CANDIDATE GUIDE

COMPREHEND AND APPLY ADVANCED KNOWLEDGE

OUTCOME 3

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CANDIDATE INFORMATION

Details	Please Complete details
Name of candidate	
Name of supervisor	
Work Unit	
Name of mentor	
Date started	
Date of completion & Assessment	

COMPETENCY STANDARD REQUIREMENTS

(Direct extract from SAIMechE's Standard of Professional Competency)

LEARNING OUTCOME 3

Comprehend and apply advanced knowledge of the widely-applied principles underpinning good engineering practice, specialist knowledge and knowledge specific to the jurisdiction and local conditions.

Assessment Criteria:

This outcome is normally demonstrated in the course of design, investigation or operations. The candidate typically:

1. Displays mastery of understanding of engineering principles, practice and technologies in the practice area
2. Applies general and underpinning engineering knowledge to support analysis and provide insight
3. Uses a fundamentals-based, first principles analytical, approach building models as required
4. Displays working knowledge of areas that interact with the practice area
5. Applies related knowledge: financial, statutory, safety, management

Range Statement:

(a) Specialist knowledge has depth in the practice area and is underpinned by the fundamental knowledge of an engineering discipline or cross-disciplinary area.
(b) A working knowledge of interacting disciplines (engineering and other) to underpin teamwork.
(c) Jurisdictional knowledge includes legal and regulatory requirements as well as locally relevant codes of practice. As required for practise area, a selection of: law of contract,

health and safety, environmental, intellectual property, contract administration, quality management, risk management maintenance, management, regulation project and construction management.

KEYS TO ICONS

The following icons are used throughout the study guide to indicate specific functions:

	**DON'T FORGET/NOTE** **This icon indicates information of particular importance**
	**CANDIDATE GUIDE** **This refers to the learning material in this module which is aligned to the SAIMechE Competency Standard**
	**EXERCISES** **Practical activities to do, either individually or in syndicate groups during the training process**
	**BOOKS AND WEBSITES** **Additional resource information for further reading and reference**
	**SELF TEST QUESTIONS** **Self-evaluation for candidates to test understanding of the learning material**
	**QUOTATIONS** **Quotations which offer interesting points of view and statements of wisdom and insight**
	**YOUR NOTE PAD** **Provided for candidate to document notes during presentation of training**

GENERAL GUIDELINES

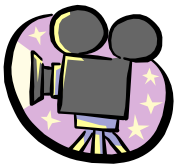
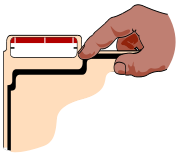
PURPOSE

This module provides easy-to-follow steps to help you to comprehend and apply advanced knowledge in an engineering environment. These follow the items listed in Section 1 above.

The purpose of the module is to introduce the Engineer to a practical methodology of addressing the challenge of meeting the requirements of the assessment criteria so as to comply with outcome 3.

The approach to this module is by no means restricted to these guidelines only, and the Candidate is expected to research any appropriate references, literature and practices that can support the essence of this competency outcome.

CANDIDATE SUPPORT

Resources	Candidate Guide 	The Candidate Guide is a manual covering the theory on the comprehension and development of advanced knowledge and provides guidance on practical exercises to meet the requirements of the assessment criteria
	Candidate Portfolio of Evidence Guide	This is a separate document which provides guidelines for Candidates on how to compile their portfolio of evidence, and a template to structure their practical task evidence into a file format for assessment by the mentor/referee
	Books and websites 	Refer to references at the end of the Candidate Guide
	Videos 	Refers to any videos that are regarded as relevant to the subject
	Folder enclosures 	This includes all handouts, checklists, etc. The Engineer's Code of Conduct

SECTION 1

COMPREHEND AND APPLY ADVANCED KNOWLEDGE

LEARNING OUTCOMES:

- Understand the concept of applying advanced knowledge
- Be aware of the need to comprehend and apply advanced knowledge in the workplace

1. Comprehend And Apply Advanced Knowledge: Principles, Specialist Knowledge, Jurisdictional And Local Knowledge

1.1 Maintaining and extending a sound theoretical approach to the application of technology in mechanical engineering practice

The role of tertiary period learning is to become skilled in understanding and applying the basic principles of science. As the Engineer progresses in the workplace these principles are applied to real engineering challenges. It will become apparent to the Engineer that many of the seemingly impractical theories do in fact have application in the real workplace in the process of analyzing and solving complex engineering problems. The new graduate should be in a position to recall the theory learnt during the engineering course and apply the necessary analysis, calculations and conclusions with relative ease compared with the Engineer who has progressed into a project or managerial role. Time diminishes the ready ability to recall and apply the theory.

The Candidate is encouraged to retain the technical literature that was used during the degree course. Engineers who have done so will frequently relate the number of instances later in their working activities that they have made use of same in resolving new problems. In a sense, the retained material provides continuity in the on-going learning process.

1.2 Identifying the limits of one's personal knowledge and skills

In carrying out the applications in 1.1 above, the Engineer will realize that he is unable to resolve all the problems using his existing theoretical knowledge. It will then be necessary to research additional knowledge to build on that already acquired. This often takes the form of a post-graduate degree and specialist courses. It is usually the Engineer's first realization of the importance of the process of Continuing Professional

Development (CPD). It is effectively the realization that engineering is a developing discipline. It is not uncommon to find that many Engineers have not actively continued to learn after graduating in a pro-active manner.

1.3 Striving to extend own technological capability

The candidate will need to identify where in the current workplace additional learning is required and to provide cases where this has been done to resolve any particular challenges. This could take the form of developing new organizational tools or systems or applying researched material to resolving an engineering problem that has been assigned to him. The Engineer begins to benefit from the learning from peers, supervisors and mentors. This is the domain of experiential learning.

The Candidate should keep a record of his work done in matters of problem resolution, design with all calculations, new information obtained at courses, seminars and conferences, etc.

1.4 Engaging in formal learning. Learning new mechanical engineering theories and techniques in the workplace, at seminars, etc.

Improving and extending knowledge requires both informal personal learning and formal structured learning. Whilst candidates will at times select to register with a post-graduate programme, there are many “semi-formal” seminars, workshops and conferences that are made available to Engineers such as those arranged by the SAIMechE Events Department. There is a growing practice of forming technical specialist groups on a peer interactive basis through networks. With the rapid development in technology, consideration must be given as to how the Candidate

maintains currency. The use of webinars and viewing internet video courses and conference proceedings is a growing practice.

1.5 Broadening your knowledge of mechanical engineering codes, standards and specifications

As engineering science has evolved, it has created a basis for utilizing the developments and practices of history so as to obviate the need to reinvent the knowledge that has emerged from this history. By recording and assembling this knowledge in prescribed formats, codes and standards have been created that can be used by Engineers in daily practice. These standards and codes are continuously being reviewed and updated as further experience is gained and as technology develops. They are created by peer group teams that draw on the collective experience, research and expertise of the profession.

The profession itself draws on the inventive and creative skills of research work in institutions such as universities, specialized research organizations, voluntary associations, and not infrequently the findings from accidents and disasters such as in air-flight and nuclear accident analysis. It is evident that Engineers have to acquire knowledge of the standards and codes that affect their working environment and which are the applicable to the problem in question.

GROUP DISCUSSION

Topics for group discussion –select from the list below.

1. Discuss the various ways that knowledge can be acquired while working.

2. Knowledge gained at tertiary level is all that is needed to support workplace projects. Discuss your view on this statement.

3. What do you think would be the best way to gain and understanding and a working knowledge of the engineering environment in which you work?

4. What is the role of Engineering Codes and how should they be used in the working environment.

INITIAL TEST

Complete the Initial Test in Appendix 1 (10 minutes are allocated for this).

SECTION 2

PRACTICAL DECISION MAKING MODEL

LEARNING OUTCOMES:

- Understand the practical steps to be taken when applying advanced knowledge
- Be competent in using the steps
- Be prepared to apply this process in the workplace on a regular and routine basis

2. Steps in comprehending and applying advanced knowledge

The Candidate should have reviewed the contents of Section 1 before proceeding to carry out the steps in this section.

Note that each of these steps is aligned with the respective assessment criterion listed in section 3.

The assessment steps:

STEP 1: Displays mastery of understanding of engineering principles, practice and technologies in the practice area

STEP 2: Applies general and underpinning engineering knowledge to support analysis and provide insight

STEP 3: Uses a fundamentals-based, first principles analytical, approach building models as required

STEP 4: Displays working knowledge of areas that interact with the practice area

STEP 5: Applies related knowledge: financial, statutory, safety, management

STEP 1: Displays mastery of understanding of engineering principles, practice and technologies in the practice area

All complex engineering problems require some applications of basic engineering theory to be able to analyse them and formulate solutions. In this step the Candidate should identify a workplace problem that requires a solution. Although a candidate normally commences in the workplace at the lowest level of responsibility, it will frequently be possible to identify a problem that requires the application of theory learnt as a student.

The candidate may, for example, be assigned to a mechanical work shop environment in which he is expected to observe the functions of machining, turning, shaping, cutting, fitting, lifting, welding, dimensional checking, assembly, work flow, and safety compliance as examples. These generally form the basis of initial practical training. Observing every one of these activities will provide some opportunity to relate them to theory, whilst at the same time providing the candidate with the practical experience forming the essence of creative engineering. It is strongly recommended to seek activities in such a practical environment, and should the employer not have in-house facilities, the Candidate should arrange for a period of time with another workplace that can provide this, or to attend one of the “boot camp” options that specifically provide a concentrated period of practical, hand-on activities. Advanced knowledge includes the learning and awareness of modern manufacturing and fabrication techniques, metrology processes, quality assurance and control and testing methods.

As the Candidate progresses through the candidacy phase, the practice area will change and take on the functions of design, project engineering, supervision and management of engineering activities. The application of some engineering principles will apply in every role.

Exercise:

In this step, the candidate is advised to seek out opportunities to identify a problem in which a learnt engineering theory can be applied to the analysis and resolution.

STEP 2: Applies general and underpinning engineering knowledge to support analysis and provide insight

This is, as mentioned in Section 1, the domain of experiential learning. Candidates should endeavour initially to spend time with artisans and journeymen skilled in the trades, not to become fully skilled in their own right, but to understand the expertise of the trades and the value of their skills in converting the concepts and designs of the Engineer into reality. The candidate will also interact with peers, supervisors, suppliers, contractors, designers, engineering managers, subject matter experts and project managers. As the candidate progresses in the organization, the level of responsibility will increase and additional workplace knowledge and experience are essential for this to happen. Situations will arise where the Candidate has the opportunity to undertake the resolving of problems where the solution requires some specialist knowledge. This may require research, accessing published information and experimentation. This step must demonstrate the use that the Candidate has made of the team in his workplace.

Aside from the technical skills that the candidate will develop from those in the trade roles, the Candidate will have the opportunity to develop insight by learning to relate to the persons concerned. A high degree of respect should be shown to the Artisan and Journeyman who have undergone extensive apprenticeship training and who are experts in their trade, but do not have an academic background. This will prove to be invaluable during the Candidate's career where regular interaction and collaboration will be required in the performance of work, and the Candidate achieves a supervisory role over the trade levels. It will illustrate the value of working as an engineering team.

Exercise:

In this step, the candidate should undertake the resolution of a problem in which the input of other workplace parties has been required. The process of this is to be explained in a

report which indicates what the candidate has learned from the contributors and how the candidate coordinated the solution.

STEP 3: Uses a fundamentals-based, first principles analytical, approach building models as required

The analysis and resolution of complex engineering problems will, as is demonstrated in Outcome 1, involve the use of calculations, computations, applications of codes, formulae, etc. We can call this the "rationalist" view. As the candidate progresses with workplace experience, it will become evident that engineering solutions are often tested with what we can call the "deductive" view based on empirical evidence. The primary sources of empirical evidence are the senses and memory. Sometimes people refer to the "sixth sense" or an intuition that questions the rational solution. One could look at a solution that has been derived using all the appropriate engineering theory, and conclude that "something does not add up, does not seem right". Should this justify a review, a re-analysis, testing of assumptions and criteria? Can the Candidate in this situation differentiate between assumptions and inferences? This important area is described in Outcome 9, item 1.5.

Exercise:

During the process of candidacy, an event of this nature is bound to occur. The candidate is required to either locate an event that has been experienced by others or ideally one that has arisen in the candidate's own experience. Provide a report on either of these options. Include the evidence of the rational approach and how this was reviewed with an empirical approach. What created the concern to do this? Was the concern justified?

GROUP DISCUSSION

STEP 4: Displays working knowledge of areas that interact with the practice area

In this step, the process is to address an engineering problem in the workplace environment that has implications in other related engineering disciplines. For example, a component exhibits a defect that appears to be a stress related fracture at a weld interface with the parent metal. This may require the candidate to undertake an analysis with the assistance of a metallurgist or an Engineer with experience in fracture analysis. This could require research into papers, articles, discussions with subject matter experts, experimentation, testing and model building.

As the Candidate's career progresses, the necessity of interacting with Engineers of other disciplines will increase where circumstances require the co-ordination of the solution with the input of these disciplines.

The Candidate should relate as to how the other interactive areas were identified, and how the relevant parties were included in the project concerned.

Exercise:

During the process of candidacy, an event of this nature is bound to occur. The candidate is required to either locate an event that has been experienced by others or ideally one that has arisen in the candidate's own experience. Provide a report on an issue which involved an interaction between two different disciplines or practice areas.

STEP 5: Applies related knowledge: financial, statutory, safety, management

Engineers have a unique function when compared to the other professions: they perform the main functions that create the built environment. These functions affect the full life cycle of the asset concerned. This process requires the interaction of statutory, social, environmental, safety, management and economic issues. This requires the Engineer become informed on the applicable requirements and to remain up to date on changes and developments.

Employers will normally have their own special induction and training documentation that should form part of the candidate's reference material.

The reality of the life-cycle is important here. Jurisdictions will normally have extended impact and are not necessarily readily identified at the point where the candidate is focused at the time of the exercise. This requires that the candidate explore the types of jurisdictional requirements that may, for example, be applicable at the termination of the life of a plant requiring the costs and mechanisms of de-commissioning to be taken into account.

Exercise:

Select a jurisdictional topic, research the material that applies in the domain of the candidates working environment, relate it to any engineering problem resolution report was that done for which the particular topic is applicable. Describe the learning made from this and include any commentary that the candidate feels is warranted. Include reference to any relevant regulations. Comment on the various jurisdictional references that were consulted to establish any impact or possible input required.

ASSESSMENT TEST

Complete the Assessment Test in Appendix 1 (30 minutes are allocated for this).

GROUP ACTIVITY

Report and 10 minute presentation evaluation.

CLASS DISCUSSION

Discuss Case Studies (Appendix 2) and Programme administration.

SECTION 3

GENERIC GUIDING PRINCIPLES

GENERIC GUIDING PRINCIPLES

1. Competency Standard

The SAIMechE Competency Standard is the fundamental document underpinning the journey to Professional Competence. It is the foundation document informing all aspects of the training programme that relates the requirements of competency to the working environment of the developing engineer. It is the standard of practice against which all activities of a competent and professional engineer are measured.

2. Outcomes

The eleven outcomes are the fundamental building blocks on the path to competency. A demonstration of understanding of these outcomes as they relate to the day-to-day working environment will indicate that a level of competency has been reached which will enable the candidate to function at a professional level within the commercial and business environment.

3. Assessment Criteria

The assessment criteria are the requirements against which the candidate is evaluated in order to determine understanding and competency. These are objective criteria which will ensure capability and transparency and set a standard that ensures a proficient level of competency and professionalism as required by industry and in the interests of public health and safety.

4. Range Statements

The range statements set the boundaries of the requirements of each outcome and determine the limits of competency as required for professional practice.

APPENDICES

APPENDIX 1: ASSESSMENTS/TESTS

INITIAL TEST (SECTION 1)

1. List three processes to assist with the achievement of advanced knowledge.

2. What would you consider to be good practice in maintaining ability and access to the theory learnt at a tertiary institution?

3. Once an Engineer has graduated, should all further learning be directed towards management only? What would you deem to be wise practice?

4. What should an Engineer do with the information that was acquired during training as well as at seminars and conferences?

5. What do you expect the role of your peer group to be in the workplace?

6. What is the role of codes and standards in engineering practice?

ASSESSMENT TEST (SECTION 2)

1. Name 3 theories learnt during your tertiary training that you believe are likely to be applied in the workplace**.**

2. What would you expect to learn from involvement with artisans and journeymen in the workplace?

3. What do you understand by the phrase “experiential learning”?

4. What do you understand by the term “sixth sense” in evaluating a problem?

5. What other engineering disciplines would you expect to interact with in the workplace in carrying out the resolution of complex engineering problems? What sort of input do you envisage would be required?

6. What do you understand by the life cycle as it affects engineering projects?

7. What do you think discipline-specific practices means? Could you list some for your engineering discipline that differ from other discipline's.

8. Are you able, in your own words if necessary, to recall and list below the 5 assessment criteria that apply to Outcome 3?

APPENDIX 2: CASE STUDIES

REFERENCES

Websites:

Gathering user needs for knowledge management
http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.200.6965&rep=rep1&type=pdf

RECORDING OF REPORTS

Formats for recording the portfolio of evidence

During the course of the candidate phase training, the Candidate will accumulate a portfolio of evidence comprising the reports supporting the various exercises covered in these guidelines for each Outcome.

Note that the PDP Administration will provide a web site document system that will allow the candidate to store all the PDP documents created as a back-up facility and will enable the candidate to allow access by the Mentor for any reviews that are required.

ASSESSMENT PROCESS

Guide to the Candidate

You will be assessed against Outcome 3.

In order to determine your level of competence you will be tested by:

- Tests done during the workshop and evaluated by fellow candidates and your mentor
- Written assignments (practical tasks given to demonstrate understanding of this Outcome through application in a work setting)
- Knowledge assessment and presentation (i.e. 10 minutes oral presentation using Power Point). Please Note: Oral presentations may need to be taped for moderation and re-assessment procedures.

You will need to prepare yourself in the following ways:

- Familiarise yourself with the contents of this guideline
- Familiarise yourself with the reporting formats required
- Familiarise yourself with the references listed
- Do the written assignments as required by this workshop
- For oral presentations of reports, a ten minute presentation is required to summarise the exercise performed

Note:

A detailed briefing on the exact requirements was given to you by the Mentor/Assessor at Introductory Workshop in order for you to prepare for the assessment process.

The evidence you will be judged on includes:

- Your proven competence in all areas questioned in the presentation (Competent or Not Yet Competent)
- The practical tasks compiled in your Portfolio of Evidence

Good luck, and remember, the mentor/assessor is there to help you.