Complex Problem Solving

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Workshop Learning Outcomes

- Explain the meaning of complex problem solving from engineering education perspective.
- Use problem crafting guideline for coming up with suitable problems with workplace settings
- Take a scholarly approach - impact and practical aspects

Outline

Objective:
Provide a clearer picture of complex problem solving from engineering education perspective, craft complex problems, take scholarly approach in the implementation, and share latest findings from practitioners.

- **What and Why …?**
- Underpinning principles for crafting problems
- Steps in problem crafting
- How? Taking the scholarly approach.
- Example: Research on CPBL – impact and practical aspects

EAC Requirements (2012)

Students of an engineering programme are expected to attain the following:

(i) **Engineering Knowledge** - Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialisation to the solution of complex engineering problems;

(ii) **Problem Analysis** - Identify, formulate, research literature and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences;

(iii) **Design/Development of Solutions** - Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations;

(iv) **Investigation** – Conduct investigation into complex problems using research-based knowledge and research methods including design of experiments, analysis, and interpretation of data, and synthesis of information to provide valid conclusions;

(v) **Modern Tool Usage** - Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities, with an understanding of the limitations;

- **(vi) The Engineer and Society** - Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice;
- **(vii) Environment and Sustainability** - Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development;
- **(viii) Ethics** - Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice;
- **(ix) Communication** - Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions;
- **(x) Individual and Team Work** - Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings;
- **(xi) Life Long Learning** - Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change
- **(xii) Project Management and Finance** - Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments;

What is a complex problem?

EAC Definition of Complex Problem Solving

Attribute	Complex Problems
Preamble	Engineering problems which cannot be resolved without in-depth engineering knowledge, much of which is at, or informed by, the forefront of the professional discipline, and have some or all of the following characteristics listed below:
Range of conflicting requirements	Involve wide-ranging or conflicting technical, engineering and other issues.
Depth of analysis required	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.
Depth of knowledge required	Requires research-based knowledge much of which is at, or informed by, the forefront of the professional discipline and which allows a fundamentals-based, first principles analytical approach.
Familiarity of issues	Involve infrequently encountered issues
Extent of applicable codes	Are outside problems encompassed by standards and codes of practice for professional engineering.
Extent of stakeholder involvement and level of conflicting requirements	Involve diverse groups of stakeholders with widely varying needs.
Consequences	Have significant consequences in a range of contexts.
Interdependence	Are high level problems including many component parts or sub-problems.

What: Problem Solving Topology

What's the Difference?

Problem Solving

- Process to obtain best answer to an unknown, subject to constraints
- Ill defined
- Brand-new
- No explicit statement
- More than one approach
- Algorithm to solve unclear
- Integration of knowledge
- Strong skills of presenting results

Exercise Solving

- Process obtain the one and only answer
- Well defined
- Encounter similar problem before
- Explicit, hints given
- Usually one approach to one answer
- Recall familiar solutions – usual method
- Subject by subject
- Presentation skills not required

(Syed Helmi, 2011)

Why complex problem?

In industry nobody gets paid to take tests but to solve problems, design innovative products and be sustainable

(David Jonassen)

Plus a whole lot of other reasons required in the 21st Century…

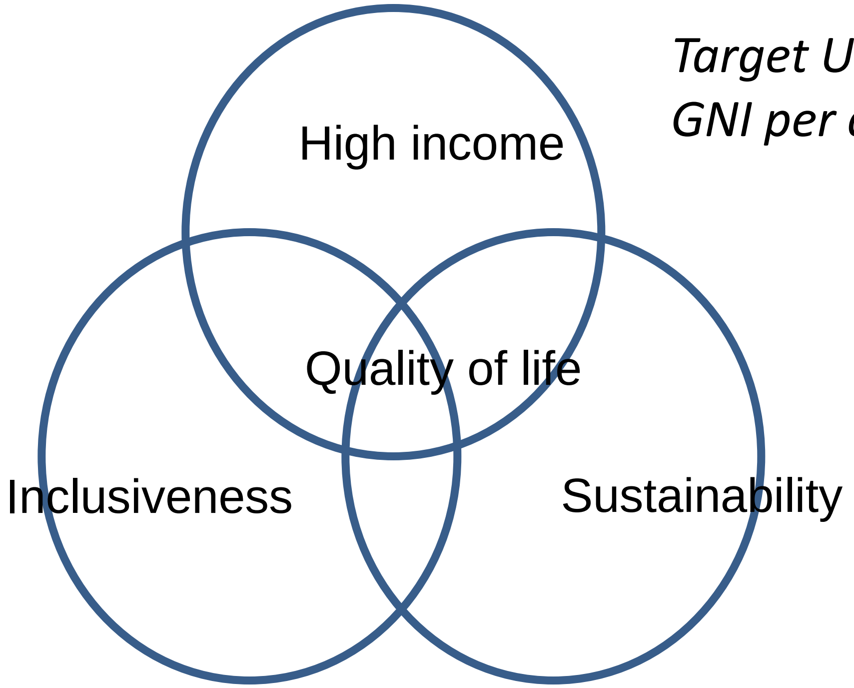
The Grand Challenges in Engineering Education

Global Sustainability	Destruction of forests, wetlands, and other natural habitats Global warming Ballooning global population
Energy	Unsustainable fossil fuel Sustainable energy technologies Alternative energy technologies Energy infrastructure
Global Poverty and Health	Green revolution 1/6 population - extreme poverty Globalization
Infrastructure	Aging infrastructure Urbanization Manufacturing to knowledge services Systems integration

(Syed Helmi, 2011)

Malaysia's New Economic Model

Source: New Economic Model for Malaysia: Part 1



Target USD 15,000 GNI per capita by 2020

Enables all community benefits from the wealth of the country

Meets present needs without compromising future generations

Educating "renaissance" engineers

engineer as specialist

recognizes the continued need for engineering graduates who are technical experts of world-class.

engineer as integrator

reflects the need for graduates who can operate and manage across boundaries, be they technical or organizational, in a complex business environment.

engineer as change agent

highlights the critical role engineering graduates must play in providing the creativity, innovation, and leadership needed to guide the industry to a successful future.