Reasonging

Engineering

About the Authors

The Thinker's Guide
The Thinking Guide to Engaging Reasoning

Foreword
Introduction
A Model of Engineering Reasoning

Seek to develop the traits of a mature engineering mind.

Intellectual standards to the elements of thought: apply

Engines concern with good thinking, routinely apply

Uses this mini-guide

The Elements

As we learn

Must be applied to

The Standards

Informed Assumptions

Points of View

Concepts

Questions

Inferences

The Elements

Logic

Relevance

Significance

Prediction

Clarity

The Standards

Intellectual Digressions

Intellectual Dignity

Intellectual Humility

Intellectual Authority

Intellectual Autonomy

Confidence in Reason

Intellectual Competence

Intellectual Esteem

Intellectual Concernness

Intellectual Competence

Intellectual Constructiveness

Intellectual Conformity

Intellectual Conformity
Integetial Traits Essential to Engineering Reasoning
To analyze thinking, we must learn to identify
and question its elemental structures.

When we understand the structure of thought, we ask important questions:

- What is my thought?
- Why are my thoughts?
- What are the assumptions of my thinking?
- What is my agenda?
- Where is my starting point?
- When is my thinking meaningful?
- What is my viewpoint?
- What is my conclusion?
- What is my problem?
- What is my purpose?
- Where is my thinking?
The Spirit of Critical Thinking

The mature thinker looks for underlying principles. He searches for the essential case, the fundamental assumption. Then, he abstracts, generalizes, and condenses. He formulates the concept of the concept. He builds it into an abstract, universal idea that transcends the particular instance. He then reflects on the abstract idea, analyzing and refining it. He looks for the kernel of the concept and presents it as a generalization. He considers all possible implications. He considers the implications of the implications. He considers the implications of the implications of the implications. And so on, ad infinitum.

A Checklist for Engineering Reasoning

1. Identify the problem.
2. Choose a method and begin.
3. Formulate some essential questions.
4. Consider the implications of the assumptions.
5. Consider the implications of the implications of the assumptions.
6. Consider the implications of the implications of the implications of the implications.
7. Which are your guiding principles and assumptions?
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10. Which are your guiding principles and assumptions?
6. The main assumption(s) underlying the author's thinking is (are)

Analyzing an Engineering Document (cont'd)
Analyzing a Design Using the Elements of Thought

Engineering purpose
- What is the purpose of this design?
- What are the market opportunities or mission requirements?
- Who defines market opportunities/mission requirements?
- Who is the customer?

Question at hand
- What system/product/process will best satisfy the customer’s performance, cost, and schedule requirements?
- How does the customer define “value”?
- Is a new design or new technology required?
- Can an existing design be adapted?
- How important is time-to-market?

Point of view

Assumptions
- What environmental or operating conditions are assumed?
- What programmatic, financial, market or technical risks have been considered acceptable to date?
- What market/economic/competitive environment is assumed?
- What safety/environmental assumptions are we making? Are these assumptions acceptable?
- What maturity level or maturation timeline is assumed for emerging technologies?
- What happens if we change or discard an assumption?
- What criteria have historically been assumed in defining a “best” or “optimum” solution?
- What assumptions have been made on the availability of materials?
- What manufacturing capability was assumed?
- What workforce skills or attributes have been assumed?

Analyzing a Design Using the Elements of Thought (cont’d)

Engineering information
- What is the source of supporting information (handbook, archival literature, experimentation, corporate knowledge, building codes, government regulation)?
- What information do we lack? How can we get it? Analysis? Simulation? Component testing? Prototypes?
- What experiments should be conducted?
- Have we considered all relevant sources?
- What legacy solutions, shortcomings, or problems should be studied and evaluated?
- Is the available information sufficient? Do we need more data? What is the best way to collect it?
- Have analytical or experimental results been confirmed?
- What insights and experiences can the shop floor provide?

Concepts
- What concepts or theories are applicable to this problem?
- Are there competing models?
- What emerging theory might provide insight?
- What available technologies or theories are appropriate?
- What emerging technologies might soon be applicable?

Inferences
- What is the set of viable candidate solutions?
- Why were other candidate solutions rejected?
- Is there another way to interpret the information?
- Is the conclusion practicable and affordable?

Implications
- What are some important implications of the data we have gathered?
- What are the most important market implications of the technology?
- What are the most important implications of a key technology not maturing on time?
- How important is after-market sustainability?
- Is there a path for future design evolution and upgrade?
- Are there disposal/end-of-service-life issues we need to consider?
- What are the most important implications of product failure?
- What design features if changed, profoundly affect other design features?
- What design features are insensitive to other changes?
- What potential benefits do by-products offer?
- Should social reaction and change management issues be addressed?
impact the quality of life in communities and regions.

In recent years, the environmental impact of air pollutants and their effects on human health and well-being have become increasingly significant. The reduction of these pollutants is crucial for improving public health and reducing environmental and economic costs. The measures to control emissions and improve air quality are essential for achieving sustainable development.

In many cities, air pollution levels have reached alarming levels, leading to respiratory and cardiovascular diseases. The use of cleaner energy sources and the promotion of renewable energy are key strategies to reduce air pollution. The development of efficient transportation systems and the implementation of green building practices are also critical in addressing this issue.

Key Concepts:
- Air quality
- Pollution sources
- Mitigation strategies
- Clean energy technologies
- Sustainable development

Questions to Consider:
1. What are the primary sources of air pollution in your region?
2. What measures are being taken to reduce air pollution and improve air quality?
3. How do these measures impact the local economy and public health?
4. What role can individuals play in reducing air pollution?
5. What are the long-term benefits of implementing sustainable practices?

Two Kinds of Engineering Questions:
- What kind of engineering knowledge is required to address air pollution?
- How can we design engineering solutions to mitigate air pollution?
Analyzing Disciplines: Mechanical Engineering

Key Concepts

- The concept of material science, stress, strain, load, and fatigue.
- The principles of mechanics, including equilibrium, forces, and motion.
- The concept of thermodynamics, heat transfer, and fluid mechanics.
- The importance of materials science in engineering design.

Analyzing Disciplines: Electrical Engineering

Key Concepts

- The concept of electrical circuits, circuits analysis, and circuit theory.
- The principles of electronics and electrical engineering.
- The concept of signal processing and communication systems.
- The importance of electrical engineering in modern technology.

Analyzing Disciplines: Civil Engineering

Key Concepts

- The concept of structural engineering, soil mechanics, and construction.
- The principles of environmental engineering and sustainable design.
- The concept of urban planning and landscape architecture.
- The importance of civil engineering in infrastructure development.

Analyzing Disciplines: Mechanical Engineering

Key Concepts

- The concept of mechanical systems, dynamics, and kinematics.
- The principles of materials science and manufacturing.
- The concept of systems engineering and project management.
- The importance of mechanical engineering in technology and innovation.
Modeling and Simulation

Analyzing Engineering Tools:

The Thinking Guide to Engineering Reasoning

Engineered Reasoning Uses Intellectual Standards
We often think that the obvious implications of this definition are:

- How we think about the problem
- How we think about the problem's solution
- Are the problems we see within the system real or generated
- Are the solutions we propose truly innovative or just superficial

However, these are not the only implications of this definition. We also need to consider:

- How we think about the problem's context
- How we think about the problem's impact
- Are the solutions we propose truly transformative or just temporary
- Are the problems we see truly systemic or just local

These considerations are what make this definition so powerful in understanding complex problems and finding effective solutions.
Are the technical terms in the passage properly defined?

Are the technical terms that are used to discuss the results presented in the correct context?

Can the logical reasoning be followed, with each paragraph building on the previous one?

Is the argument of the passage clear, with each paragraph presenting a coherent point?

Are the technical terms used consistently throughout the passage?

Is the overall structure of the passage logical, with a clear introduction, body, and conclusion?

Would the passage benefit from additional examples or illustrations?

Would comprehensive charts or other figures improve comprehension?

Are the concepts presented in the passage applied to real-world scenarios?

Are the technical terms used appropriately throughout the passage?

Are the key points of the passage summarized effectively?

Does the final sentence effectively conclude the passage?

Is the overall writing style clear and concise?

Is the passage proofread for grammar and punctuation errors?
<table>
<thead>
<tr>
<th>Logic</th>
<th>Depth</th>
<th>Accuracy</th>
</tr>
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<tbody>
<tr>
<td>What is the conclusion?</td>
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<td>Does the conclusion follow from the assumptions?</td>
</tr>
<tr>
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<td>Is the conclusion supported by the evidence?</td>
<td>Are the assumptions consistent with the evidence?</td>
</tr>
<tr>
<td>Importance</td>
<td>Purpose</td>
<td>Standards</td>
</tr>
<tr>
<td>What is the purpose of evaluating the evidence?</td>
<td>What is the purpose of providing the evidence?</td>
<td>What are the standards for evaluating the evidence?</td>
</tr>
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</table>

**Elements of Reasoning**

- **Premise**: A statement that supports or confirms the conclusion.
- **Conclusion**: The statement that is being argued or defended.
- **Premises**: At least one statement that provides support for the conclusion.

**Questions**

- Does the conclusion follow from the premises?
- Are the premises relevant to the conclusion?
- Are the premises consistent with each other?
- Are there any hidden assumptions?
- Are there any logical fallacies?

**Purpose**

- To persuade the reader.
- To inform the reader.
- To explain the reasoning.

**Inference**

- Deductive inference: The conclusion follows necessarily from the premises.
- Inductive inference: The conclusion is likely to be true if the premises are true.

**Reasoning**

- The process of drawing a conclusion from premises.
- The use of evidence to support a claim.

**Evaluation**

- The process of assessing the validity and strength of the reasoning.
- The process of assessing the quality of the evidence.

**Conclusion**

- A statement that summarizes the reasoning and reaches a conclusion.
- A statement that is supported by the evidence provided.

**Relevance**

- The degree to which the evidence is relevant to the conclusion.
- The degree to which the premises are relevant to the conclusion.

**Standards**

- The criteria used to evaluate the quality of the reasoning.
- The criteria used to evaluate the quality of the evidence.

**Conclusion**

- A statement that summarizes the reasoning and reaches a conclusion.
- A statement that is supported by the evidence provided.
Analyzing & Assessing Engineering Research Paper

Your purpose must be reasonable and clear.

Principle: To reason well, you must clearly understand your purpose and
Common Problems: (1) unclear (2) trivial (3) unrelated (4) contradictory
Primary Standards: (1) clarity (2) significance (3) relevability (4) contribution
(5) utility

Purpose

1. Evaluate the purpose of the research paper.
2. Ensure the purpose of the research paper is clear and relevant.
3. Identify the main questions addressed in the research paper.
4. Assess the significance and contribution of the research paper.
5. Evaluate the clarity and relevability of the research paper.
6. Consider all significant implications and conclusions.
7. Search for multiple ways to improve the research.
8. Assess the significance of the key concepts in the research.
9. Assess the clarity and significance of the research paper.
10. Identify any potential improvements to the research.
<table>
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<tr>
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<th>Critical Reactions</th>
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**Questions at Issue or Central Problem:**

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**Critical Reflections**

The purpose of this discussion is to engage in critical thinking and reflect on the assumptions and implications of the case study presented. By examining the context, evidence, and implications, we can develop a deeper understanding of the situation and propose effective strategies for improvement.

**Principle of Reasoning**

- When making decisions, it is essential to consider all relevant factors and evidence. This includes understanding the assumptions underlying the situation and evaluating their impact on the outcomes.
- Critical thinking requires recognizing the limitations of evidence and the potential biases that may influence our judgments.
- Ethical considerations play a significant role in decision-making, as they involve weighing the moral implications of our actions.

**Common Problems**

- Unclear (1) Evidence (2) Interpretation (3) Assumptions
- Communication (4) Collaboration (5) Team Dynamics
- Ethical (6) Cultural (7) Political

**Primary Standards**

- Clarity (2) Logicality (3) Professionalism
- Ethical (4) Cultural (5) Political

**Inference and Interpretation**

- Drawing conclusions based on evidence requires careful consideration of the data and the context in which it was gathered.
- Understanding the implications of our decisions is crucial for effective problem-solving.
-Critical thinking involves questioning assumptions and considering alternative perspectives.

---

**Conclusion**

By engaging in this critical reflective discussion, we can enhance our understanding of the situation and develop strategies that are informed by a thorough analysis of the evidence and considerations involved.

---

**References**

- (1) Evidence-Based Practice (2) Critical Thinking (3) Ethical Reasoning
- (4) Cultural Competence (5) Political Awareness
- (6) Formal Assessment (7) Applied Learning
### Skilled Thinkers: Unlikely to Experience Emotionality

- **Common Problems:**
  - (1) Threshold
  - (2) Baseline
  - (3) Underload

- **Primary Standards:**
  - (1) Predictability
  - (2) Flexibility

**Point of View:** The thinker's guide to equating reasoning

---

### Concepts and Ideas

- **Principle:** Reasoning can be only as sound as the assumptions on which it is based.

- **Primary Standards:**
  - (1) Conciseness
  - (2) Relevancy

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### Interpersonal

- **Principle:** Emotionality can be any or sound the assumptions on which it is based.

- **Primary Standards:**
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### Logic

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### Teamwork

- **Principle:** Emotionality can be any or sound the assumptions on which it is based.

- **Primary Standards:**
  - (1) Conciseness
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**Point of View:** The thinker's guide to equating reasoning
The Questioning Mind in Engineering:

Implications and Consequences

Critical Reflections

Unstated Considerations

The Wright Brothers'
The Cost of Thinking Gone Away

In recent years, the emphasis on critical thinking has declined, with many students and instructors focusing more on rote memorization and regurgitation of information. This shift has raised concerns about the ability of students to apply critical thinking in real-world situations, leading to a decline in problem-solving skills and analytical abilities.

One of the main issues is the increasing use of technology and social media, which has led to a decrease in face-to-face interaction and verbal communication. This has resulted in a decline in the ability of students to engage in meaningful discussions and debates, which are essential for developing critical thinking skills.

Another factor contributing to this decline is the lack of emphasis on critical thinking in the classroom. Many teachers focus on delivering content rather than encouraging students to think critically and develop their own ideas. This has led to a decrease in the quality of education and a lack of preparedness for the challenges of the modern world.

To address these issues, educators need to reevaluate the curriculum and adopt a more holistic approach to teaching. This includes incorporating critical thinking exercises into the classroom, encouraging students to engage in discussions and debates, and providing opportunities for students to apply their skills in real-world situations.

In conclusion, the decline in critical thinking skills is a serious concern that needs to be addressed. By reevaluating the curriculum and adopting a more holistic approach to teaching, we can help students develop the skills they need to succeed in the modern world.
other class notes on the number of ideas and reflections in public.

Engaging in critical thinking and understanding the
effect of public policies on the environment is crucial for
effective development. The role of the environment is
everywhere in the economy, from public-good policies
to national security. Understanding the impact of
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Engaging and Public Policy

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Humanitarian Responsibility and Product Safety

and communities, in the health, welfare and economic viability of individuals and
have positive social opportunity to socially contribute to
make products worth excellent ethical products. Some
underperform, however, their self-interests and not situations are not desired
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Evaluating Student Work in Engineering

EngagingReasoningObjectives

The Time Line's move in Engineering Reasoning

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The Time Line's move in Engineering Reasoning
The Problem of Epistemic Thinking

In practice, the core idea of ordinary thinking is to expand our knowledge and understanding of the world through the acquisition of new information. However, this expansion of knowledge is often achieved by ignoring the complexity of the information itself.

As a result, we tend to think in terms of simple, clear-cut categories and to ignore the inherent complexity of the information we encounter. This leads to a tendency to oversimplify complex ideas and to ignore the nuances and subtleties that are often crucial to understanding a concept.

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3rd International Academy on Critical Thinking
August 25-28, 2009
St John's College, Cambridge University

Announcing the
27th Annual International Conference on Critical Thinking
July 22-25, 2007
Pre-Conference: July 20-21
University of California at Berkeley
to be held near the
Critical Thinking for Children—Designed for K-6 Classroom Use

Focuses on developing higher-order thinking skills in young children through practical, real-world problem-solving activities.

- 1000 asleep copies 5/00 edn; 200-699 copies 5/25 edn
- 25-199 copies 5/00 edn; 200-699 copies 5/25 edn
- £17.95

Factual: The Art of Mental Thinking and Manipulation—Introduce the essence of critical thinking concepts in a fun and engaging way.

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Christina Bushman

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Sent: Monday, January 22, 2007 6:31 PM
To: 'Christina Bushman'
Subject: Solutions manual copying

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I need to also get PDF copies of a few problems in Chapter 3 - these are 3.2, 3.7, 3.8 and 3.11. These are in addition to problems 2.4, 2.7, 2.10 and 2.12 in Chapter 2.

I will be traveling the rest of this week, but will still be able to receive e-mails.

Thanks,
Eric