Professional Competence Development and Assessment for Engineers

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Module 1

Introduction

Professional Tracks

The **International Engineering Alliances (IEA)** has defined three professional tracks, namely:

- Engineer
- Engineering Technologist
- Engineering Technician

Each track plays a **different role** defined by:

- Distinct competences; and
- Level of responsibility to the public.

This presentation focuses on the **Engineer track.**

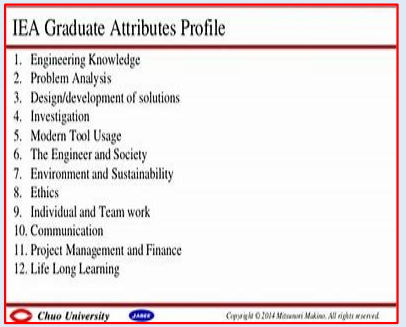
However, this presented materials can also be **generally applied** to Technologist and Technician Tracks.

Graduate Engineer

At the point of graduation, engineers should have gained the following knowledge and attributes.

Knowledge Profile
WK1 – WK9

Graduate Attributes
WA1 – WA11


IEA Graduate Attributes Profile

1. Engineering Knowledge
2. Problem Analysis
3. Design/development of solutions
4. Investigation
5. Modern Tool Usage
6. The Engineer and Society
7. Environment and Sustainability
8. Ethics
9. Individual and Team work
10. Communication
11. Project Management and Finance
12. Life Long Learning

Chuo University

Note that Knowledge Profile forms the basis for Graduate Attributes.

Graduate Engineer

- The fundamental purpose of engineering education is to build **a knowledge base and attributes** to enable the graduate to continue learning and proceed to work domain for formative development -- IEA.
- The role of a **Graduate Engineer (GE)** is applying knowledge of mathematics, science, computing and engineering fundamentals, with an engineering specialization to develop solutions to **complex engineering problems**.
- A GE is typically required to satisfy the **academic requirements** before he is deemed ready to enter into **formative development** in engineering practice.

Acknowledgement

- Reference is made to the "**Graduate Attributes and Professional Competences**" published by **the International Engineering Alliance (IEA)** regarding graduate attributes, knowledge profile, and professional competence profile.
- Please refer to **https://www.ieagreements.org** for authoritative details.
- FEIAP has also adopted the above-mentioned attributes and profiles.

Module 2

Professional Competence

Professional Competence

- At the graduate level, engineers should have built a knowledge base and attributes to enable them to continue learning and proceed to work domain.
- Graduate Engineers should henceforth proceed to acquire the competence to practise at the level of Professional Engineer **(PE).**
- For this purpose, they need to learn and acquire **professional competence**.

What is Professional Competence?

Professional Competence

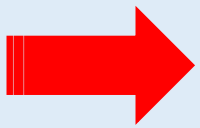
ECUK defines professional competence as:

- The professional's **ability** to carry out engineering tasks successfully and safely within own field of practice.
- This requires individual skills, knowledge and understanding, personal behaviour and approach, to work collaboratively with others to achieve the intended **outcomes**.
- This also includes the **ability** to make professional judgments, and an awareness of the **limits** of own ability and knowledge in order to seek assistance when required.

Professional Engineer Competence

It follows that :

- A **professionally competent person** should have the **attributes** necessary to perform the activities within own profession to the **standards** expected of a PE in independent practice – Thus, he needs to know the standard.
- **Competence standard** typically comprises essential **competence elements** that are exemplars of these attributes. This is normally set in the form of a **reference profile** such as the IEA Professional Competence Profile.



IEA Professional Competence Profile

IEA Professional Engineer Competence

Competence Element	Professional Engineer
Comprehend and apply universal knowledge: Breadth and depth of education and type of knowledge	**EC1:** Comprehend and apply advanced knowledge of the widely-applied principles underpinning good practice
Comprehend and apply local knowledge: Type of local knowledge	**EC2:** Comprehend and apply advanced knowledge of the widely-applied principles underpinning good practice specific to the jurisdiction of practice
Problem analysis: Complexity of analysis	**EC3:** Define, investigate and analyse complex problems using data and information technologies where applicable
Design and development of solutions: Nature of the problem and uniqueness of the solution	**EC4:** Design and/or develop solutions to complex problems considering a variety of perspectives and taking account of stakeholder views
Evaluation: Type of activity	**EC5:** Evaluate the outcomes and impacts of complex activities

IEA Professional Engineer Competence

Competence Element	Professional Engineer
Protection of society: Types of activity and responsibility to consider sustainable outcomes	**EC6:** Recognize the reasonably foreseeable economic, social, cultural and environmental effects of complex activities and seek to achieve sustainable outcomes
Legal, and regulatory, and cultural: No differentiation in this characteristic	**EC7:** Meet all legal, regulatory, and cultural requirements and protect public health and safety in the course of all activities
Ethics: No differentiation in this characteristic	**EC8:** Conduct all activities ethically
Manage engineering activities: Types of activity	**EC9:** Manage part or all of one or more complex activities
Communication and Collaboration: Requirement for inclusive communications. No differentiation in this characteristic	**EC10:** Communicate and collaborate using multiple media clearly and inclusively with a broad range of stakeholders in the course of all activities

IEA Professional Engineer Competence

Competence Element	Professional Engineer
Continuing Professional Development (CPD) and Lifelong learning: Preparation for and depth of continuing learning. No differentiation.	**EC11a:** Undertake CPD activities sufficient to maintain and extend competences and enhance the ability to adapt to emerging technologies and the ever-changing nature of work
Judgement: Level of developed knowledge, and ability and judgement in relation to type of activity	**EC11b:** Recognize complexity and assess alternatives in light of competing requirements and incomplete knowledge. Exercise sound judgment in the course of all complex activities
Responsibility for decisions: Type of activity for which responsibility is taken (WA10)	**EC12:** Be responsible for making decisions on part or all of complex activities

Holistic Assessment

- The IEA Reference Profile consists of **thirteen (13 or 12+1) competence elements.**
- However, each GE has **unique** work experience because of the nature of job. The unique **nature** and requirements of their **role** will result in them having a higher level of competence in some areas and limited experience in other areas.
- On the whole, they will have to demonstrate an **appropriate balance of competences** to perform their role effectively at PE level.

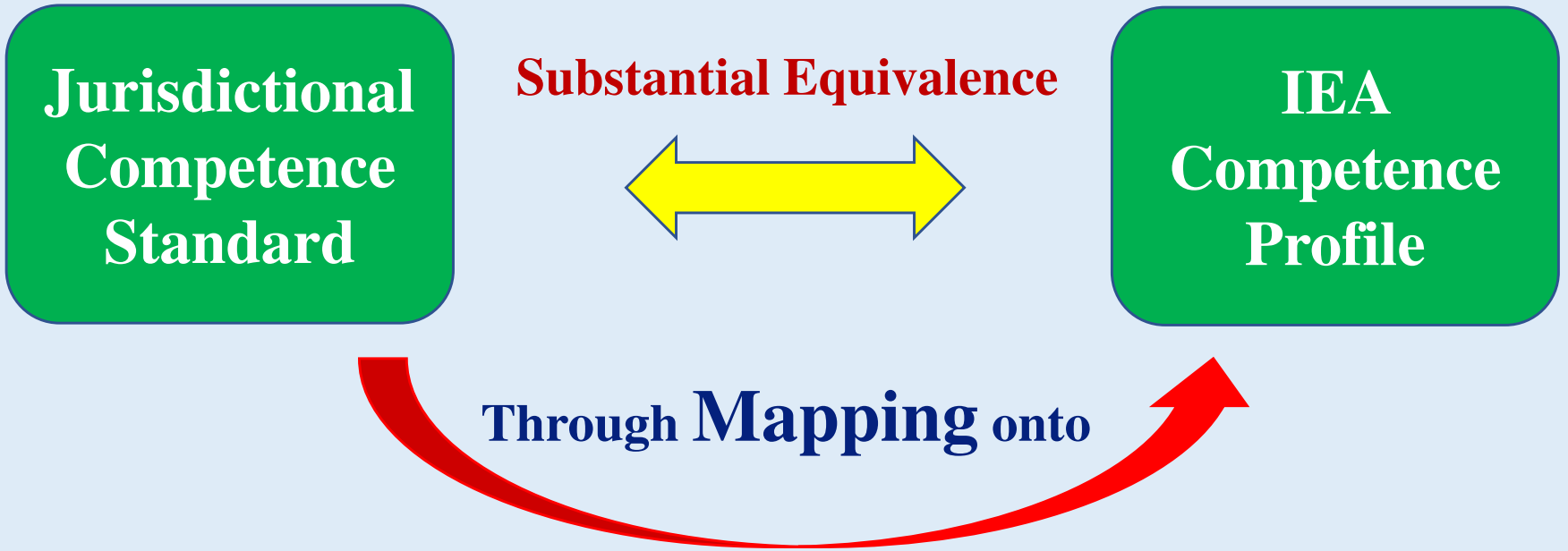
Competence Standard

- The engineering regulatory / professional body in each jurisdiction should develop its own **jurisdictional professional competence standard.**
- For the purpose of international recognition, each body has to prove **substantial equivalence** to a common reference standard or benchmark.
- The widely accepted common reference standard is the **IEA Professional Competence Profiles**.
- Normally, substantial equivalence is illustrated by a **comparative table** showing how a jurisdictional standard meets the reference profile.

Development of Standard

Adopt and Adapt Strategy

By adopting and adapting the competence elements of a reference profile such as EC1 – EC12, a jurisdiction is in effect mapping out a **comparative table** to demonstrate substantial equivalence to the reference profile.



Competence Mapping -- Example

UK-SPEC For CEng. Competence Areas		Competence Elements	Corresponding
A	Knowledge and Understanding of Engineering	A1 and A2	EC1 and EC2
B	Design and Development of solution to Complex Engineering Problems	B1, B2 and B3	EC3, EC4, EC11b, and EC12
C	Responsibility, Management and Leadership	C1, C2, C3 and C4	EC5, EC9, EC11b, and EC12
D	Communication, Inter-personal Skills and Collaboration	D1, D2 and D3	EC10
E	Commitment to professional standards, recognizing obligations to society, profession and environment	E1, E2, E3, E4 and E5	EC6, EC7, EC8, and EC11a

Cover all the 13 IEA competence elements

Jurisdictional Standard

Why have

Jurisdictional Competence Standard ?

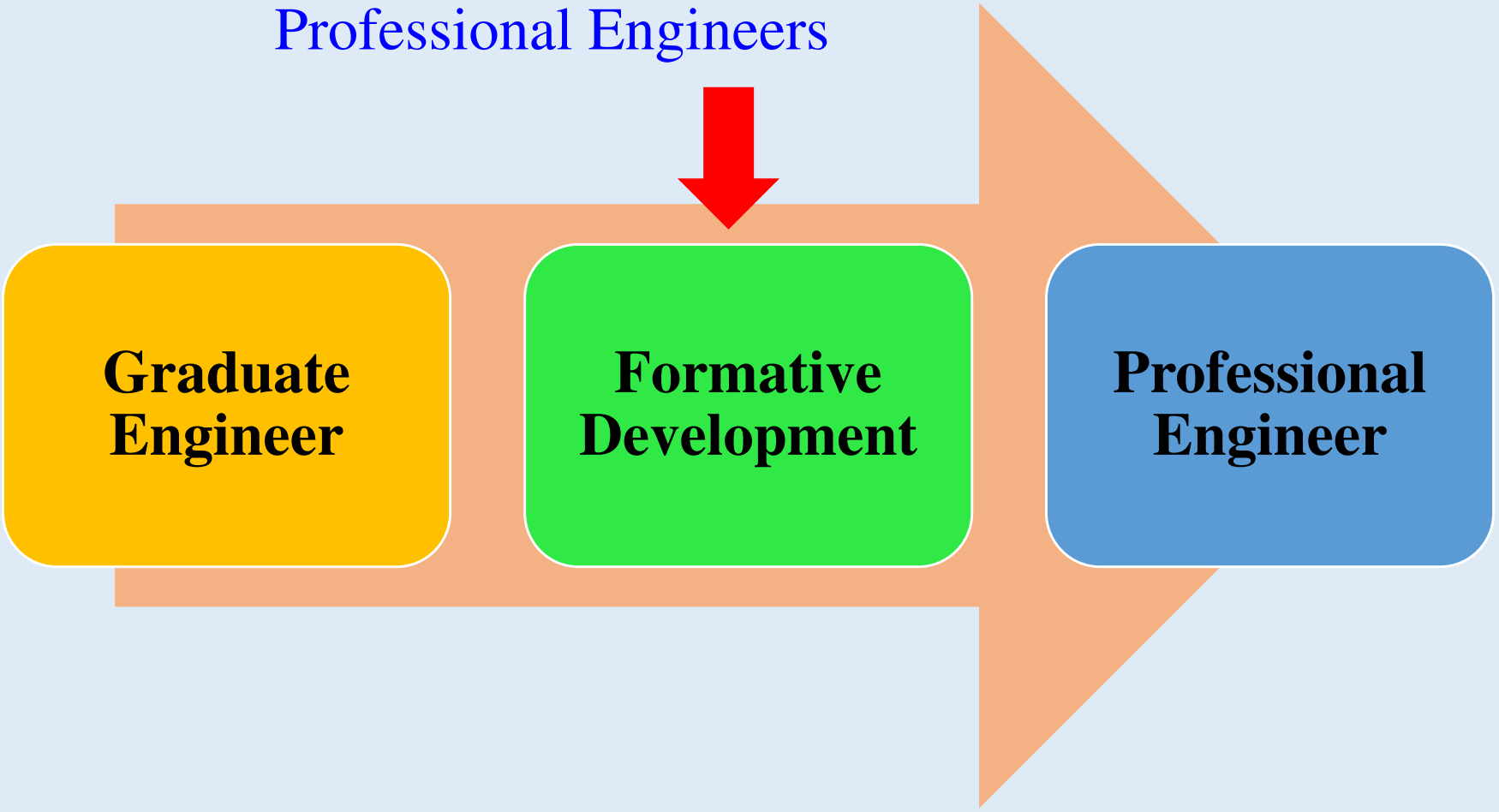
- Provide GEs with a list of competence elements against which they will be assessed for PE registration.
- Give direction and focus to GEs on acquiring the prescribed competence in their Formative Development.

Module 3

Formative Development

Formative Development

A process that Graduate Engineers must undergo before they become Professional Engineers



Formative Development

What is Formative Development?

From IEA Perspective

The main purpose of formative development is to build on the educational base to develop the competences required for independent practice. It is a **process** in which GEs work with engineering practitioners and progress from an assisting role to taking more individual and team responsibility until **competence** can be demonstrated at the level required for **registration as Professional Engineer**.

Formative Development

General Requirements

Academic Qualification

Engineers should graduate with a fully **accredited degree** to be deemed fit to undertake a programme of practical training and experience leading to professional competence and registration.

Mentorship Arrangement

The training and experience should be obtained under the supervision of a suitable PE typically in a **mentorship** arrangement.

Mentorship Arrangement

- Mentorship arrangement provides more **structured training and development** that will ensure GEs acquiring the right combination of knowledge, skills and attitude to pass the competence assessment for PE registration.
- The success of this structured development depends on **two key roles**, namely:
  1. Primary Role

     Graduate engineers play the primary role to learn and acquire the competence.
  2. Mentoring Role

     Supervising PEs play the mentoring role by guiding and facilitating GEs in this learning process.

(1) GE Playing Primary Role

- Learning and acquiring the prescribed competence of the standard is the primary role of GEs in this development process. **The onus is on them.**
- Invariably, they have to go through the **learning curve** – a process in which they progressively gain experience, knowledge, and skills as well as professional attitude.
- This process normally takes **several years**. The key to success in this process is the learning attitude of graduate engineers themselves.

Learning Attitude

The **desired learning attitude** typically has the following characteristics:

- ✓ have a **passion** for own work
- ✓ possess **motivation** to succeed
- ✓ make full use of **learning opportunities**
- ✓ take **initiatives** to learn
- ✓ have **perseverance** to last through learning
- ✓ walk the **last mile**
- ✓ conduct oneself with **integrity**
- ✓ Have **ends** in mind

Have Ends In Mind

To have the ends in mind, GEs should take the initiative to find out the following:

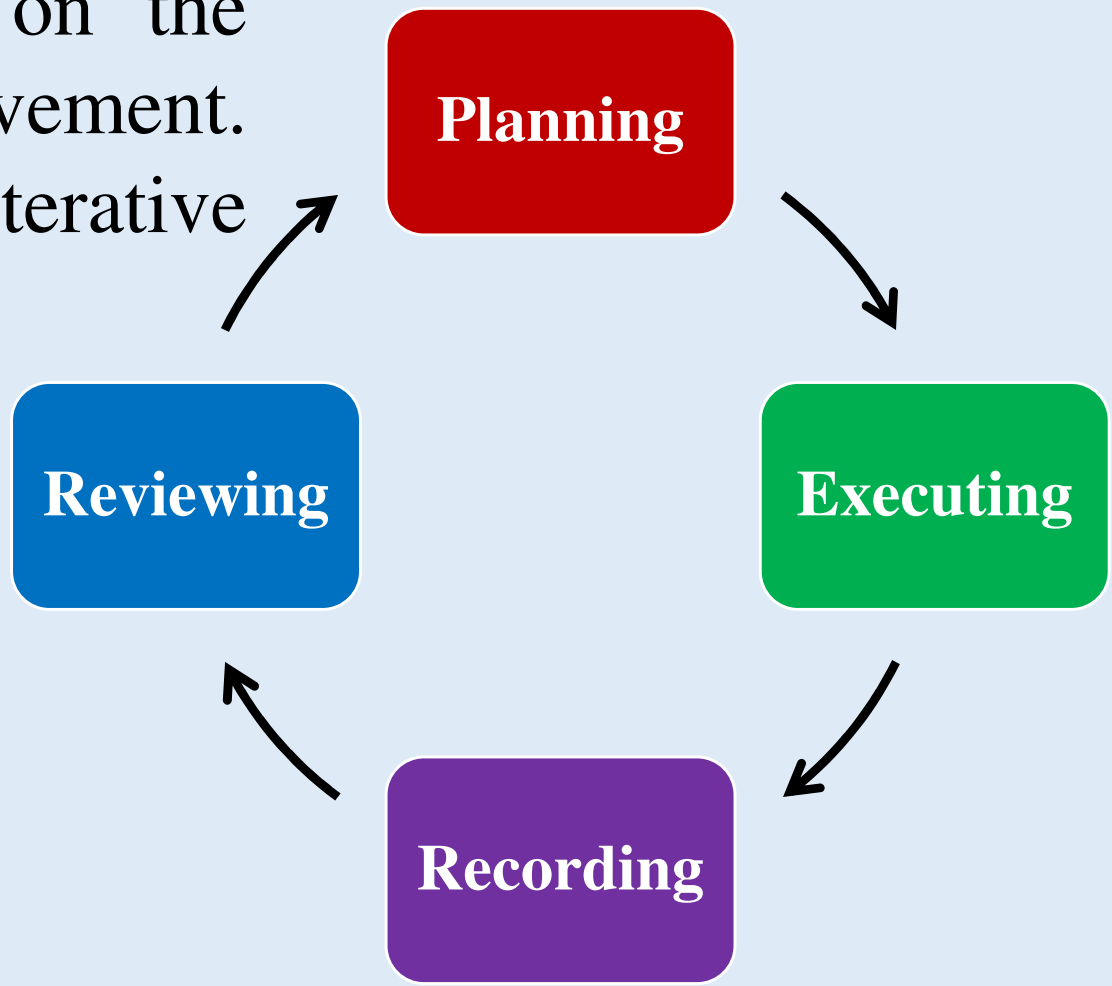
- ✓ On what criteria and how they will be assessed to qualify as PE. Thus, they must know **Professional Competence Standard** and **Assessment Method**.
- ✓ How to demonstrate that they have met the assessment criteria. They must collect **Evidence of Competence** gained during formative development.

They should then take the initiative to have a workable **development action plan** to achieve these ends.

Development Action Plan

Professional Development is commonly carried out on the basis of continual improvement. It has four phases in an iterative cycle :

- **Planning**
- **Executing**
- **Recording**
- **Reviewing**



Planning

- **Planning** is done through devising a **development action plan** that meets the following **goals**:
  - ✓ **Job roles** set by the company; and
  - ✓ Requirements defined by **competence standard.**
- Create an **action plan** for each of the goals:
  - ✓ Identify different types of activities or actions that help develop competence covering all elements.
  - ✓ Think about what to do, what recourses are needed, and who can offer help in work settings.
  - ✓ Schedule regular meetings with supervising PE.
- Discuss the development action plan with the **Mentor** to ensure feasibility in actual working environment.

Executing

- **Executing** is done through carrying out the **action plan.**
  - ✓ Execute the planned actions or activities.
  - ✓ Dedicate time and put in effort to make them happen.
  - ✓ Get necessary guidance, support and corporation.
- Find suitable ways to learn from the action plan.
  - ✓ Ascertain that learning outcomes meet requirements of competence elements.
  - ✓ Ensure adequate training and experience in design, field, communication and management.
- Collect lessons learned from the execution to loop back to action plan for review and improvement.
- Maintain motivation and resilience.

Recording

- Prepare proper **logged** reports and documentation in the form of a **log book** to be reviewed and verified by Mentor during scheduled meetings.
- **Recording** is typically done by putting together a **portfolio of evidence** that covers all the competence elements prescribed in the competence standard:
  - ✓ Compile **evidence** of all **learning outcomes**.
  - ✓ Link learning outcomes to meeting the requirements of the professional **competence standard**.
  - ✓ Keep **records** and get them **signed off** by Mentor.
- Ascertain that the recording is up-to-date, relevant and complete.

Reviewing

- **Reviewing** is done by meeting with Mentor regularly (quarterly, ..) to evaluate the plan – periodic review.
- **Track** the progress to find out if Mentee is meeting the set goals and requirements of competence standard.
- Reflect on the learning progress -- try to cover the missing parts; work on the areas that need further improvements; and enhance the areas of strength.
- Mentee has to submit Annual Report for yearly appraisal by Mentor Panel; an important milestone to gain advice and endorsement.

Log Book - Example

- Record job tasks performed in chronological order.
- Describe the role played, and each activity/action done.
- Describe **learning outcomes** in terms of knowledge gained, understanding enhanced, problems faced and analysed, solutions proposed, and lessons learned.
- Include learning outcomes related to communications, ethics, management and leadership.
- Include courses, talks, seminars, etc by summarising the learning outcomes.
- Link learning outcomes to competence elements.
- Attach details such as investigations, studies and calculations, if necessary.

(2) PEs Playing Mentoring Role

- Many jurisdictions have stipulated that formative development of GEs should be done under proper **supervision of PE(s).**
- The **main role** of **supervising PEs as Mentor** is to provide guidance and facilitation to **GEs as Mentee** in their journey to become **professionally qualified**.
- The guidance and facilitation should be **focused** on meeting the requirements of competence standards so that Mentees are given every opportunity and support to acquire the competences required to qualify as a PE.
- Mentor should try to help enhance levels of competence of Mentees and accelerate their professional development.

Mentoring Relationship

- **Mentoring relationship** tends to be voluntary on both sides. It is often entered into with a defined time limit (3-5 years), and / or with defined goals.
- Supervising PEs help GEs learn; and monitor their **professional development** in the context of actual working environment.
- Both sides should have **periodic meetings** to discuss and review the progress and achievement; and identify opportunities for improvement.
- At the **defined end** of mentoring, the verified and endorsed **log-book** will be returned to the Mentee to be used as the basis for preparing **portfolios of evidence**.

Suitability of Mentor

To better guide and facilitate the professional development of a GE, the supervising PE should meet the following **criteria**:

- ✓ Willing to volunteer as the Mentor of a particular GE through matching.
- ✓ In the same or related engineering discipline as that of the GE.
- ✓ Has relevant experience to give guidance.
- ✓ Has been a registered PE for at least 5 years.
- ✓ Has been trained as a Mentor.
- ✓ Preferably comes from the same organisation.
- ✓ Preferably has a good measure of people skills.

Mentoring Programme

- Some GEs are able to find a suitable PE within the **same organisation** that runs a formal mentoring programme to match mentors with mentees.
- Not all GEs are lucky enough to find a suitable PE within the same organisation. In such cases, they can look for other mentoring programmes like those provided by **professional organisations**.
- **Jurisdiction** should facilitate a **mentoring programme** in which graduate engineers can arrange a mentor of the same discipline from the same or a different organisation.

Mentoring Programme

Cross jurisdictional mentoring

FEAIP may help …

When the mentor training programme is **not feasible within a jurisdiction** owing to the lack of PE specialising in a certain engineering discipline or sub-discipline, the jurisdiction could help the graduate engineer by arranging through FEAIP with other jurisdictions for mentoring assistance.

Advice to GEs

- ✓ Select the **industry sector** that meets individual career interest and aspiration.
- ✓ Join the **company** that can provide professional development.
- ✓ Go for the **job** that will give the right type of experience as specified by the role & responsibility.

Whatever the actual situation, **GEs** bear the primary responsibility for their own **professional development**.

Module 4

Competence Assessment

Competence Assessment

When ready, a GE can apply to sit for Competence Assessment.

What is Competence Assessment?

Competence Assessment is the holistic assessment of a GE's professional competence against the **competence elements** of a Jurisdictional Competence Standard to confirm if he/she meets the standard holistically.

Competence Elements exemplify a set of individually assessable **outcomes** that must be collectively demonstrated in order to practise effectively as PE.

Outcome Based Assessment

It follows that

Competence represents the **outcome** of practical training and working experience of GEs during their formative development.

Thus, **competence assessment** is commonly termed as **Outcome-based Assessment**.

Next issue is:
How to assess competence; or rate **attainment of competence level;** or indicate performance?

Performance Indicators

- The **professional competence profile** does not specify performance indicators or how the competence elements should be assessed for different areas of practice or for different types of work.
- The regulatory / professional body in each jurisdiction should define its own performance indicators, namely **actions** on the part of assessed person that demonstrate what **level of competence** has been attained**.**
- Typically, competence is described in **several levels;** each level indicates different degree of attainment by assessed person against a competence element.

Assessment Rubrics – Example

One example of assessing the level of attainment in each competence element is given by the following rubrics.

Level of Attainment	Generic Statement of Attainment
1	Little or no evidence of competence
2	Some evidence of competence
3	Acceptable evidence of competence
4	Strong evidence of competence

Assessment Rubrics

- The attainment levels indicate **different competence levels** on the **learning curve** as GEs acquire their working experiences. It always starts from level 1, and moves upwards to 2, 3 and finally to level 4.
- Moving from one level to the next level depends on the **competence / ability** acquired by a GE, not on the length of time the GE spends on the work.
- Different GEs may require different time to move from one competence level to the next. The **focus** of measurement is on competence, not time.

Assessment Rubrics

- Each Competence Element has **four thresholds** (performance indicators) that indicate four different levels of attaining the competence by assessed person.
- Jurisdiction should establish a **threshold statement** that gives a standard interpretation of each threshold. The statements typically consider the **maturity of learning** in terms of the :
  - ✓ awareness, knowledge, experience and ability gained,
  - ✓ action done, contribution made, outcome achieved,
  - ✓ role played, decision made, responsibility taken,
  - ✓ Other considerations such as size and complexity.

Evidence Based Assessment

- Assessing competence is based on the **evidence** given by assessed person to demonstrate the attainment level in each **competence element** listed in the jurisdictional competence standard – **Evidence-based Assessment**.
- Attainment levels are normally differentiated by the **amount and substantiality of evidence** demonstrated by assessed persons to show the breadth and depth of their grasp of the subject matter.
- The evidence must be drawn from **work experience**, specifically as they encounter engineering problems or engage in engineering activities.

Sources of Evidence

Sources of evidence normally include the following documentations:

1. **Application Form.**
2. **Training & Experience Report.**
3. **Technical / Project Report.**
4. **Portfolios of Evidence.**
5. **Various other Document for Assessment.**

GE should be properly briefed on the types of documentation required for Competence Assessment.

Assessment Methods

Assessment methods / tools vary between jurisdictions; and may include any or any combination of the following methods / tools -- the list is **not exhaustive**:

Self assessment / self appraisal report
Oral examination / peer interview
Writing essays / making presentation in person
Examinations / tests (sit-in or online)
On the job assessment
Assessing portfolios of evidence
Evaluation of technical / project reports

Assessment Methods

- Each assessment method / tool has its strength and limitation; hence there is no best method.
- Typically, each jurisdiction will select **a combination of methods / tools** that can best assess the competence prescribed in its own competence standard.
- Each jurisdiction should also set its own **criteria for passing** the competence assessment.

GEs should be well informed of :

✓ The methods / tools used for competence assessment.

✓ The passing criteria of the assessment.

Module 5

Summing Up

Summing Up

- GEs should have the **knowledge base and attributes** to go into work domain.
- Jurisdiction should establish its own **standard** against which **competence** is assessed for PE registration.
- GEs should take **ownership** in learning and acquiring the **competence required by the standard**.
- Supervising PEs as **mentor** should guide GE in their formative development.
- Jurisdiction should select **assessment methods** and **passing criteria** most suitable in its context.
- Competence assessment should be **outcome-based** as well as **evidence-based.**

Thank You