**ES2631 Critique and Communication of Thinking and Design**

**AY2025-2026 Semester 1**

**Week 3 - STUDENT**

**Engineering Reasoning Framework: Intellectual Standards**

**Identifying topics for Assignment 1**

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| **Lesson Objectives**  By the end of this week’s lesson, you will be able to:   1. State and explain the nine universal intellectual standards in the engineering reasoning framework 2. Apply the intellectual standards to the elements of thought 3. Brainstorm for ideas for Assignment 1 |

**Recap**

Based on this week’s lecture:

1. What are the nine intellectual standards in the Engineering Reasoning Framework?
2. What does each intellectual standard refer to/mean (pp. 21-26)?

**Applying the Intellectual Standards to the Elements of Thoughts**

Paul, Niewoehner, and Elder’s (2019) model of critical thinking comprises two interrelated tools: the Elements of Thought (EoT), which break down the components of reasoning, and the Intellectual Standards, which serve as criteria to evaluate the quality of each component.

**Applying the Intellectual Standards to each Element of Thought ensures that every part of our reasoning is held to the highest standards of clarity, accuracy, precision, relevance, depth, breadth, logic, significance, and fairness.**

For example, when considering the “Information” element, we do not merely ask *what* information we have, but also whether that information is accurate, precise, relevant, and so on. When examining “Assumptions”, we scrutinise if those assumptions are clearly stated, fair, and logical.

This systematic approach encourages us not only to *think*, but to think **critically** (Niewoehner, 2006). By consciously applying the Intellectual Standards to each EoT, we can:

* Identify weaknesses or biases in our reasoning,
* Foster more rigorous and reflective thought processes,
* Make better-informed decisions,
* And communicate our ideas more effectively and ethically.

Ultimately, this practice leads to deeper understanding, greater intellectual discipline, and the development of true critical thinkers—both in academic contexts and in everyday life.

**Activity 1 - Worked Example: ERP System as an Engineering Solution**

In Week 2, we identified the EoT behind the ERP system as an engineering solution. This week, we will identify the relevant intellectual standards that apply for each of the element of thought and apply them accordingly.

**1. Purpose -** To reduce traffic congestion on major roads and the CBD in Singapore, especially during peak hours, by influencing motorist’s driving habits

**2. Question at Issue -** What can effectively change motorist’ driving habits in order to reduce congestion in Singapore’s CBD?

**3. Information -** Traffic flow data (to determine the number, location and operating hours of the gantries), research on what fee levels would actually influence motorist behaviour, case studies/pilot studies, technical specifications, public feedback

**4. Inference -** Evidence suggests that introducing variable road pricing at key congestion points will encourage many motorist to either avoid peak times, take alternative routes, switch to public transport or carpool, reducing congestion

**5. Concepts -** Dynamic pricing, traffic flow theory, system optimisation, behavioural economics, and smart city infrastructure

**6. Assumptions -** Cost deterrence changes driver behaviour, and that people have viable public transport alternatives, congestion reduction is a shared societal goal, the public will accept the implementation and pricing as fair and necessary

**7. Implications**

- Intended: Less congestion and smoother traffic on roads where ERP is implemented, supports Singapore’s goal towards a more sustainable, car-lite society

- Unintended: Potential congestion on alternative, non-ERP routes, possible perception of unfairness, changes in travel patterns or time

**8. Point of View**

- Government planners: Need for efficient and sustainable urban transport

- Motorists/car owners: Concerns about extra cost, convenience and alternative options

- Public transport users: May benefit from less congested roads or face more crowding in buses/trains

- Environmentalists: In favour due to lower emissions

- Businesses in CBD: May suffer from less customers

**Activity 2 – Identifying and applying Intellectual Standards on your identified solution in Week 2**

In Week 2, your team selected an engineering example and identified its respective EoT. Now, have a look at your identified EoT and identify and apply the most prominent intellectual standards to each of your EoT.

Share them with your classmates and discuss if the standards were applied correctly and if the ones chosen are the most suitable.

**Activity 3 – Brainstorming for Ideas for Assignment 1**

**Reviewing Examples**

Review the extracts from students’ group presentations from a previous semester (uploaded to the Canvas module for the week). Focus on how the students approached the assignment topic, how they used the elements of thought to structure their presentation, what was effective and what could be improved. Discuss your views with your groupmates.

**Brainstorming ideas for your own Project**

In your groups, discuss and come up with some possible problems you would like to tackle and the possible solutions, keeping in mind the EoTs and IS.

You may consult your tutor for feedback on initial topic ideas. The goal is to leave this session with at least one promising idea you feel excited (or at least interested) to develop further for Assignment 1.

As you research your topics, pay attention to your **sources of information**. Refer to the Sources handout (Week 4 module) to understand what kinds of sources you can use, how to assess sources for credibility and how to reference them in your work. These ideas are reinforced in the Week 4 lecture and will be discussed in class next week.

**References**

Niewoehner, R. J. (2006). Applying a critical thinking model for engineering education.*World Transactions on Engineering and Technology Education*, 5(2), 341.

Paul, R., Niewoehner, R. & Elder, L. (2019). *The Thinker’s Guide to Engineering Reasoning: Based on Critical Thinking Concepts and Tools.* Rowan & Littlefield Publishers.