Conceptual Model for Professional Competence and its Educational Foundation for Engineer and Engineering Technologist Roles

First ENAEE Conference
Porto: November 2012
Hu Hanrahan

Outline

1. Professional competence
2. Engineering roles
3. Competency model: contextual and conceptual dimensions
4. The educational level:
   – Washington and Sydney Accord Graduate Attributes
5. What changes from graduation to independent practice?
6. The Professional Level:
   – IEA Professional Competencies
Context: Engineering Professional Lifecycle

- Expert/Academy in Field
- Experienced in Independent Practice
- Competent for Independent Practice
- Graduate-level competence

---

Varied engineering practice systems …

- National systems may have different levels:
  - No general regulation of engineering practice
  - Registration: Certification of competence and regulation of professional conduct
  - Licencing based on registration
- Common objectives are:
  - Effective engineering solutions
  - Protect public health and safety
  - Protect environment and sustainability
- Focus on fundamental rather than national system requirements
Pellegrini et al Degree Model

This is saying that:
• Industry needs an entry level engineering graduate with a minimum practical knowledge
• Industry can absorb graduates with a wide range of theoretical ability

It does not consider that:
• Readiness to work is not necessarily readiness to take responsibility; that comes with further experience
• The trajectory of the two kinds of graduates a number of years after graduation

Competency model: contextual and conceptual dimensions

- **Conceptual or Theoretical**: codified, hierarchical theory moving to greater levels of abstraction and conceptual difficulty
- **Contextual or Practical**: methods connected to an application context, generally more segmented

In engineering, these dimensions are connected

The combination is related to the type and level of problem

Applying Theory requires contextual knowledge
Executing practical methods requires a theoretical base
IEA: Graduate Attribute Overview

Knowledge-oriented
1: Using engineering knowledge

Skill-oriented Group
5: Modern Tool Usage
9: Individual and teamwork
10: Communication
11: Project/Engineering Management

Problem-solving Skill Group
2: Problem analysis
3: Design/development of solutions
4: Investigations

Attitude-oriented Group
6: The Engineer in Society
7: Environment and Sustainability
8: Ethics
12: Life long learning

Defined Knowledge Profile
Defined Level of Problem Solving

See www.ieagreements.org

Conceptual-Contextual Components

WA1, WK1-4, WK8: For CEP
Apply engineering knowledge some at discipline’s forefront and some drawn from the research literature

SA1, SK1-4, SK8: For BDEP
Apply engineering knowledge defined, applied procedures, processes, engaging with Technological literature

WA2: Analyse CEP
WA3: Design solution to CEP
WA4: Investigate CEP

SA2: Analyse BDEP
SA3: Design solution to BDEP
SA4: Investigate BDEP

WA5, WK6: For CEP:
Create, select and apply techniques, resources, tools, including prediction and modelling

SA5, SK6: For BDEP
Select and apply techniques, resources, tools, including prediction and modelling

WAn/SAn = Washington Sydney Accord Attribute n
WKn/SKn = Washington Sydney Accord Knowledge Profile n
CEP = Complex Engineering Problems
BDEP = Broadly-defined Engineering Problems
## Defining the Level

### Knowledge Profile:

**Statements of Level of:**

1. Mathematics
2. Natural Science
3. Engineering Science
4. Engineering Speciality
5. Design
6. Engineering practice
7. Engineering in society
8. Research Knowledge

Graded for engineer, technologist and technician

### Problem Solving:

**Statements of Level of:**

A: The difficulty of recognising and defining the problem
B: The difficulty of defining the required outcome
C: The complexity of the solution path
D: The engineering knowledge required

Graded for engineer, technologist and technician

---

## The IEA Professional Competencies

- The IEA Professional Competencies (PC) define the required competency of person who is able to practice independently, in a defined engineering role.
- The PC define the competency for:
  - Professional Engineer and similarly titled practitioners
  - Engineering Technologists and similarly titled practitioners
  - Engineering Technicians and similarly titled practitioners
- The PC are defined using:
  - 13 Outcomes
  - Level definition for engineering problem solving
  - Level definition for engineering activities
How Engineering Competencies Develop?

**Graduate Attributes**
- Knowledge has a strong theoretical base with appreciation of context
- Problem solving focus on design and investigation
- Understand and reason about issue, impacts and ethics
- Know and understanding engineering management

**Professional Competencies**
- Knowledge becomes strongly contextual
- Problem solving requirements supplemented by need to exercise judgement
- Protect society, meet regulatory requirements
- Act ethically
- Take responsibility for actions
- Manage engineering activities

---

Visualising Development after Graduation

Theoretical (Conceptual)

Practical (Contextual)
Reflections

• Development of engineering professionals
  – Requires an educational base: the accredited degree
  – Achieving competence for-independent-practice
• IEA educational standards are informed by professional competence requirements
• Engineering roles are distinguished by definitions of level of:
  – Indications embedded in the outcomes
  – Problem solving
  – Knowledge profile