart 9: Example of a typical timescale
> Exercises

SCO Design process

> ***Animation***

Selection of the desing team

The design team may be hired by the client or contractor, with or without design competition, but the design work itself will be basically the same for all procurement routes.

Design process

Feasibility studies aim at defining the project, and include studies of possibilities and limitations of the construction site, and most often involve all users and stakeholders.
Design brief is the main concept of the project, to be used for the first application for planning approval/building permit. The design team must identify the designs.
Detailed design must be based on the approved design brief, and may continue in parallel with the construction works.
Drawings have been produced on computers since early 1980's (several types of software). The number of drawings and associated information has steadily increased, and coordination is a challenge. A new tool; Building Information Model (BIM) is a digital communication platform which assists coordination. Use of BIM improves the interaction between those involved.

Formal procedures

Design criteria are given by Local Plans and other legislation, and may present limitations. Clients may also define design criteria, for economical/contractual reasons.
Building permits are legally binding, and projects must comply with the given design criteria. Major changes of projects will need new formal approval. Completion certificates will require 'as-built'-documentation, proving that the project is performed as approved.

Changes of design

The implications of changing the design include cost and delays. The consequences of change will escalate rapidly after approval of the building permit, and the costs related to changes are considerable after the start of construction on site. Any change of design caused by archaeological discoveries should therefore be identified as early as possible.

For further more detailed information see Handbook.

Additional elements

> Chart 10: Typical process cycle for construction projects
> Exercises

SCO Pre-planning desk top investigations

> ***Animation***

Importance of the pre-planning desk top investigations.
Pre-planning desk top investigations are important to determine the nature and characteristics of the future steps in any construction. Most of the time, they are also the cheapest way of identifying the characteristics of the site. Typically they may identify obstructions, underground services, in ground structures, geotechnical conditions, environmental hazards and archaeological remains.
According to results of them, the extent and nature of site investigations can be determined. In that sense, this stage can be helpful when evaluating cost of the next stages to achieve best value. These investigations may show site conditions which can sometimes cause changes and/or a halt to the entire project.
What pre-planning desk top investigations do include?
Pre-planning desk top investigations includes primarily the work done without visiting the site and/or getting samples from the site. Typically they include; a review of existing reports, papers and any other document related to the site of interest that can be obtained via internet, libraries, museums, municipalities, local offices, etc. Inspection of any available topographic maps of the area and the study of current and past aerial photographs and satellite photographs can be very useful at this stage. Some maps or databases prepared by local authorities to show the land use and characteristics of the study area can also be great help (e.g., site of previous uses database, geological maps, geotechnical maps, hydro-geological maps, seismic hazard maps, etc.). The use of land for certain activities can be a good indicator of possible environmental problems.

For further more detailed information see Handbook.
> Exercises

SCO Geotechnical evaluation

Definition of geotechnical site investigations

Site investigation can be defined as the process by which geological, geotechnical, and other relevant information which might affect the construction or performance of a civil engineering or building project is acquired. Every structure has to be constructed in or on ground and a site investigation is required for a safe and economic structure. In this sense, site investigation is very important step of any construction project and activity. It has been realized that spending a small amount of the total construction budget at the beginning for the site investigation can save significant levels of cost particularly if unforeseen problems are discovered during engineering works.

Important soil properties

The ground at the site of interest may consist of rock and/or soil. In the majority of the construction cases, soil is the primary material that engineers have to deal with, though tunneling can involve rock strata. Soils are, in nature, generally heterogeneous and irregular, often having properties which are undesirable from the point of view of a proposed structure. The geological and engineering properties of soil are generally characterized by geotechnical parameters (such as strength, compressibility, and permeability of soil) which are also used in the design process. Among others, the design involves the decisions about the type and size of foundations of the structures, slope stability, retaining structures, remediation of soils, etc. The primary aim of the geotechnical site characterization is mainly to determine those geotechnical parameters. Specialists in geotechnical parameters are normally civil engineers and in most countries they will often have a postgraduate geotechnical education: such people are termed 'geotechnical engineers'. Geologists with an interest in the relevance of geology to civil engineering or building construction are called 'engineering geologists'.

For further more detailed information see Handbook.
> Exercises

SCO Environmental Evaluation

Assessment of environmental impact in construction.
Every construction has influence on the environment and conversely environmental issues influence construction. It is almost compulsory in every country to have an environmental impact assessment for new construction that shows non-existence of or minimized adverse effects on the environment by the new structure. An environmental assessment can be regarded as a procedure that ensures that the environmental implications of decisions are taken into account before the design is completed

Elements of environmental impact studies

The existence of contamination on a construction site is a serious problem and it may require expensive solutions. In general, previous use of the land provides important clues about the possible contamination. If the site is contaminated, the contaminated soil should be subject to remediation processes. At this stage, remedial investigations and feasibility studies become important. Waste remediation efforts are heavily influenced by or dictated by statutory and regulatory compliance. In general, regulatory standards and guidance provide very prescriptive procedural and technical requirements.

Soil exploration studies, including archaeological investigations, are also affected by the existence of contamination. Regular geotechnical methods should be applied with caution. Sampling quality without cross-contamination is a very important consideration. In some cases geophysical techniques are preferred to avoid exposure to the contaminated samples.

For further more detailed information see Handbook.
> Exercises

SCO Site investigation techniques

Importance of site investigation

Every site investigation should be planned properly. The planning will cover all aspects of site investigation from general to specific and may include some of the following: the desk study and walk-over survey; subsurface exploration including engineering geophysics, boring, drilling, probing and trial pitting; sampling (undisturbed or disturbed); laboratory and/or field testing.

Elements of geotechnical site investigation

Geotechnical site investigations aim to determine the following information related to conditions at the site: source and nature of the soil deposits, soil profile, location of the bedrock, location and variation in the ground water table, and engineering properties of the soil. According to the needs, various methods of subsurface exploration, laboratory and/or field testing can be used. Laboratory and field tests are critical to determine the engineering properties of the soil. There exist empirical and semi empirical relationships that correlate measured values in the field with the design geotechnical parameters. Standard penetration tests (SPT) and cone penetration tests (CPT) are the most commonly used geotechnical tests around the world. Vibration penetration tests (VPT) are also used in some contexts.

Methods of geophysical research

In recent years, geophysical techniques for subsurface site characterization have become increasingly common. Geophysical methods encompass a wide range of surface (e.g., ground penetrating radar, resistively, seismic refraction, seismic reflection) and down hole measurement (e.g., nuclear and non-nuclear logs) techniques which provide a means of investigating subsurface hydro-geologic and geologic conditions, and locating materials buried underground such as pipelines or archeological remnants. Because geophysical measurements can be made relatively quickly, they provide means to increase sample density, hence eliminate one primary factor that limits the accuracy of site characterization.

For further more detailed information see Handbook.

> Exercises

SCO Risk management

Elements of risk management

Risk management is an issue that covers all aspects of any construction including financial and economic conditions. It is one of the most important issues for the avoidance of foreseeable and unforeseeable developments. Unforeseen environmental and/or geotechnical problems at the site often substantially increase the cost of the construction and cause delays. A comprehensive site investigation is crucial to reduce some of the risks associated with construction.

Is the archaeology a risk?

The existence of archaeological and cultural remnants at a site can be considered as a risk for construction. If it is not foreseen before the construction starts, significant delay to the construction phase can be expected until an appropriate solution can be found to deal with the remains at the site. The existence of archeological remains should be considered as early as possible in the feasibility and design stages of projects, hence preventing unexpected and unplanned consequences. This may also provide opportunities to add value to a project by integrating aspects of the historic environment with the final design, generating community benefits and positive publicity.

For further more detailed information see Handbook.

> Exercises

SCO Physical mitigation

Elements of risk management

Physical Mitigation means the reduction and possible avoidance of the detrimental impact of Engineering Works on

Archaeological remains

When planning Engineering Works a prime consideration is the spatial relationship which exists between the Archaeology and the Engineering works. It is vitally important that the vertical stratification of the sub-soil is accurately determined in terms of where the Archaeology exists and where suitable load bearing strata are situated. It is also vital that the horizontal distribution of Archaeology is accurately assessed. This will identify whether the Engineering works will be above or below the level occupied by Archaeology and whether there are sufficient locations in and around the Archaeology to place them. This sets the criteria for the mitigation strategy and identifies whether it is an avoidance strategy or a minimisation strategy.

Mitigation by minimal intrusion

Mitigation by minimal intrusion requires close collaboration between the Engineer and Archaeologist. It requires the Archaeologist to identify areas of the site where archaeology can either be recorded and removed or recorded and then disturbed by Engineering Works. Where it can be removed Engineering Works may be constructed in the cleared areas. Where Archaeology can be disturbed a percentage area of loss should be agreed and the works designed within these parameters. Piling is frequently used to minimise loss of Archaeology.

Building services

Most sites will require building services:
Utilities (Electricity, Gas, Water, Drainage)
Data and communications ducts
Where Archaeology is at depth, services may be placed above.
Where Archaeology is shallow the methodology of Minimal Intrusion should be adopted.

For further more detailed information see Handbook.

> Exercises

SCO Contractual aspects of Mitigation

Importance of mitigation design

Mitigation design is carried out using the best data available at the time. The design team may have complete confidence in the data or they may have less than complete confidence in the reliability of the data. If the data is accurate then the mitigation design will cater for the actual conditions which will arise on site during the construction process and as a result the contractor's work will not be subject to alteration. However the reliability of data concerning any hidden obstructions (e.g. Archaeology) or geotechnical conditions (e.g. Soil Strength) is dependant upon the quality of the survey. Only on sites where access is complete, as in the case of Greenfield sites, can a survey be considered to be truly comprehensive. In all other situations there is a risk that the contractor will encounter unforeseen ground conditions in the form of unknown Archaeological obstructions or poor sub-soils.

How to limit risk

To limit the risk of time and expense claims from the contractor it is best practice to make some allowance within the contract to enable the contractor to price reasonable risk. Clauses within the conditions of contract will set out what rules apply to the discovery of unforeseen ground conditions and what steps the various parties involved in the contract must take.

The Engineer and Archaeologist should inform the Project Manager of the level of risk they believe exists on site and the possible nature of disruption to the contractor which may result. This enables the Project Manager to make reasonable provision in the contract for the risk.

For further more detailed information see Handbook.

> Exercises

→ LU Importance of archaeologists and engineers co-operation *by Kenneth Aitchison*

SCO Pre-excavation ground modeling

Digital techniques

Today there are digital techniques employed which are used to describe site conditions and superimpose future constructions. Examples showing these techniques are:

Anthropogenic elements recorded in subsurface structures, deposits and subsurface features are:

- terraces and irrigation-canals for farming,
- cuttings and embankments from railway- and road-engineering,
- dikes and channels for flood defence,
- landfills for relief levelling,
- as well as banks and ditches from e.g. military constructions and fortifications,
- quarries, pits and dumps from mining-activity.

> See figure 2

Why use GIS?

Research-focus is to provide a guideline on how to locate and characterize and model man made ground, by using historic-geographical techniques and the latest Surface Information Systems such as Geographical Information Systems (GIS) and subsurface Geoscientific Information Systems (GSIS) such as GSI3D.

How to use GIS?

Timelapse Land-use sequences from historic maps and drawings, historical reports, archaeological excavations as well as from aerial photographs are constructed (figure 2). The structures and distribution of man-made ground deriving from the cartographical work provide potential boundaries and outcrops of artificial ground units. These data sets, in combination with borehole information, are integrated into a subsurface modelling software (GIS3D and the respective subsurface viewer), where sediment units can be addressed and distinguished by means of their 3-dimensional relationship, regarding textural, lithological, morphological as well as genetical features and properties.

> See figure 2

> Exercises

SCO Construction - Advanced works

Why carry out archaeological advanced works?

Advanced archaeological works represent good practice as archaeological remains are evaluated, recorded and possibly removed prior to the start of construction works. The main advantage of archaeological works carried out under an advance works contract is the reduction in potential impacts on the rest of the construction programme should any unforeseen discoveries be made.

When to start archaeological advanced works?

The period before the construction phase of a project starts can be used to put in place an appropriate mitigation strategy. There are of course situations where undertaking archaeological excavation ahead of the main construction phase will not be appropriate, as mentioned when the proposed site is still in use. Then it may be impossible for the appropriate sections to be adequately sectioned off. The use of advance works will also only be possible where some certainty that adequate finance is in place for the development to proceed and where the developer already owns the site.

For further more detailed information see Handbook.
> Exercises

SCO Construction – Concurrent working
Where there is no possibility of having an advanced works contract then the site works should be planned in such a way that the contractor and archaeologists do not clash on site. Archaeologists and engineers must co-operate.

Once the need for excavation to preserve archaeological evidence has been determined, the developer must build adequate time into the construction programme for excavation to take place. The length of time required and the length of time allowed can potentially be a source of conflict between archaeologist and developer, however as the programme of excavation must be agreed with the curator before planning permission will be granted then negotiations should lead to an acceptable period for all. In achieving an agreement which is satisfactory to both parties it is recommended that a detailed specification based on the archaeologists' scope of works is agreed.

How to plan concurent works properly?
Where possible the plan of work for both the archaeologists and the contractor should ensure that the archaeological excavation is completed before the contractor needs access to that area of the site. However the contractor's activities in other areas of the site can proceed in parallel with the archaeological excavation. Close collaboration is required between both parties when working in this way, particularly with regard to health and safety.

For further more detailed information see Handbook.
> Exercises

SCO Construction – watching brief
Where watching brief should be used?
A watching brief is used when there is a need to have an archaeologist on site at the time of excavation works for the purpose of indentifying the presence of archaeological remains which require recording. Unless there is excellent colaboration between the archaeologist and contractor during this process serious conflict can arise leading to contractural disputes.

Elements of watching brief
A watching brief can involve the planning, execution, and control of construction operations for any of the aforementioned types of construction. Planning requires scheduling of the work and selection of construction methods and equipment to be used. Initially, a detailed study of the contract documents is required. This is followed by the establishment of a sequence of construction operations. Subsequent planning steps involve selection of construction methods and equipment to be used for each work item to meet the Schedule; preparation of a master, or general construction schedule; development of schedules for procurement of labor, materials, and equipment; and forecasts of expenditures and income for the project. In any construction area, where the desk study and site evaluation suggest that excavation is not necessary but archaeological remains are known to exist or where there are no known archaeological remains but the potential for discovery remains high it may be appropriate for a watching brief to be undertaken.

Developer, contractor and archaeological consultant co-operation
Where a watching brief is required the archaeologist will be engaged directly by the developer who will agree to give sufficient time to identify and record archaeological finds and features. In many cases the watching brief strategy will not be an ideal solution for either party, in many cases the excavation techniques employed by construction workers can lead to archaeological evidence being damaged before it can be fully evaluated and developers can become frustrated by the excavation process if they don't fully appreciate what is involved. Again, a detailed specification and strong communication links between the developer, contractor and archaeological consultant will improve the working relationship.

For further more detailed information see Handbook.
> Exercises

→ LU Engineering Works in a Historic Landscape Context *by Kenneth Aitchison*

SCO *Case study* – Fulham Palace, London
Fulham Palace is a Grade I listed building standing within a Scheduled Monument and is the single most significant heritage asset within the London Borough of Hammersmith & Fulham.
In October 2006, in partnership with The Fulham Palace Trust and with major financial support from the Heritage Lottery

Fund, the London Borough of Hammersmith and Fulham successfully completed the first phase of refurbishment of the Palace.

Scope of works
The scope of the works to the Palace and its grounds was extensive, comprising significant internal restoration and refurbishment and a comprehensive renewal of services throughout the site. Installation of all new services was designed to protect any areas of intact archaeological strata from being subdivided or interrupted unnecessarily. New services were therefore positioned either to follow, or run tight to corridors of previous disturbance by existing services.

Proper strategy
The archaeological strategy adopted during the project successfully delivered a meaningful archaeological record whilst maintaining the momentum of the refurbishment work.

Project planning benefited from previous detailed assessment of the historic buildings and archaeological remains. Careful consideration of the proposed design and contract methodology at an early stage in the refurbishment project, by conservation and archaeological professionals, helped to minimise any adverse effects on historic fabric and buried archaeological remains.

The project design highlighted areas in which extant archaeological remains were at risk from the new work and provided a proactive framework for integrating groundworks and archaeological recording.
Pre-emptive excavation and recording in programme-critical areas were undertaken.

Ongoing archaeological recording identified potential obstacles to the refurbishment works and informed the development of engineering solutions.

For further more detailed information see Handbook.
> Exercises

→ **LU** Urban (brown field) – Poland *by Kenneth Aitchison*

SCO *Case study*
> ***Animation***

Some history
The Palace was originally the residence of the Morsztyn family (construction between 1661-1664) The building was purchased by King Augustus II (1713) and enlarged and used by both him and his successor, Augustus III. In 1842 the Palace finally assumed its final shape and in 1925 the Tomb of the Unknown Soldier was added to the series of colonnades. Building served as the seat of the Polish General Staff (figure 1). The Palace was flattened by retreating German army, only the Tomb of the Unknown Soldier surviving the blasts (figure 2).

Reconstruction trial
For 60 years only the Tomb of Unknown Soldier was visible on the Saski (nowadays Piłsudski's) Square. In 2005 City council of Warsaw has decided to spend the 201 million złoty to rebuild Saski Palace (figure 3). Budimex Dromex have been awarded the tender to undertake the work at 21st June 2006. Completion was set for 2009 (figure 3).

Lesson learned
Some elements of the project caused lack of success: Contractor was obliged to do some of the pre-designing works only. Sappers did not find any undetonated devices. Contractor did not prepared comprehensive archaeological research. Builders, during excavations, have found over 10,000 rare archaeological finds including baroque sculptures, secret tunnels, ancient wells, German helmets and wine glasses bearing August III's monogram. No provision was made for discoveries of this scale, although – still optimistic – organized special 'days of archaeology' on site - in November 2006 for several days citizens of Warsaw got the chance to visit the cellars of the former Palace. According to the plan - the cellars supposed to be

demolished to clean the space for future underground parking purpose (figure 4). According to archaeological research, the importance of findings was so high, that Warsaw Monuments Preservation Office decided to protect the area by introducing the cellars to the Protected Monument Register (in July 2007) - which made further construction of the Palace impossible.

> See figure 1, 2, 3 & 4

Present state

The last elements of the project were as follows: in January 2008 the agreement (for construction of the Palace) between the Contractor and City Council of Warsaw was cancelled (the city and contractor financial loss was not announced).

From September to November 2008 new contractor (Mostostal) was appointed to professionally cover and protect the cellars. The contract was signed for 2,2 mln złoty (500 thousand EUR). The cellars' walls will be cleaned, protected against fungus, covered with geotextile and filled with sand. On top layer of humus (25 cm) was foreseen.

Future???

Recently City Council open a tender for another 'pre-design' of the Palace. Only one company sent the tender documents (Polish-Belgium design office 'Projekt', the same company which design the Palace in 2006). Designers have to answer the question – how to build the Palace, saving the cellars with their archaeological deposits.

Future of the Palace is the real enigma (the fact is – it was in this building that the German Enigma machine cipher was first broken in December 1932!).

> Exercises

→ **LU** Best practice Norway – Marine *by Kenneth Aitchison*

SCO *Case study* – Oslo harbour

The redevelopment of road E18 in the eastern part of the Oslo fjord was started in 2005 and will finish in 2010. The project is an immersed tunnel, 1100 m long and 15 m deep underneath the areas of Bjørvika and Bispevika. The development area has been the central harbor area of Oslo for the last 1000 years, and the operation will be the most extensive redevelopment of any historical harbor in Norway. Excavation was undertaken on land and in water, in both polluted and uncontaminated areas. No site investigation prior to the construction phase was possible. The excavation is a unique marine excavation. Unlike ordinary investigation work, this investigation was undertaken as 1) surveillance during the construction work and 2) there was continuous digging during the investigation and excavation phase.

On the harbour side, as a means to protect the areas where the artefacts were located, a Coffer Dam was formed. Excavated material was moved to designated areas where the archaeologists could examine them. The finds were documented in relation to position, and a map of the site and its finds was created.

Under the polluted sea, machinery excavated cultural layers from the seafloor and brought the material to the surface. This was placed on a barge; the archaeologists could then examine the contents.

Best practice

> Research stage:

The project initiator should provide the archaeological sector with an overview of the use of the area. The area of development should be archaeologically surveyed. To prevent delays to the project, all parties need to establish good communication from the outset. The harbour authority's archives hold the best information on earlier harbour use and alteration.

> Excavation stage:

Regular meetings between the involved parties are required as a means to avoid major misunderstandings. The construction sector often uses different personnel for the planning and the construction phase. It is important that both parties cooperate fully with the archaeological sector as early as possible.

For further more detailed information see Handbook.

→ **LU** Turkey – Subterranean *by Kenneth Aitchison*

SCO *Case study* – Marmaray Project

The Marmaray Project provides a full upgrading of the worn out commuter rail system in Istanbul, connecting Halkali on the European side with Gebze on the Asian side with an uninterrupted, modern, high-capacity commuter rail system. Two existing railway tracks on both sides of Bosphorus will be fully upgraded to three tracks and connected to each other through a two track railway tunnel under Istanbul and the Bosphorus. The line goes underground at Yedikule, continues through the Yenikapi and Sirkeci new underground stations, passes under the Bosphorus, connects to the Uskudar new underground station and emerges at Sogutlucesme.

The interaction between construction and archaeology was extensive during the Project. It is considered one of the success stories where there were gains in terms of both the Project and archeological and cultural heritage. Many discoveries were made. The archeological studies at the sites of Marmaray Project had important ramifications. It was shown that the history of Istanbul went back as early as 8000 B.C. Furthermore, the first harbour archaeological excavation in Turkey with such a extensive coverage was performed during Marmaray Project. Many archaeological findings were discovered during the harbour excavations. It is known that similar harbours exist in different parts of Turkey. It is expected that the experience gained here will contribute to many harbour excavations in other parts of Turkey.

For further more detailed information see Handbook.

> Highlights of best practices in Marmaray Project:

The strategy of interaction between archeology and construction had been determined before the beginning of construction. A certain amount of budget was itemized for archeological works. Archaeologists were working continuously on the site of constructions. Some delays and changes in project were accommodated in the construction to save historical remains. Archaeological artifacts were protected carefully and exhibited at various museums.

> Exercises