SLT and Complex Problems

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Student Learning Time (SLT)

- Effective learning time or student effort in learning or the learning volume (a quantitative measurement of **all** learning activities) in order to achieve the specified learning outcomes

- Include all learning activities **- formal and non-formal**

- Total time required by student to learn a particular component of curriculum: **Official Contact** Time + **Guided Learning** Time + **Self Study** Time (Independent learning) + **Assessment** Time

- Synonymous to student's academic load, e.g. credit hours

Student Learning Time (SLT)

Effective Learning Time or Student Academic Load (SAL) or Learning Volume can be in a variety of ways:

- About 8 hours/day
- 40-48 working hours/week
- 560-670 hours/14 week semester
- Normally 15 – 16 credits per semester
- 1 Credit Hour about 40 SLT (per semester)

Student Learning Time (SLT)

- Management instrument for both the directed, guided and independent learning,
- Component of time management – SLT promotes ethics and discipline in student's effort towards learning
- Enhancing "life-long-learning" skills
- An indicator of effort in learning and study smart
- Educate on how the "learning by doing" in respect to effort in learning i.e. student-centred outcome-based approach
- Effective control of prescribed study duration

Guideline for Estimating SLT & CAL (Course Academic Load)

Teaching modality	Time (hr) per unit of teaching	Additional time to be added (hr)	Total time (hr) per unit of teaching
Lecture	1	1-2	2-3
Tutorial	1-2	1-2	2-4
Lab Practical	3	2-3	5-6
Small Group Discussion	1-2	1	2-3
Fixed Learning Module	3	0	3
Problem-based learning	2-3	2-3	4-6
Presentations	1	3-4	4-5
Each 2000 word written assignment	10-20	0	10-20
Case summary (per case)	3	0	3
Research Project (total)	240-400	0	240-400

Guideline for estimating SLT & CAL (Course Academic Load)

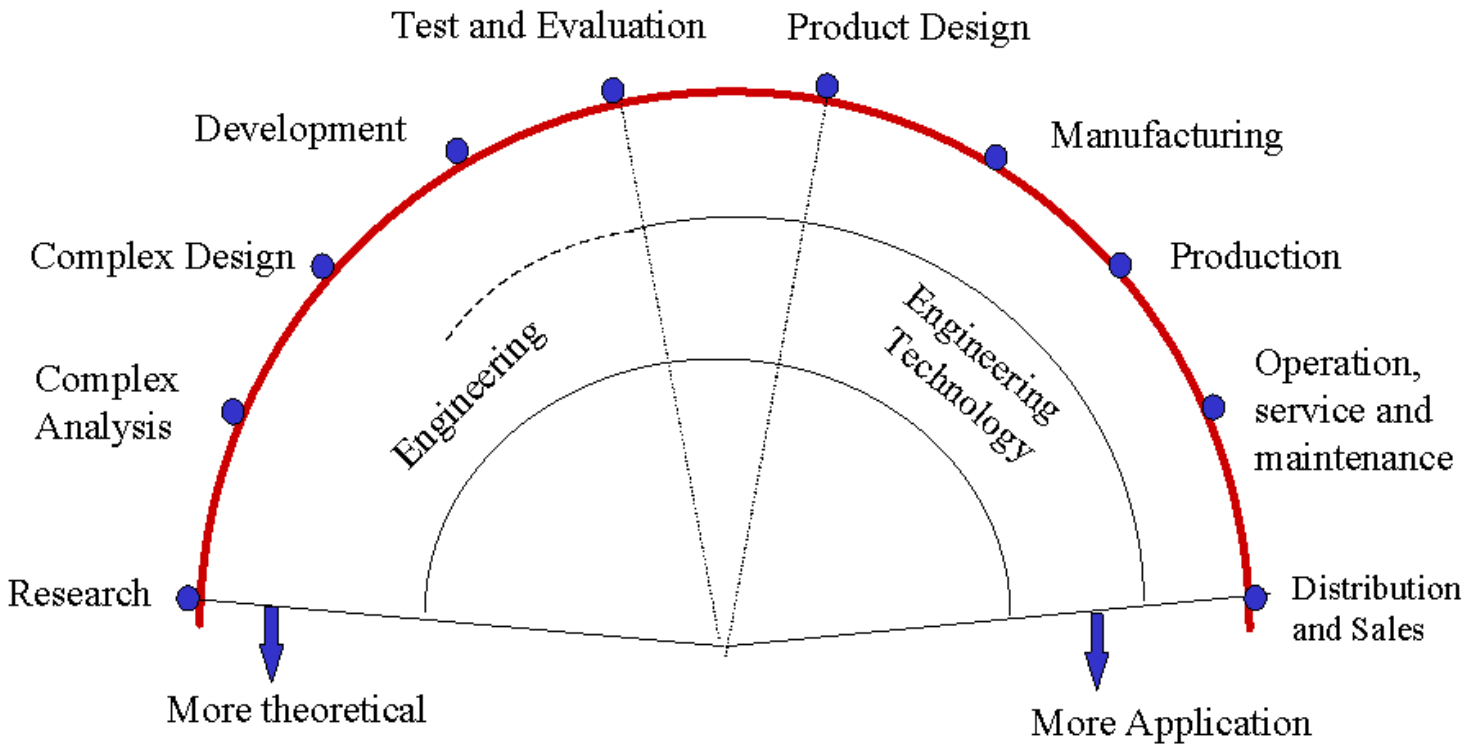
Teaching modality	Time (hr) per unit of teaching	Additional time to be added (hr)	Total time (hr) per unit of teaching
Industrial training (total)	320 (should be at least 2 months)	0	320
Demonstration per session	1-2	0	1-2
Electronic/Online learning per session	3-5	0	3-5
Clinical per session	Whatever time that has been allocated	0	Whatever time that has been allocated
Field work per session	Whatever time that has been allocated	0	Whatever time that has been allocated

Roles of Engineering Personnel

Engineer Graduate	Engineering Technologist Graduate	Engineering Technician Graduate
Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization respectively to the solution of complex engineering problems	Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to defined and applied engineering procedures, processes, systems or methodologies	Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to wide practical procedures and practices

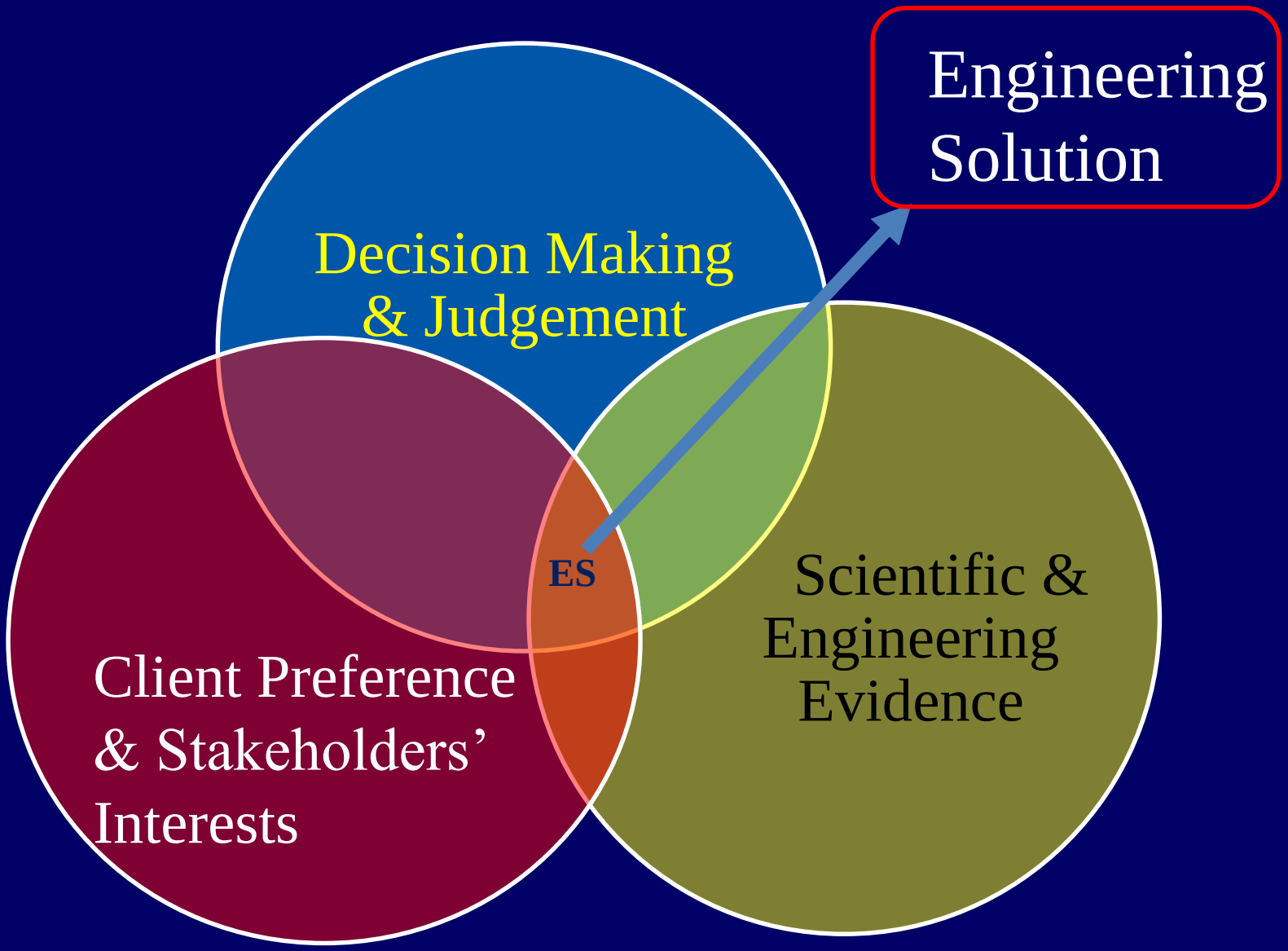
Engineering and Engineering Technology

Spectrum of Technical Job Functions



bing.com/images – engineering spectrum

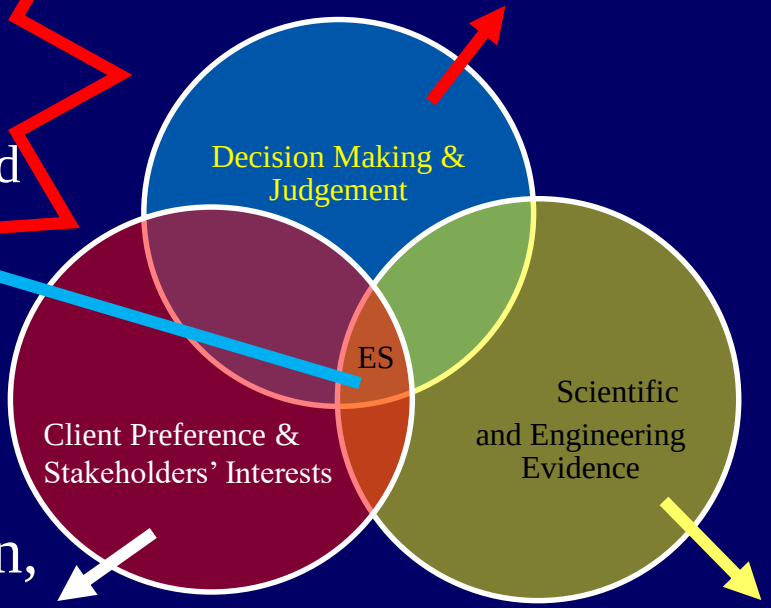
Engineering Solution for a Complex Problem



Engineering Solution

Comparison of Solutions, Cost Effectiveness, Using Relevant Tools, Selection of Best Solution,
Judgement, Decision Making

Engineering Solution based on Sound Judgement – Education Outcomes Demonstrated



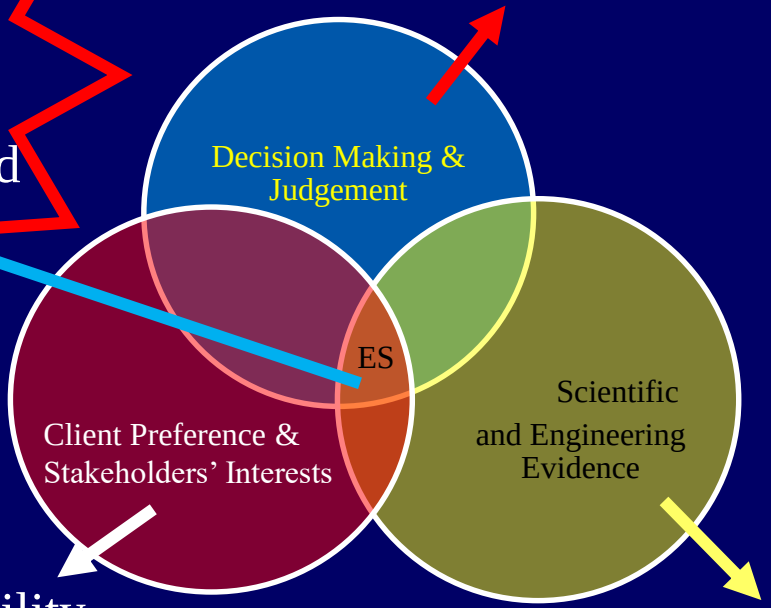
Collecting Information, Negotiation, Values, Resolving Conflicting Issues & Interests, Convincing Stakeholders

Research, Experiences of Others, Relevant Engineering Principles and Scientific Theories and Methods

Education Outcomes: Engineering Solution

Design & development of Solution, Modern Tool Usage, Individual & Teamwork, Project Management & Finance

Engineering Solution based on Sound Judgement – Education Outcomes Demonstrated



Engineer & the World, Environment & Sustainability, Ethics, Individual & Teamwork. Communication, Project Management & Finance

Engineering Knowledge, Problem Analysis, Investigation, Lifelong Learning

In Line with UN Sustainable Development Goals

Goal 1: No Poverty
Goal 2: Zero Hunger
Goal 3: Good Health and Well Being
Goal 4: Quality Education
Goal 5: Gender Equality
Goal 6: Clean Water and Sanitation
Goal 7: Affordable and Clean Energy
Goal 8: Decent Work and Economic Growth
Goal 9: Industry, Innovation and Infrastructure

via Best Practices in Engineering Profession/Projects, and Innovative Engineering Solutions

In Line with UN Sustainable Development Goals

Goal 10: Reduced Inequalities
Goal 11: Sustainable Cities and Community
Goal 12: Responsible Consumption and Production
Goal 13: Climate Action
Goal 14: Life Below Water
Goal 15: Life on Land
Goal 16: Peace, Justice and Strong Institutions
Goal 17: Partnerships for the Goals

via Best Practices in Engineering Profession/Projects, and Innovative Engineering Solutions, Mobility of Engineering Personnel for Development and Smart Partnership

Complex Problem

Need to think broadly and systematically and **see the big picture**

Complex Problem

Difficult Decision

Uncertain Strategy

Confusing Idea

Contentious Product

Intractable Change

Difficulty & Uncertainty

- **Complexity** – the problem contains a large number of diverse, dynamic and interdependent elements
- **Measurement** – it is difficult or practically unfeasible to get good qualitative data
- **Novelty** – there is a new solution evolving or an innovative design is needed

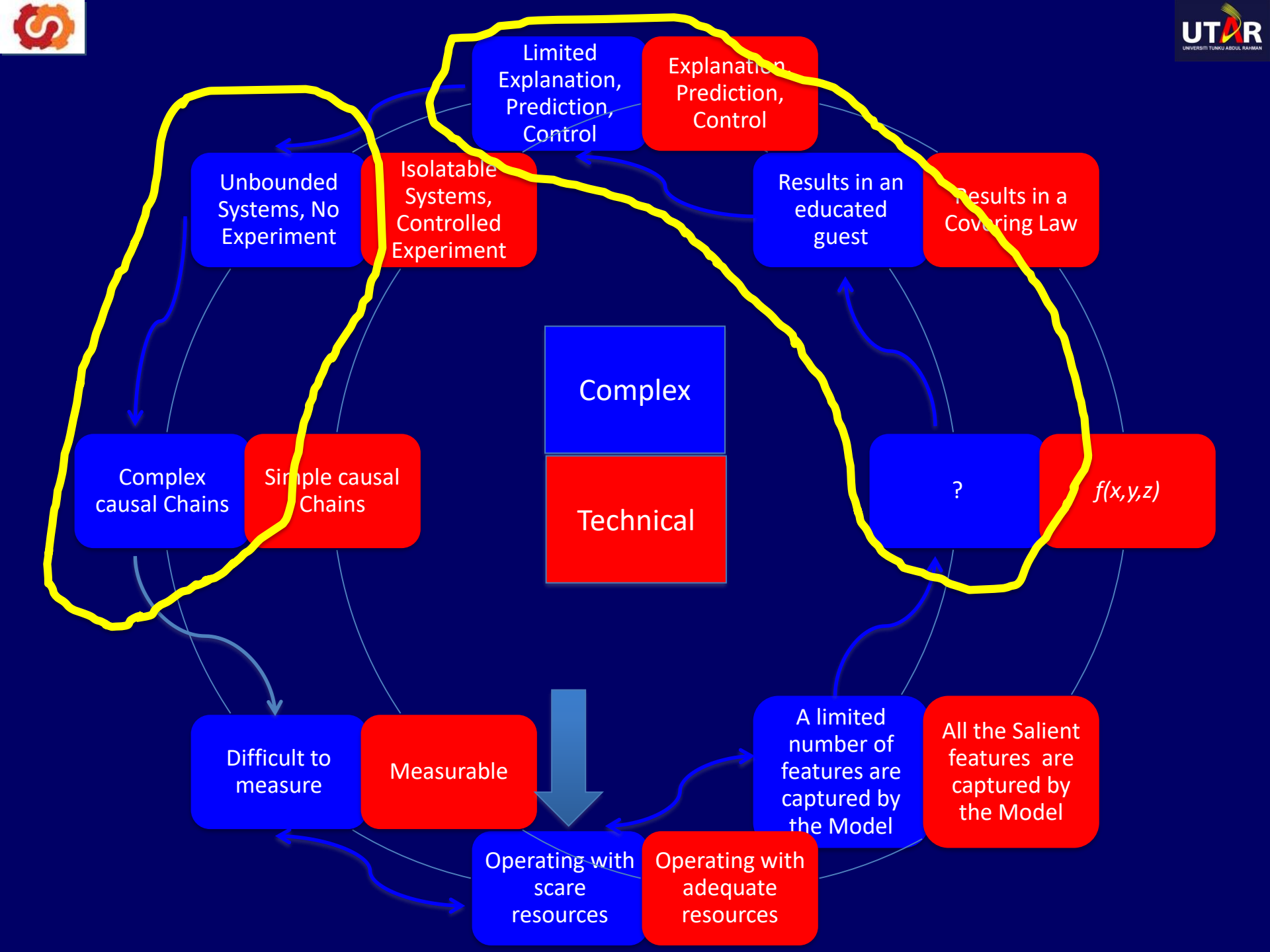
Characteristics of Problems

Technical Problems

- Isolatable boundable problem
- Universally similar type
- Stable and/or predictable problem parameters
- Multiple low-risk experiments are possible
- Limited set of alternative solutions
- Involve few or homogeneous stakeholders
- Single optimal and testable solutions
- Single optimal solution can be clearly recognised

Complex Problems

- No definitive problem boundary
- Relatively unique or unprecedented
- Unstable and/or unpredictable problem parameters
- Multiple experiments are not possible
- No bounded set of alternative solutions
- Multiple stakeholders with different views or interest
- No single optimal and/or objectively testable solution
- No clear stopping point


Limited Explanation, Prediction, Control
Explanation, Prediction, Control
Unbounded Systems, No Experiment
Isolatable Systems, Controlled Experiment
Results in an educated guest
Results in a Covering Law
Complex
Technical
Complex causal Chains
Simple causal Chains
?
f(x,y,z)
Difficult to measure
Measurable
A limited number of features are captured by the Model
All the Salient features are captured by the Model
Operating with scare resources
Operating with adequate resources

Complex Problem

Scientific/Technical Problems can combine to form

A Complex Problem

Complex Engineering Problems

	Complex Engineering Problems have characteristic WP1 and some or all of WP2 to WP7*:*
Depth of Knowledge Required	**WP1:** Cannot be resolved without in-depth engineering knowledge at the level of one or more of WK3, WK4, WK5, WK6 or WK8 which allows a **fundamentals-based, first principles analytical approach**
Range of conflicting requirements	**WP2:** Involve wide-ranging or conflicting **technical, engineering and other issues**
Depth of analysis required	**WP3:** Have **no obvious solution** and require abstract thinking, originality in analysis to formulate suitable models
Familiarity of issues	**WP4:** Involve **infrequently** encountered issues
Extent of applicable codes	**WP5:** Are **outside problems** encompassed by standards and codes of practice for professional engineering

"Graduate Attributes and Professional Competencies" published by the International Engineering Alliance which are also adopted by FEIAP (https://www.ieagreements.org)

Complex Engineering Problems

	Complex Engineering Problems have characteristic WP1 and some or all of WP2 to WP7*:*
Extent of stakeholder involvement and conflicting requirements	WP6: Involve **diverse groups of stakeholders with widely varying needs**
Interdependence	**WP 7:** Are **high level problems** including **many component parts or sub-problems**
Consequences	**EP1:** Have **significant consequences** in a range of contexts
Judgement	**EP2:** Require **judgement in decision making**

Engineering Activities

	Attributes	Complex Activities
1	**Preamble**	**Complex activities** means (*engineering)* activities or projects that have some or all of the following characteristics:
2	Range of resources	**EA1:** Involve the use of **diverse resources** (and for this purpose resources includes people, money, equipment, materials, information and technologies)
3	Level of interactions	**EA2:** Require **resolution of significant problems** arising from interactions between **wide-ranging or conflicting technical, engineering or other issues**
4	Innovation	**EA3:** Involve **creative use of engineering principles and research-based knowledge** in novel ways
5	Consequences to society and the environment	**EA4:** Have significant consequences in a range of contexts, characterized by **difficulty of prediction and mitigation**
6	Familiarity	**EA5:** Can **extend beyond previous experiences** by applying **principles-based approaches**

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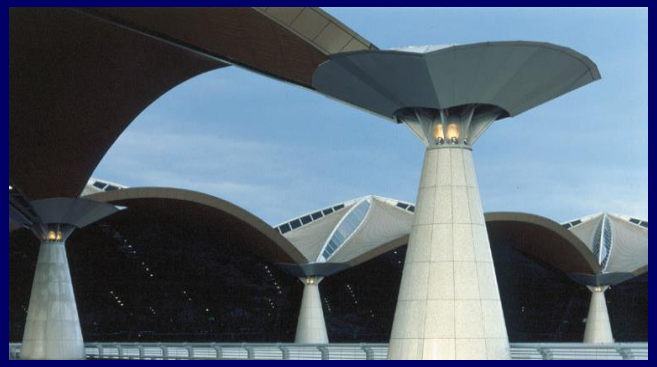
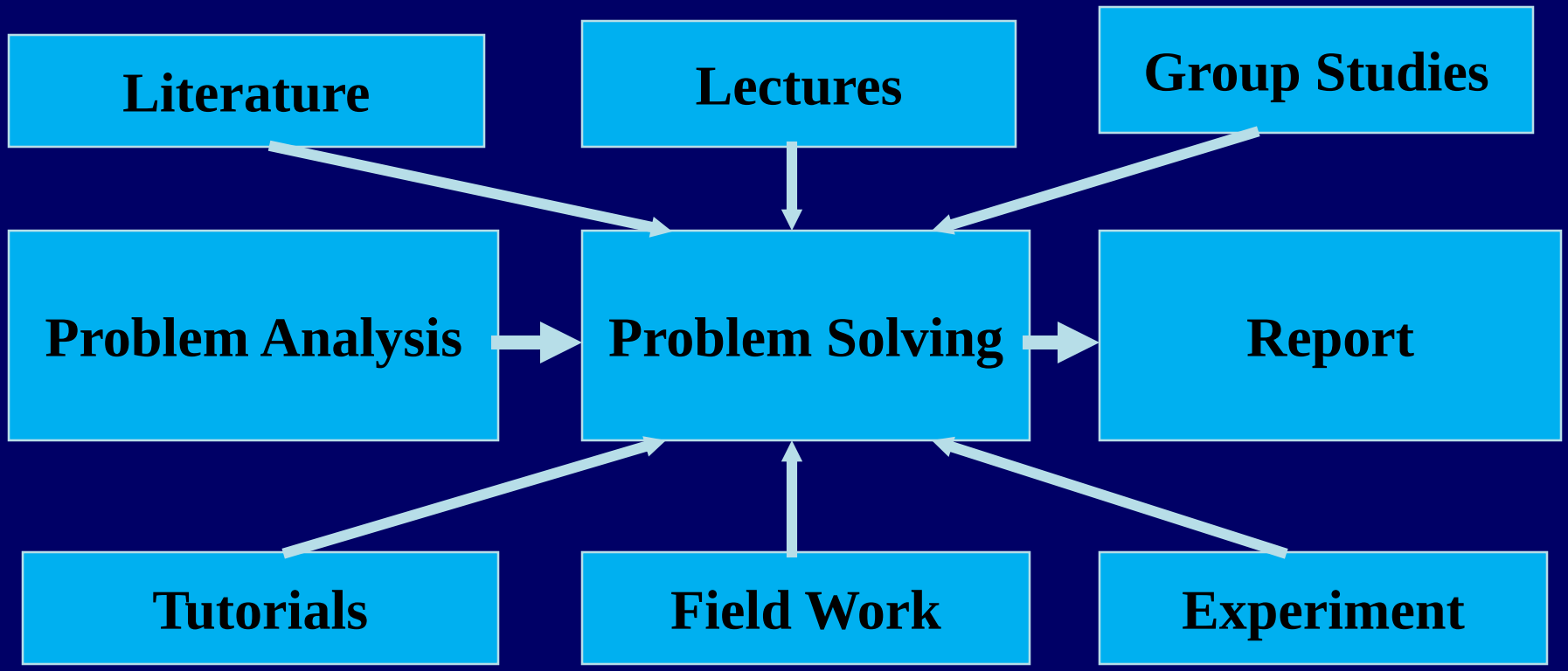
Problem Oriented, Team-Based Project Work as a Learning/Teaching Device

1. Problem-oriented project-organized education deals with the solution of theoretical problems through the use of any relevant knowledge, whatever discipline the knowledge derives from. We are dealing with **KNOW WHY** (Research Problems)
2. In design-oriented project work, the students deal with **KNOW HOW** problems that can be solved by theories and knowledge they have acquired in their previous lectures (Design Problems)



Problem Organised Project Work or POPBL (Project Oriented Problem Based Learning)



How are Complexity and UN Sustainable Development Goals integrated into the curriculum?

- Final Year Project – Real-life *Complex Problem Solving*
- Industrial Placement
- Design Project – Real-life *Complex Engineering Activities*
- General Courses
  - Core & Specialist (Engineering) Courses
  - Elective Courses

  with Open-ended Questions and Assignment, CEA

Lessons learnt from Accreditation Activities related to Assessment

- Does not know the Teaching Plan
- Done without Referring to the Plan
- Does not know How to Translate Plan into Assessment
- Assessing at Low-Medium level (not Challenging)
- No Feedback to Students except at the End of Semester
- Does not know How to Relate Assessment to Expected Outcomes
- Repetition
- Marking Issues – delegated, peer marking, etc.
- Traditional Assessment

THANK YOU

FOR LISTENING