JBM Guidance on providing evidence for programmes of Further Learning to Master's level for CEng

Introduction

Chartered Engineers are characterised by their ability to develop appropriate solutions to engineering problems, using new or existing technologies, through innovation, creativity and change. They might develop and apply new technologies, promote advanced designs and design methods, introduce new and more efficient production techniques, marketing and construction concepts, or pioneer new engineering services and management methods. Chartered Engineers are variously engaged in technical and commercial leadership and possess effective interpersonal skills. (UK-SPEC)

This document provides guidance and contains examples of some types of activities and evidence which could be undertaken and submitted to complete the appropriate Learning Outcomes (LOs) to demonstrate further learning (FL) to Masters' level for CEng. **It should be read in conjunction with the JBM Requirements for Further Learning Programmes to CEng (FLJBM09a).** Those requirements include, for example, the minimum overall number of LOs to be included in 'Technical' and Non-technical' FL programmes and the number of LOs from each of the 6 broad areas of learning (Science and Mathematics etc.).

This document is guidance, not requirements. The opportunities available for learning will vary with the nature of each participant's work as a professional engineer and therefore the further learning plan should be tailored to the individual and their work/company context. Work opportunities provide a springboard for the required further learning, but additional private study will almost certainly be needed to enable participants to fully meet all the requirements.

The expectation of the JBM is that the LOs can be addressed as outlined below but it is emphasised that this is only indicative guidance and that it is the responsibility of each participant to prepare a learning plan of how they propose to achieve the desired educational base and, more importantly, evidence which demonstrates they have done so, to the satisfaction of the assessors. Some examples of activities and evidence are given as guidance of how an LO can be completed, but it is emphasised that the wording of the LO itself is the high level requirement, not the activities or examples as described. Other activities and evidence may be used to demonstrate the required learning at Masters' level.

It is appreciated that engineers usually work in teams, with supervision/oversight, so the evidence should make clear what their input was to each example, and how that related to the wider team.

Masters' Level

Some examples of general approaches that can help a participant demonstrate Masters' level learning on the topic of a learning outcome are:

- Using one (or perhaps two) specific examples that they have been active in – examples are much more effective evidence than general claims/statements
- Show an ability to critically evaluate particular situations and outcomes using engineering principles
- Demonstrate insightful assessment of a range of risks for a project and critical appraisal of the relative merits of mitigation options, with an ability to convey this concisely
- Critically compare options for solving a particular engineering problem
- Provide evidence of a high level of understanding of a specialist engineering topic and an ability to apply it to a new situation
- Reflection on formal learning from courses, seminars and the like, and how this can be applied in the workplace

NB These are not the only approaches!

Guidance on Master's level characteristics that assessors look for in the portfolio that a participant prepares for demonstrating their further learning to Masters' level is available from a number of sources, for example:

- The Accreditation of Higher Education Programmes (AHEP), 3rd edition published by the Engineering Council:
- Quality Assurance Agency for Higher Education
- SEEC level descriptors

Guidance on Master's level marking/assessment/grade criteria is also available, for example:

- Leeds university
- Warwick University
- Kingston University

(links at March 2015)

Preamble to the examples of activities and evidence for each learning outcome (LO)

1. The key requirement is to demonstrate Masters' level learning on the topics of the LOs. The name of the broad areas under which LOs are listed also indicates the area in which evidence should be provided, e.g. the "current problems and/or new insights" for LOii are listed under the broad area of 'Science and Mathematics'.
2. Attention is drawn to the notes on Masters' level learning earlier in this document.
3. Masters' level requires knowledge, but Masters' level learning is typically demonstrated through the application of that knowledge and critical evaluation of the outcomes. Merely conveying knowledge and facts, even on highly specialist topics, is rarely sufficient to show the required Masters' level learning.
4. The aim of the examples of activities and evidence given in the following Tables is to try and assist participants, their employers and mentors to identify activities and evidence available in the context of their own work as professional engineers that could serve as a springboard to show Masters' level learning in the various LOs. The activities and examples of evidence are NOT prescriptive; there are many other activities and topics of evidence that could also enable a participant to demonstrate the required Masters' level learning. Demonstration of that learning is the key aim for the participant. Evidence presented that is about one of the example topics listed but which doesn't show Masters' level learning on that LO will not be acceptable.
5. Several examples of activities and evidence are given in the following Tables, but **the evidence required for a participant would typically only need one, or perhaps two, relevant examples of evidence from that engineer's work, treated in depth to show their Masters' level learning**. Multiple activities may be involved in the evidence.
6. Examples of activity and evidence listed under one LO might also serve for a different LO, if suitably evaluated and presented, but a good range of topics and examples will typically be needed across the FL programme as a whole.
7. It is anticipated that most engineers undertaking a programme of further learning to Masters' level will need to undertake some private study/investigation/evaluation linked to but beyond their normal day-to-day work, and in addition to the time preparing/presenting the evidence itself.
8. The focus of the evidence should be on the participant's reflection and evaluation about their actions and learning. Enough project information should be included to give context and to help convey the learning well. However, care should be taken to avoid overloading the evidence with more project detail than is needed to show the learning. Reflective statements in a further learning report can provide additional supporting evidence
9. A common error in evidence is to include more factual information about a project than is needed and too little that conveys the Masters' level learning of the participant. It is typically more effective to focus on one or two particularly pertinent aspects of a project and treat them in depth. The whole point is to clearly demonstrate to the assessors in the evidence, ideally in the written evidence, that the required further learning has been achieved. The assessors should not have to indirectly deduce or infer the participant's learning from the evidence or from their personal knowledge of the participant.
10. Examples of evidence will often include some form of report in which conclusions are reached after critically analysing the output of a suitable engineering activity e.g. of investigation, feasibility study, design, a monitoring programme, testing, a survey or research, but other forms of evidence are acceptable. **If an interview is part of the evidence used in assessment, a written record of the interview describing that evidence should be retained, and be available for audit purposes.**
11. If using abbreviations, a glossary of them should be included in the evidence – particularly important for self-managed programmes where the assessors may be engineers with a different specialism. (A glossary of terms and abbreviations in JBM documents about further learning is available separately.)

JBM Further Learning Programme (CEng)

Learning Outcome (i) - Science, Mathematics (SM1):
A comprehensive understanding of the relevant scientific principles of the specialisation.

Examples of Activity	Examples of Evidence (The evidence must show your Masters' level learning on this topic)
Engineering solutions are founded on physical, biological, natural and social sciences. Therefore there is a need to have an understanding of those sciences. You are continuously developing this knowledge formally and informally but there are particular aspects of these sciences that relate to civil engineering and this will depend on the branch of civil engineering you are in. Fundamentally this is about understanding and explaining things. Understanding the science underlying a situation enables better informed judgements when going beyond existing practice. For example, understanding how a material will perform if temporarily over-stressed, such as its non-linear stress/strain performance or it's plasticity/brittleness, enables its limitations to be taken account of. Examples of activities include:- • Selection of materials, products and processes that solve a particular problem which requires researching those items • Reading relevant technical journals and attending technical meetings • Value engineering and the observational techniques to understand and explain the difference between design, prediction and behaviour • Validation of design predictions • Materials (including geo materials) testing and appraisal • Use of qualitative and quantitative assessments with sound understanding of their scientific basis and limitations • Community surveys • Forensic reports, condition surveys • Asset management reports • Numerical analyses, with a good understanding of its basis and limitations	Some examples of potential topics for providing evidence:- • Appraisal of how a component of works would perform if it had to operate beyond its normal design range, e.g. in an emergency or unplanned temporary works loading situation. • Design of surveys/data acquisition explaining the issues to be measured and how they were measured, what the measurements meant, measures to help check data validity or to manage errors or anomalies. Critical evaluation of results including reasons for anomalies. These include quantitative and qualitative surveys. • Design thinking that deals with uncertainty and risk. • Predictions of actual performance / failure conditions, e.g. of load/strain performance of a test pile loaded well beyond its likely design load. • Critically appraising the short and long-term implications of heat generation in a very large concrete pour • Refurbishment/upgrade projects where the existing facility was designed to past codes/standards can be a source of potential topics, e,g, where underlying scientific principles have had to be assessed to achieve compatibility of new with old. • Critically appraising the technical implications for the performance of a project element that was constructed not quite as specified (e.g. a structural element or a water conduit or road alignment). • Monitoring reports which include conclusions based on interpretation of the data, supported by review of the background to the data and project • Reports giving a critical appraisal of technical papers and technical articles, on this topic. • Contributions to papers published in technical journals on this topic • Reports on numerical analyses that involve this topic • Critical appraisal of the use of the maturity method of assessing short-term concrete strength gain, and its limitations. • Cofferdam design

JBM Further Learning Programme (CEng)	
Learning Outcome (ii) - Science, Mathematics (SM2): **A critical awareness of current problems and/or new insights most of which is at, or informed by, the forefront of the specialisation.**	
Examples of Activity	**Examples of Evidence** (The evidence must show <u>your Masters' level learning</u> on this topic)
The world is continually changing and as engineers we are party to that change as we deal with social, environmental, economic and technological issues. Examples of such change include: technological developments in our industry, climate change, resource depletion, the carbon economy, changing sea levels and security of resource supply. In addition to a broader understanding of how the world is changing, engineers need to develop a critical awareness of the potential technical engineering implications of such changes. As engineers we will be engaged with others in society in making soundly based, ethical decisions. Some of these will be based on scientific evidence which we have to master. Examples of activities include:- • Investigating new products, systems or processes that could improve construction operations, risk, reliability, safety or cost-effectiveness, e.g. new techniques in surveying or monitoring, developments in off-site modular construction • Investigating a new material that may have potential to help solve a current issue with design or construction of temporary or permanent works • Appraising the potential implications of failures or near failures of temporary or permanent civil engineering structures reported in the technical press / literature for structures the participant might be involved with. • Assessing suspected shortcomings of existing Standards or Codes of Practice e.g. for new situations, and contributing to industry debate about them. • Attending technical meetings • Following emerging issues in the construction press and facilitating discussion of them with colleagues	Some examples of potential topics for providing evidence:- • Critical appraisal of current knowledge and research in a specialist area, related to a technical problem in the workplace • Technical presentations on state of the art matters to colleagues to demonstrate understanding and critical evaluation of them • Contribution to papers published in technical journals • Demonstrate involvement in reviews of technical papers or internal company feedback reports • Contributions to technical panels and consultations, with examples • Critical appraisal of new product, system, process or material, (or use of them in a different way), that has potential to make a contribution to a future project, or could have done so to a past project. This to include consideration of the technical basis, and appraisal of the potential benefits and risks. For example, critical appraisal of how laser scanning survey techniques of existing structures coupled to a 3D BIM model could have helped identify problems in a refurbishment project earlier, and so helped reduce disruption, including critical appraisal of the risks/drawback/limitations as well as benefits. • Relevant technical topics considered as a member of technical panels of the JBM Institutions or other relevant organisations • Critical appraisal of risks posed by the potential implications of an emerging technical issue and of options for their mitigation.

JBM Further Learning Programme (CEng)	
Learning Outcome (iii) - Science, Mathematics (SM3) **Understanding of concepts relevant to the discipline, some from outside engineering, and the ability to evaluate them critically and to apply them effectively, including in engineering projects.**	
Examples of Activity	**Examples of Evidence** (The evidence must show <u>your Masters' level learning</u> on this topic)
This is about the technical practice of engineering. The key is being able to critically evaluate technical concepts and information and apply the output to produce an engineering solution. Examples of concepts: serviceability as distinct from ultimate collapse, how forces 'flow' through a structure, models (mathematical, physical, conceptual) as simplifications of real situations to facilitate problem solving, margins of safety (and ways they can be achieved), stability, traffic flow and congestion, water flow principles, contrast of dynamic loading to static loading, sustainable design, 'whole of life' thinking (including end of life e.g. demolition / replacement / upgrading), ductility, resilience, designing for uncertainty, climate change, ground settlement as distinct from strength, how fire propagation occurs, non-linear stress-strain behaviour, driver behaviour, traffic 'rat-runs', soil consolidation over time, creep in materials, success, failure, inter-relationship of capital and operational costs of infrastructure/equipment, public interest/consultation, consideration of wider stakeholders. Examples of activities include:- • Leading edge analysis, design and construction. • Developing failure mechanisms for unusual structures taking into account the possible forces and geometry • Retrofitting existing infrastructure • Critical appraisal of potential for extension of the operation of structures or infrastructure beyond their original design life and/or parameters, and measures that could enable that. • Application of numerical methods with discernment • Design thinking and analysis for unusual or complex temporary works • Design of soil structure interaction problems • Evaluation of scientific data from multiple sources • design for high-hazard circumstances • Involvement in formal planning process and gaining consents to carry out works	Some examples of potential topics for providing evidence:- • Design reports on advanced, complex, or unusual structures, or temporary works • feasibility study report • Options report for extending the operational life or range of structures or infrastructure. • Reports on numerical studies and associated checks • Project risk assessment and associated mitigating measures, including technical aspects of engineering. • Report on serviceability • Foundation design report • Design options report e.g. for: retaining walls, bridge/culvert structures, drainage including sustainable drainage measures, traffic relief of a village, junction improvement, road pavement remedial measures, structure retrofit.

JBM Further Learning Programme (CEng)	
Learning Outcome (iv) - Engineering Analysis (EA1): Ability both to apply appropriate engineering analysis methods for solving complex problems in engineering and to assess their limitations.	
Examples of Activity	**Examples of Evidence** (The evidence must show <u>your Masters' level learning</u> on this topic)
Much of engineering is about modelling reality to produce solutions to known hazards. Hence it often includes making assumptions, choosing appropriate models, assembling data and undertaking option analyses. Examples of activities include:- • Appreciating the limitations of design methods • Undertaking design of unusual or non-standard highways or structures, or in unusual/complex situations • Numerical modelling with discernment • Planning and operating a test or monitoring programme to verify design assumptions and/or to check actual performance with design/predicted performance and appraise reasons for observed difference. • Design using the observational method (e.g. propped retaining walls) including trigger levels for interventions during implementation • Sensitivity analyses and 'sense/reality' checks • Scenario analyses • Outline designs and designs at funding or tender stage which have more limitations than full detailed designs Note: "Complex: implies engineering problems, artefacts or systems that involve dealing simultaneously with a sizeable number of factors that interact and require deep understanding, including knowledge at the forefront of the discipline, to analyse or deal with." (Engineering Council [2014], AHEP 3rd Ed)	Evidence will typically include a report or commentary to focus assessors' attention on the participant's learning. It may well include selected extracts from design/analysis work to illustrate that learning, but simply providing a mass of design/analysis output or a design report is very unlikely to suffice. Some examples of potential topics for providing evidence:- • Design reports for temporary or permanent works showing assumptions made, options compared, and how uncertainty and limitations have been dealt with. • Validation checks of numerical analyses e.g. against 'standard' cases. • Review of software output for a complex problem against 'hand' calculations • Critical appraisal of the validity of assumptions in design thinking and in the associated analysis, including those embedded in analysis tools e.g. charts or software. • Brain storming exercises and associated critical comparison of engineering options • Reports on the example activities adjacent • Design of complex temporary works including appraisal of uncertainty and limitations. • Design of interim solutions as temporary measures for • Reports on designs strongly influenced by external constraints e.g. for a basement adjacent to highly sensitive off-site structures or design of significant road improvement works involving very complex traffic management.

JBM Further Learning Programme (CEng)	
Learning Outcome (v) - Engineering Analysis (EA2): Ability to use fundamental knowledge to investigate new and emerging technologies.	
Examples of Activity	**Examples of Evidence** (The evidence must show <u>your Masters' level learning</u> on this topic)
A professional engineer has to have ability to research into new ideas in order to enhance their work, deal with increasingly complex challenges, and take advantage of new opportunities and ways of working. That would include an ability to critically evaluate the technology and make sound, risk based judgements about its use in practice. Examples of activities include:- • Application of new materials, products and processes • Review of the state of the art materials, products and processes • Innovative approaches to design or planning of implementation • Use of emerging features or tools linked to BIM for design, construction, asset management • Innovative approaches to construction • Use of new surveying or monitoring instrumentation, or use of it in a new situation • Development of low carbon solutions • Critical appraisal of the potential impact/benefit and risks that could arise from implementation of such technologies. • Application of new software tools or surveying • Investigating such technology could include, for example, searches of literature, web forums, reviews, use of the principles in other contexts / disciplines, competitor manufacturer/supplier information. *Note: This can be 'new or emerging' in other companies or countries or disciplines, rather than new and emerging in society as a whole.*	The evidence is likely to include reflective critical evaluation of the potential benefits / opportunities/ risks of the technologies, using some fundamental knowledge, or thinking from first principles, and taking account of limitations. Some examples of potential topics for providing evidence:- • Incorporating interim monitoring or checks on a new technology to confirm the pre-use appraisal of it. • Undertaking pilot studies of an emerging technology with detailed observation and appraisal of its performance prior to higher risk situations • Use of laser scanning tools to facilitate investigation or design or construction of an extension to an existing building. • Use of robot sensors to gather information more cost-effectively or in a hazardous environment. • Planning or implementation of BIM in emerging or enhanced ways • New tools for 3D designs that support improved construction efficiency • Use of satellite based technology for improved automation or feedback or quality control of construction • Use of tablets such as iPad to enhance some aspect of quality • Contributions to research reports or technical papers or to discussion at Institution meetings • Technical presentations on leading edge technology or software tools to colleagues • Reflective consideration of how a new or emerging technology could have helped a project (or not), even if that technology is not actually being used on it.

JBM Further Learning Programme (CEng)	
Learning Outcome (vi) - Engineering Analysis (EA3): Ability to collect and analyse data and use appropriate engineering tools to tackle problems that are unfamiliar to the graduate, such as those with uncertain or incomplete data or specifications, by the appropriate innovation, use or adaption of engineering analytical methods.	
Examples of Activity	**Examples of Evidence** (The evidence must show your Masters' level learning on this topic)
Civil engineering is an innovative industry as many projects that are deal with are done for the first time, in the particular circumstances of that location. However, it is also an industry that learns from past experience including failures and shortcomings. It involves uncertainty which is either natural or anthropogenic. Therefore much of what is done is based on site-specific observations, drawing on (but not limited by) experience of prior practice. These observations can be used to develop guidelines and standards, inform practice or allow solutions to be developed and monitored. Examples of activities include:- • Planning and implementing an investigation to gather data relevant to planning and implementing a project, or for its subsequent operation. For example, data on structures, traffic flow, flood conditions, operational requirements, water levels, ground conditions, marine conditions, land ownership, client requirements, key stakeholder aspirations, e.g. regulatory authorities. • Analysis of such data, including dealing with uncertainty. • Forensic analysis of past failures or shortcomings • Qualitative or semi-quantitative assessments of non-numerical information e.g. from interviews with stakeholders, or qualitative observations of damage • Scenario analyses • Selection and use of appropriate software packages • Selection of design parameters • Critical appraisal of potential for extension of the operation of structures or infrastructure beyond their original design life and/or parameters, and measures that could enable that. • Systematic, reasoned selection of parameters with audit trail, and use of them in design models, with sensitivity analyses.	Much of the evidence is likely to be based on the interpretation of technical data. Some examples of potential topics for providing evidence:- • Reports related to the examples of activities. • Selection of design parameters based on design criteria e.g. for temporary works scheme • Planning and use of site surveys and investigation • Synthesis and analysis of traffic and transport survey data to develop engineering solutions. • Flood studies and flood risk modelling • Forensic reports • Ground investigations with interpretation • Selection of appropriate models, methods of analyses, and input parameters.

JBM Further Learning Programme (CEng)	
Learning Outcome (vii) – Design (D1): **Knowledge, understanding and skills to work with information that may be incomplete or uncertain, quantify the effect of this on the design and, where appropriate, use theory or experimental research to mitigate deficiencies.**	
Examples of Activity	**Examples of Evidence** (The evidence must show <u>your Masters' level learning</u> on this topic)
Engineering design thinking involves much more than analysis/calculation, and often involves design with incomplete or uncertain data. A participant would need to demonstrate independent judgement of the implications of any information shortcomings, notably risks and opportunities missed, in order to inform decisions about the need to take measures to improve the design data. The participant must also demonstrate independent judgement and implement a 'risk hierarchy' in determining the extent of additional survey work to be undertaken or whether this can be accommodated by applying enhance factors of safety in design. Examples include:- • Identify, assess, judge risk, and plan mitigation of it: o undertake a 'gap analysis' to identify missing information eg topographic survey, site investigation, traffic data, details of adjacent structures, including their foundations, and appraise the significance of those gaps on the design. o Critically compare the benefits of gathering additional design information to the implications of doing so, e.g. cost and delay. o Prepare a reasoned proposal for investment of time/resources into gathering additional information to mitigate gaps. o Undertake mitigation • Undertake upper and lower bound sensitivity analyses of a data set to support judgement. • Planning and operating a test or monitoring programme to verify design assumptions and/or to check actual performance with design/predicted performance and appraise reasons for observed difference. • Design using the observational method (e.g. propped retaining walls) including trigger levels for interventions during implementation	A reflective report could use examples from the participant's experience to demonstrate their Masters' level learning on design thinking. Some examples of potential topics for providing evidence:- • Reports on the activity examples. • Summary of assessment made and measures taken with justification for decisions made.

JBM Further Learning Programme (CEng)	
Learning Outcome (viii) – Design (D2): **Knowledge and comprehensive understanding of design processes and methodologies and the ability to apply and adapt them in unfamiliar situations.**	
Examples of Activity	**Examples of Evidence** (The evidence must show <u>your Masters' level learning</u> on this topic)
The participant must demonstrate knowledge of engineering principles, implementing a process or devising a methodology in situations with some unfamiliarity. The design process does not necessarily include detailed design. Design for either permanent or temporary situations is acceptable. It is not necessary for the design to be implemented. Checks of design viability, e.g. by a small scale trial, could be included before applying to the unfamiliar situation.	A reflective report using an example from the participant's experience, including:- • Details of the problems encountered and the design thinking of the solution. • Include clear details of the adaptation and unfamiliarity. • Appraisal of the processes and methodologies usually employed, how they can be utilised to solve the problems identified and what changes need to be made to suit the unfamiliar situation. • Consideration of an alternative design for an unfamiliar situation • Evidence of risk appraisal e.g. using trials before full application (if appropriate)

JBM Further Learning Programme (CEng)	
Learning Outcome (ix) – Design (D3): **Ability to generate an innovative design for products, systems, components or processes to fulfil new needs.**	
Examples of Activity	**Examples of Evidence** (The evidence must show your Masters' level learning on this topic)
This is a skill that is developed over time because of the experience gained through the practice of civil engineering and the knowledge gained through independent study. It enables you to use innovative solutions to practical problems which can be beneficial to your clients, your organisation and wider society either financially, environmentally, technically or socially. Note this LO refers to "design for products, systems, components or processes". It is not limited to innovative design of physical structures or infrastructure. Examples of activities include:- • Temporary or permanent works design that incorporates this LO's characteristics • An innovative approach to an alternative design e.g. that enables major temporary works to also serve as permanent works • Emergency planning • Retrofit solutions • Designing improvements to a construction process • Innovative use of offsite construction • using information modelling for design of a process in an innovative way	Some participants may not have opportunities in their work situations to tackle problems in this way. Consideration of an alternative, innovative option/approach to a design for something related to their work, or of a hypothetical situation in their field of work, would be acceptable. Where participants are part of a team introducing innovation their contribution to the team should be clearly evident. Some examples of potential topics for providing evidence:- • Reports on the activity examples. • Design calculations that involve innovative solutions • Innovative use of existing equipment or processes • Use of materials in new situations • Innovative temporary works design • Design approach for retrofit solutions

JBM Further Learning Programme (CEng)	
Learning Outcome (x) – Economic, legal, social, ethical and environmental context (EA1): Awareness of the need for a high level of professional and ethical conduct in engineering	
Examples of Activity	**Examples of Evidence** (The evidence must show <u>your Masters' level learning</u> on this topic)
Ethical, professional behaviour is a cornerstone as to how a chartered engineer goes about his duties. Participants must demonstrate a level of awareness of how to conduct their work in an ethical manner Activities could include • Study of professional Codes of Conduct • Attendance on courses concerning ethics • Demonstrating an ethical approach in the workplace • Resolving conflicts of interest • Acting as expert witness	Evidence should demonstrate that the participant has fully understood the requirements and demonstrated them in their workplace • Record of discussion with Assessor on specific topics of code of conduct • Evidence of applying learning from courses • Discussion of conflicts between commercial pressure and client care • Evidence of resolving disputes \ conflicts impartially

JBM Further Learning Programme (CEng)	
Learning Outcome (xi) - Economic, legal, social, ethical and environmental context (EA2): Awareness that engineers need to take account of the commercial and social contexts in which they operate	
Examples of Activity	**Examples of Evidence** (The evidence must show your Masters' level learning on this topic)
Engineering does not take place in a vacuum and in developing a solution it is necessary for the engineer to consider the impacts that a project can have in a wider context Activities could include • Undertaking cost v benefit study • Determining costs of different engineering solutions • Preparing a tender cost estimate \ fee submission • Preparing specifications that maximise local benefit from a project • Considering impact of projects on local communities • Preparing specific impact assessments for Statutory Process • Preparing project Logistics Plans • Preparing stakeholder management and engagement plans	Evidence should demonstrate that the participant has understood the need to recognise commercial and social drivers as an integral part of developing sustainable solutions • Formal reports and analysis resulting from activities • Records of discussions on specific topics with Assessor • Presentations to colleagues \ clients on specific solutions

JBM Further Learning Programme (CEng)	
Learning Outcome (xii) - Economic, legal, social, ethical and environmental context (EA3): Knowledge and understanding of management and business practices, and their limitations, and how these may be applied in the context of the particular specialisation;	
Examples of Activity	**Examples of Evidence** (The evidence must show <u>your Masters' level learning</u> on this topic)
A thorough understanding of how business is conducted and projects are managed is required by all practising engineers. This included a knowledge of the supporting systems and processes that are used by organisations to run their business Activities will be wide ranging and reflect not only the practices encountered in the workplace but also demonstrate an understanding of their effectiveness and how they can be improved • Development of procedures and processes for new activities • Inspection, audit and improvement of existing processes • Leading lessons learned sessions to identify process limitations • Undertaking manpower planning and developing recruitment strategy • Understanding and applying corporate financial reporting systems • Understanding and applying "back office" functions such as human resources, accounts, training and legal requirements • Business development	Evidence must demonstrate that the participant fully understands how a business operates in their area of specialisation • Formal reports covering activities undertaken • Documented processes they have developed and implemented • Participation in staff recruitment and engagement • Client profiles and project pursuit plans • Systems audit reports, NCRs and close out reports • Record of discussion of specific management issues with Assessor • Organisation charts for areas of responsibility

JBM Further Learning Programme (CEng)	
Learning Outcome (xiii) - Economic, legal, social, ethical and environmental context (EA4): Awareness that engineering activities should promote sustainable development and ability to apply quantitative techniques where appropriate	
Examples of Activity	**Examples of Evidence** (The evidence must show <u>your Masters' level learning</u> on this topic)
Ensuring designs, construction and maintenance are activities are sustainable is an essential part of an engineer's duties Participants will be involved in a wide range of activities which may include • Research into low carbon technology and application • Calculation and evaluation of carbon footprint of alternative solutions • Research into use of recycled materials • Energy usage and running cost studies • Water harvesting and reuse • Solar and alternative energy use • Working to BREEAM and CEEQUAL standards • Public transportation studies • Schemes to promote cycling, car sharing, public transport use • Preparation of Section 61 notices	Evidence must demonstrate knowledge of how sustainability and contain and demonstrate analysis techniques that are appropriate for the area of specialism • Reports and calculations for studies • Discussion paper on appropriate alternative materials • Output from BREEAM and CEEQUAL assessment • Detailed analysis underpinning Section 61 notices

JBM Further Learning Programme (CEng)	
Learning Outcome (xiv) - Economic, legal, social, ethical and environmental context (EA5): Awareness of relevant regulatory requirements governing engineering activities in the context of the particular specialisation	
Examples of Activity	**Examples of Evidence** (The evidence must show your Masters' level learning on this topic)
Engineering activities are generally carried out within an overarching regulatory framework with additional requirements for a specific discipline. Participants are expected to have an awareness of the overall framework with specific knowledge in their own specialism Activities could include • Courses or formal training on ISO 14001, OHSAS 18001 • Research and application of regulations such as Bribery, Diversity, Equality Acts • Application of Waste regulations • Water discharge and abstraction provision • Research and application of Codes of Practice • Planning Applications, Transport and Works Act submission, Development Consent Orders • Discharging duties as Principal Designer \ Principal Contractor under CDM	Evidence should demonstrate knowledge of the regulatory environment in which the participant is employed and how this has been applied to the activities undertaken • Formal accreditation from courses attended • Discussion of course learning and application • Submissions and reports associated with activities • Recorded discussion with Assessor on activities • Presentation to colleagues on activities undertaken and conclusion reached

JBM Further Learning Programme (CEng)	
Learning Outcome (xv) - Economic, legal, social, ethical and environmental context (EA6): Awareness of and ability to make general evaluations of risk issues in the context of the particular specialisation, including health & safety, environmental and commercial risk.	
Examples of Activity	**Examples of Evidence** (The evidence must show <u>your Masters' level learning</u> on this topic)
Risk is present in all activities that an engineer undertakes. The participant is expected to demonstrate an ability to undertake risk assessments and develop appropriate mitigation strategies from activities undertaken in the context of their specialism Activities may include • Study of \ training in, relevant legislation such CDM regulations • Health and Safety risk assessments and mitigations • Design risk assessment and mitigation • Development of safe systems of work • HAZOP, HAZID studies and mitigation • Environmental risk assessment • Commercial risk assessment • Risk pricing • Programme Risk assessment • Study and evaluation of methods of risk quantification and evaluation	Evidence must demonstrate that the participant has knowledge of the techniques used to assess and manage all project risk in the area of his specialism and that these are applied in the course of their duties • Record of discussion with Assessor of risk evalution and mitigation • Presentation to colleagues on risk evaluation and mitigation • Managing risk issues • Completed risk registers • Calculations for commercial or programme risk using techniques such as Monte Carlo analysis • Output from studies • Method statements detailing risk mitigation

JBM Further Learning Programme (CEng)	
Learning Outcome (xvi) - Engineering practice (EP1): Advanced level knowledge and understanding of a wide range of engineering materials and components;	
Examples of Activity	**Examples of Evidence** (The evidence must show <u>your Masters' level learning</u> on this topic)
Design, construction and maintenance rely on an engineer's knowledge of materials and their performance in both a structural and in service context. The participant is expected to have an advanced level of understanding of how the range of materials encountered within their specialism perform Activities may include • Investigation into material failures • Research and selection of new materials • Identification of how recycled materials can be used effectively • Research into material durability and performance • Techniques for testing and verifying material properties • Research into common material problems in construction • Identification of relevant design parameters for materials • Research into fabrication of components and offsite construction • Material specification • Selection of alternative materials	Evidence must demonstrate that the participant has a detailed knowledge of the materials and components used in his area of specialism. This should include new and materials and any constraints associated with their use. • Formal reports on studies and investigations • Laboratory reports on materials testing and conclusions reached • Record of discussion with Assessor on material selection • Presentation to colleagues on new materials • Justification of alternative material selection criteria • Specifications for materials or components

JBM Further Learning Programme (CEng)	
Learning Outcome (xvii) - Engineering practice (EP2): **A thorough understanding of current practice and its limitations, and some appreciation of likely new developments;**	
Examples of Activity	**Examples of Evidence** (The evidence must show <u>your Masters' level learning</u> on this topic)
All engineers need to understand current practice in relation to design construction and maintenance in relation to their specialism. In addition they need to understand the risks and limitations that exist in these practices and the new techniques that are emerging Activities could include • Analysis of benefits of using self compacting concrete • Use of codes of practice in non standard situations • 3D modelling application and data handling • Use of GPS survey and data accuracy • Appraisal of bulk earthworks machine automation using GPS • Structural condition monitoring and application of new technology • Appraisal of design or construction or maintenance practice in light of changes in regulation (CDM) • Research into specialist areas to identify best practice • Attendance at conferences, seminars, Institution meetings • Lessons learned workshop for process improvement	Evidence should demonstrate a thorough knowledge of current practices and the limitations, or issues, associated with their use. In addition the participant should demonstrate knowledge of new and emergent practices, or techniques, and the benefits that they will deliver. • Reports detailing analysis of current practices and how limitations are recognised and overcome • Record of discussion with Assessor on new techniques such as use of mobile technology for transmitting data direct to the workplace • Presentation to colleagues \ meetings \ conferences on application of new technology • Record of attendance at event and key learning points recorded • Case studies identifying best practice

JBM Further Learning Programme (CEng)	
Learning Outcome (xviii) - Engineering practice (EP3): **The ability to apply engineering techniques taking account of a range of commercial and industrial constraints.**	
Examples of Activity	**Examples of Evidence** (The evidence must show <u>your Masters' level learning</u> on this topic)
Engineering solutions are not developed and implemented in isolation and are subject to a wide range of constraints including commercial, programme, quality, safety and sustainability. The participant needs to demonstrate that any solution has considered these issues and achieved an acceptable balance Activities could include • Design optioneering, costing and selection • Research into alternative methods of construction • Research into alternative maintenance measures • Assessment of risk profiles associated with design or construction options • Selection of materials to meet structural design, construction and maintenance requirements • Identification of highway pavement options and selection of appropriate solution • Identification and design of appropriate temporary works	Evidence should demonstrate the participants ability to apply their knowledge of engineering techniques in a practical situation that recognises the influence of business constraints. • Formal reports detailing analysis carried out • Recorded discussion with Assessor on why a particular technique was adopted • Cost v benefit study covering a range of solutions • Method statements for construction activities • Option selection matrix for pavement construction

JBM Further Learning Programme (CEng)	
Learning Outcome (xix) - Engineering practice (EP4): Understanding of different roles within an engineering team and the ability to exercise initiative and personal responsibility, which may be as a team member or leader;	
Examples of Activity	**Examples of Evidence** (The evidence must show <u>your Masters' level learning</u> on this topic)
Participants should understand their role and responsibilities within their organisation and how this interfaces with other team members. Activities should also show how they use their experience to identify and undertake tasks that contribute to the effectiveness of the team and demonstrate responsibility for achieving desired outcomes Activities could include • Undertaking specific roles as part of a team e.g risk manager, highways engineer, drainage designer • Preparing organogramme for a project • Defining roles and responsibilities for a team • Undertaking secondment to another function e.g. Human Resources, Training, Procurement • Identifying innovation and implementing within team \ office \ project \ organisation	Evidence must demonstrate the participant's knowledge of how teams are structured and the roles and responsibilities of the members. They must also demonstrate that they have successfully undertaken a team role. • Discussion of role and progression with Assessor • Reports detailing experience in particular role with appreciation of interface to other discipline • Case studies detailing innovation implemented • Organogram showing own and team roles with description of responsibilities

JBM Further Learning Programme (CEng)	
Learning Outcome (xx) - Additional general skills (G1): **Apply their skills in problem solving, communication, information retrieval, working with others, and the effective use of general IT facilities**	
Examples of Activity	**Examples of Evidence** (The evidence must show your Masters' level learning on this topic)
This is a wide ranging learning outcome that will by its nature be partially covered by several of the previous sections particularly with regard to problem solving and team working. The LO also requires the participant to demonstrate an ability to manage information and data and to use IT systems effectively. Activities could include • Preparation of briefing notes, notices, third party notification • Preparation of method statements • Undertaking staff \ workforce \ stakeholder briefings • Setting up electronic document filing systems • Use of common IT systems for document production, spreadsheets, presentations • Handling data from BIM \ GIS models • Implementing data security • Use of standard programmes for design, CAD, schedule, cost	Evidence should demonstrate that the participant can apply their theoretical knowledge to solve practical problems. They should also demonstrate that they can communicate their solutions to others and are able to use the IT effectively in all aspects of their work • Copies of documents produced when undertaking workplace activity • Record of discussion of data handling issues \ solutions with Assessor • 3D models, BIM output, GIS output • Discussion ot IT systems used in specialism and their effectiveness • Records of briefings delivered

JBM Further Learning Programme (CEng)	
Learning Outcome (xxi) - Additional general skills (G2): Plan self-learning and improve performance, as the foundation for lifelong learning/CPD	
Examples of Activity	**Examples of Evidence** (The evidence must show your Masters' level learning on this topic)
This is wide ranging learning outcome that by its nature requires the participant to reflect on their learning needs in order to undertake more complex tasks, use advanced analysis techniques or manage larger teams or projects and as a consequence plan learning and development to bridge any gaps or deficiencies in knowledge. Activities could include • Annual performance reviews with line manager • Career appraisal and development reviews with line manager • Preparation of Development Action Plans • Preparation of Further Learning Plan to deliver the Learning Outcomes • Seeking feedback from colleagues to measure performance • Reflection on career objectives and required skills • Career planning • Reading professional journals and publications	Evidence should demonstrate commitment to further learning and the ability to recognise areas where development is required. • Formal reports associated with undertaking activity e.g. DAP, CPD • Record of discussion with Assessor and identified actions • Feedback from colleagues • Record of courses undertaking and key learning points • Discussion of journal articles with Assessor

JBM Further Learning Programme (CEng)	
Learning Outcome (xxii) - Additional general skills (G3): Monitor and adjust a personal programme of work on an on-going basis	
Examples of Activity	**Examples of Evidence** (The evidence must show your Masters' level learning on this topic)
This requires the participant to prepare and monitor a personal knowledge development programme that reflects the opportunities afforded within their workplace and to adjust the identified learning opportunities in response to changes in workload or work type. Activities could include • Identification of work scopes that the participant can be involved in and associated learning needs and opportunities • Undertaking formal courses to broaden or deepen knowledge of specialism • Updating learning programme • Discussing learning needs with line manager and colleagues	Evidence should demonstrate that the Further Learning Plan is being monitored by the participant and their Assessor and adjusted as new, or changed, opportunities emerge in the workplace • Documented Further Learning Plan • Record of formal reviews of FLP with Assessor • CPD and DAP records