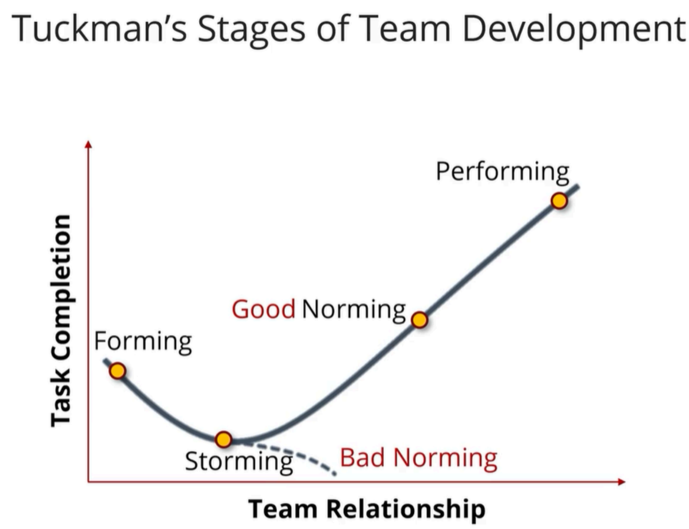
APSC 101 Study Notes
<u>Intro to Engineering II</u>

Contents

1. Professional Skills / Working in a team

1.1. Tuckerman's Stage of Development

Tuckerman's Stages of Development: Forming, Storming, Norming, Performing



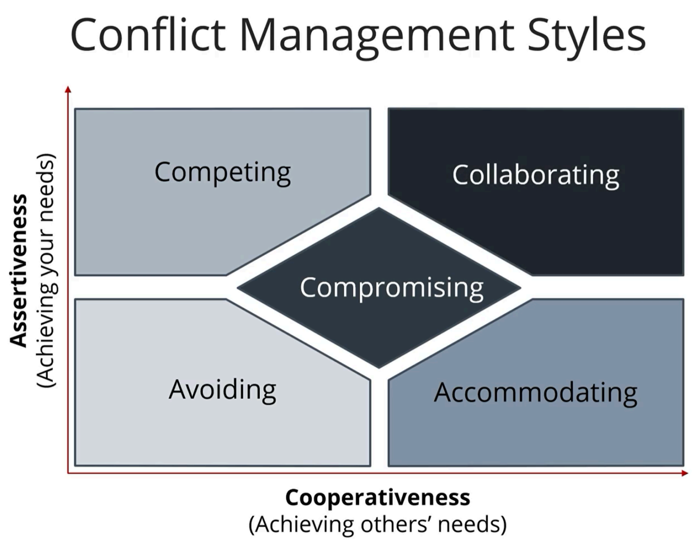
1.1.1. Important Notes

- relationships within members get BETTER over time
  - this includes storming, as team members are more willing to speak their minds
- conflict occurs at all stages

1.1.2. Good vs Bad Norming

- Good norming is healthy
- Bad norming –> team dysfunction
  - e.g. one team member routinely misses meetings and team does nothing

1.2. Conflict Management



Avoiding: Good when tensions high.
Accommodating: Good when the issue matters more to the other party.
Competing: Good when issue is self-critical and immediate.

Compromising: Good if time is short and relationships/problem must be balanced.
Collaborating: When you have time to work towards finding the ideal solution for everyone.

Good teams change their style as situation demands.

1.3. Equity Diversion Inclusion (EDI)

Equity: Everyone has same opportunities and outcomes
Diversity: recognizing and valuing different background, identity, experiences, and different points of view

1.4. Biases

Implicit biases: subconcious stereotypes about groups, learned through what we see
Microaggressions: small, subtle, or indirect discriminatory actions or statements
Stereotype threat: when people feel concerned about conforming to a stereotype for a group they belong to

Allyship: acting to support those facing discrimination in or underrepresented groups

- Reactive allyship: in response to an incident of bias (e.g. team member steps in to defend another)
- Proactive allyship: when someone actively engages to make marginalised individuals feel more included and respected

1.5. 5 Keys to an effective team

- **Dependability**
- **Structure & clarity**
- **Meaning**
- **Impact**
- **Psychological safety** *[most important]*

Does not depend on skills of team members.

2. Risk Management

Risk = Severity × Likelihood

Risk ≠ Hazard

Risk: *Possibility* of harm, consequences, or damage.
Hazard: *Capacity* of equipment, material, or processes to cause

harm.

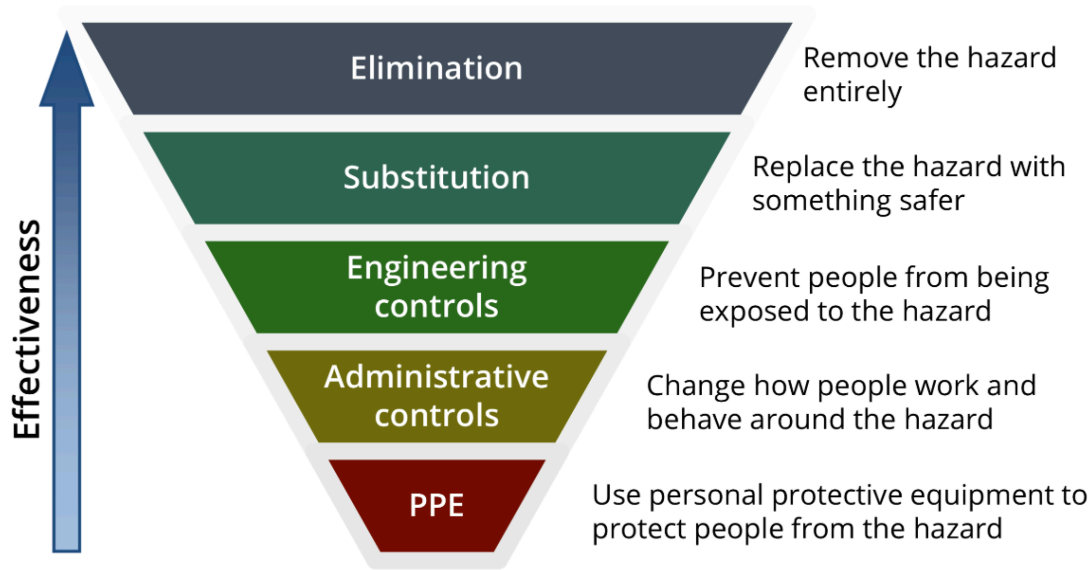
2.1. Risk Sources

Preventable: Controllable.
General time management issues included, such as not anticipating delays.
Strategic: Taken for possibility of greater reward.
For example, rushing through decision making stages for earlier project completion, this is a strategic risk, not preventable.
External: Outside of control.

2.1.1. Risk vs Hazard

Risk: possibility of harm, consequences, or damage
Hazard: capacity of equipment, material, or processes to cause harm

2.1.2. Control Hierarchy for Safety Hazards



3. Drawings (tbd)

3.1. Orthographic

- dash dot –> center line
- dash –> hidden lines

4. Feedback

4.1. 7 Cs (recap)

Clear - easy to follow, easy to understand
Correct - Factually accurate, prepared according to professional standard
Concise - Brief, efficient
Concrete - Detailed, vivid, and specific. Main point is clearly evident
Complete - includes info relevant to the audience, conveys what audience should do
Courteous - polite and respectful, geuine and sincere
Considerate - empathetic and mindful, prepared with receiver in mind

4.2. 3x3 Feedback Model

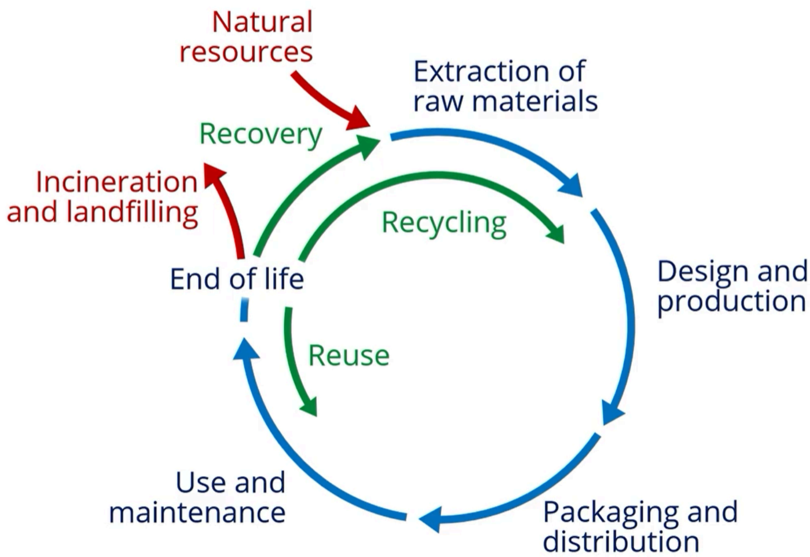
Sender	Message	Receiver
Clear consistent, unambiguous speech and body language	**Concrete** descriptive, specific, and non-judgmental; focuses on receiver	**Clear** consistent, unambiguous speech and body language
Courteous polite and respectful tone, language, and body language	**Complete** includes observations, impacts, suggestions, and follow up	**Courteous** receptive; polite and respectful tone, language, and body language
Considerate time and method of feedback considers the receiver	**Considerate** is empathetic and relevant to the receiver	**Complete** acknowl-edge the feedback; ask for clarification

5. Systems Thinking (covered in APSC100, will be tested again in 101)

6. Life Cycle Thinking

Life cycle thinking: accounting for all impacts of a product or process across all stages of its life cycle

6.1. Life Cycle Stages



At product end of life, the following options are ranked most desirable to least desirable

1. **Reuse:** reuse the product in its current state, upcycle unwanted products to products of higher quality or value, or repurpose the product to a new use
2. **Recycle:** process the raw materials in the product and produce something new
3. **Recovery:** extracting as much energy or material from product as possible before disposing of it

Another is **reduce**, which is to change behaviours as a society to reduce what we consume and use.

6.2. Life Cycle Assessment (LCA)

- systematic evaluation of the impacts of energy and material inputs and outputs for a product/process across all life cycle stages

1. **Goal Definition and Scope**
   - System boundary: a description of what elements are included or not included in an LCA
   - Functional units: a reference measure of performance to use as a baseline in comparing options

Possible functional unit: 100 million lumen-hours of light

	Incandescent	CFL	LED
Life (hrs)	1,000	8,500	50,000
Brightness (lumens)	900	900	800
Number of bulbs*	111.1	13.1	2.5

*100 million lumen-hours

2. **Inventory Analysis**
3. **Impact Assessment**
   - impacts of each material and energy flow are quantified
4. **Interpretation**
   - systematically review work of each stage as new information comes in

6.2.1. Challenges with LCA

- Detailed knowledge of material and energy flows required
- Impacts must be known and quantified
- Focuses on environmental impacts
- ***difficult to use early in design process***

6.3. Risk Tools

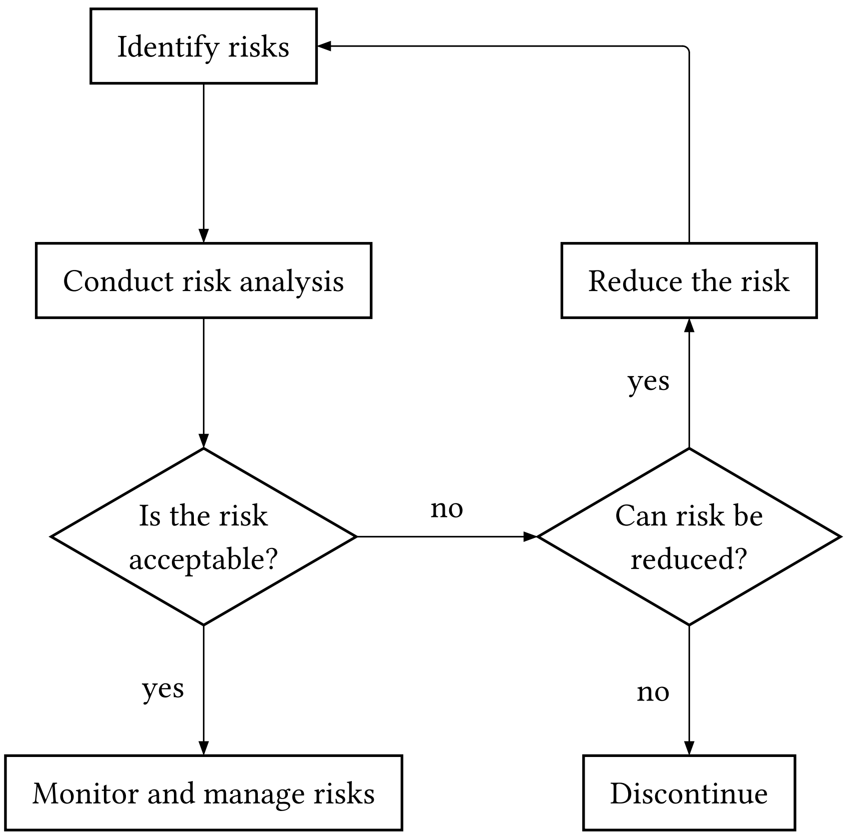


Figure 1: Risk Management Process

		Risk Source		
		Preventable	Strategic	External
Risk Category	Safety		N/A	
	Technical			
	Project Management			
	Operational			

Table 1: Risk Classification Table

A risk classification table is a tool used to identify and classify risks based on their severity and likelihood.

		Severity				
		1	2	3	4	5
Likelihood	5					
	4					
	3					
	2					
	1					

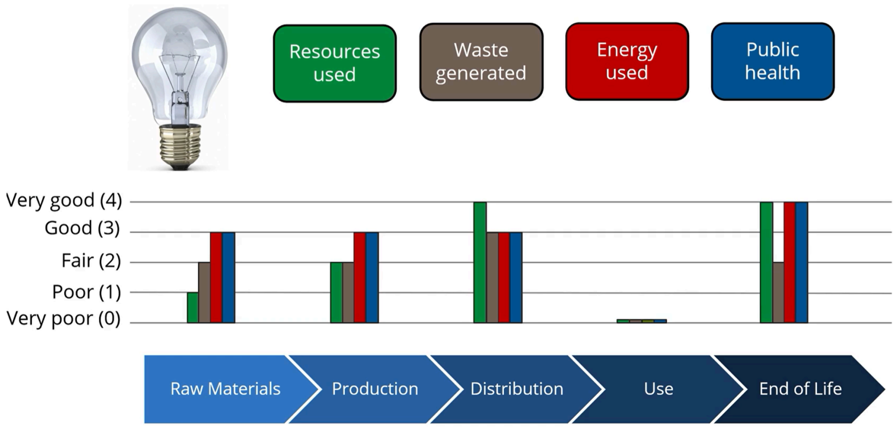
Table 2: Risk Matrix

ID	Description	Severity	Likelihood	Rating	Mitigation
1					
2					
3					

Table 3: Risk Register

6.4. Streamlined Life Cycle Assessment (SLCA)

- for each criterion and for each life cycle stage, evaluate performance of product/process on a qualitative scale.
  e.g. “very poor” to “very good” or “significant negative impact” to “significant benefit”



- results usually tabulated in SLCA Matrix

Life Stage	Raw materials	Production	Distribution	Use	End of life
Resources used	1	2	4	0	4
Waste generated	2	2	3	0	2
Energy used	3	2	3	0	4
Public health	3	3	3	0	4

- values in matrix then summed to determined environmentally responible product rating (R_{ERP}).
  equivalent to score in WDM if all weights were 1

6.4.1. Usage of SLCA

1. use R_{ERP} to benchmark performance against other products
2. use SLCA ratings to determine areas of greatest negative impact

6.4.2. Benefits of SLCA

- SLCA faster, easier, less expensive to complete
  - SLCA takes days, LCA can take months
- SLCA qualitative (easier to use with criteria which are more difficult to quantify), but also makes results **less precise**
- SLCA suitable for any stage of design process (especially early where potential influence on design decisions is greatest)
  - LCA suitable for existing products / very late in design process (where precise assessment of impact is required)

6.5. Sunk Cost

Sunk cost: a cost that has already been incurred and cannot be recovered.

Sunk cost usually include equipments already bought, exploration and consultation already done: they would not be reversed to money.

6.6. Duty to Consult

The Government of Canada has a duty to consult and, where appropriate, accommodate Indigenous groups when it considers conduct that might adversely impact potential or established Aboriginal or treaty rights.°

7. Design Specification

7.1. Design Parameter

The engineering factors of a product or service, e.g. “battery capacity”.

7.2. Attribute

The apparent properties affecting user experience, e.g. “battery life”.

7.3. Requirements

“Yes” or “no” questions, used mostly in screening. Typically expressed in forms of thresholds, e.g. “germ level lower than 300”, “potable”.

7.4. Satisfaction

“Extent” questions, used mostly in ranking and scoring. Typically shown as a curve, with satisfaction changing with attribute value, e.g. “3-8 hours of battery life, the higher the better”. Sometimes, the higher the value, the worse the satisfaction.

The satisfaction line is curved because consumers perception of improvements at different level vary. For example, an 1 to 2 hours battery life improvement will likely be strongly felt by users, but a 7 to 8 hours battery life extension would not have such positive reception, as the users are already pretty satisfied with 7 hours.

Building satisfaction curve involves market analysis, consumer/customer interview, experiments and more.

8. Mining

8.1. TODO: processes

9. Rainwater Harvesting System

9.1. Factors of Flow Rate

TODO

9.2. System Pressure

$$P_{\text{pump}} = \rho g h_{\text{storage}} + \underbrace{f \frac{L}{D} \frac{\rho v^2}{2}}_{\text{friction}} + \underbrace{K \frac{\rho v^2}{2}}_{\text{restrictions}} + \underbrace{C_f v}_{\text{filter}} \tag{1}$$

- C_f filters' friction coefficient. Changed by filters on the *rising* edge.
- L is the pipe length, and it *does not necessarily* change if x, y, z of the tanks are changed.

9.3. Maintenance

- Filters
  Life of a filter is determined by the filter size immediately larger than itself. E.g. life of a $1\ \text{m}$ filter is affected by the presence of a $5\ \text{m}$ filter, but not by the $200\ \text{m}$ if the prior is already present.
- Power sources
  Can be either diesel fuel engine or solar panels and battery. Solar has outstandingly low risk exposure, but might be less reliable.