

## APPLYING FAILURE MODES, EFFECTS, AND CRITICALITY ANALYSIS AND HUMAN RELIABILITY ANALYSIS TECHNIQUES TO IMPROVE SAFETY DESIGN OF WORK PROCESS IN SINGAPORE ARMED FORCES

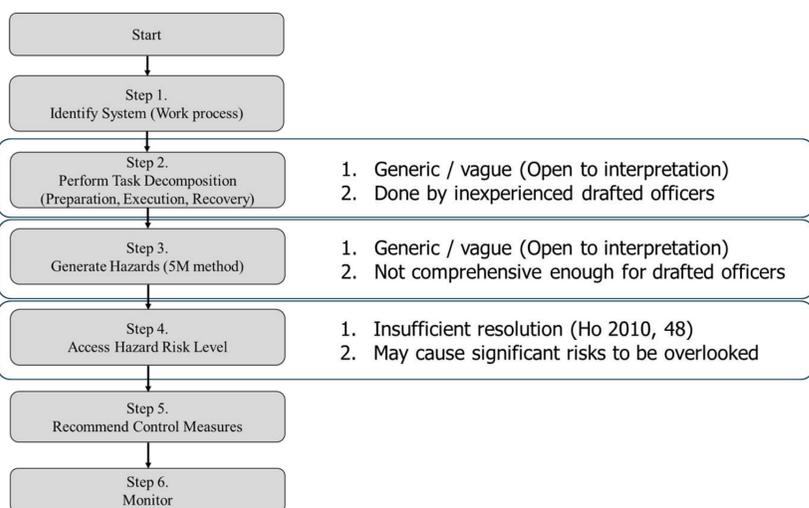
Student: Soon Weihao Kevin

Thesis Advisor: Karen S Holness | 2<sup>nd</sup> Reader: Lawrence G. Shattuck

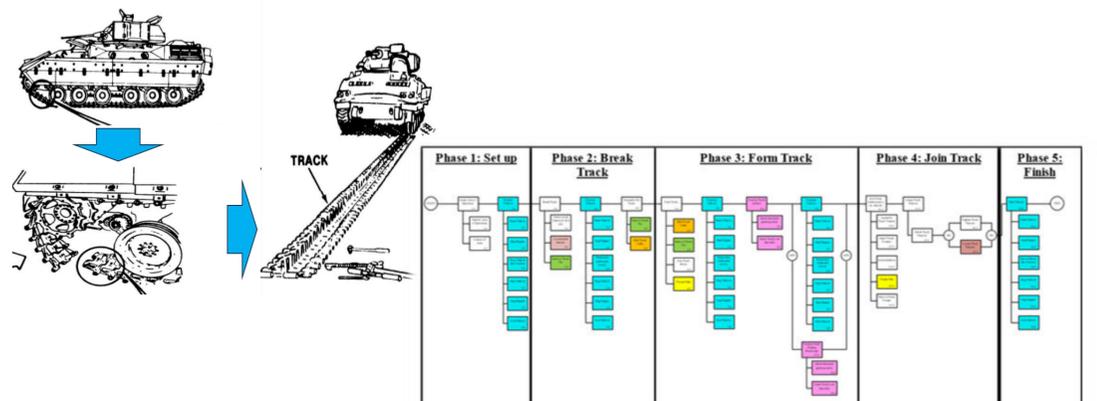
### 1. Objectives of thesis

Conduct a proof-of-concept study to apply a well-practiced systems safety method, PFMECA and a well-known HRA method, HEART to identify hazards in SAF work processes

### 2. Current Risk Assessment Shortfall

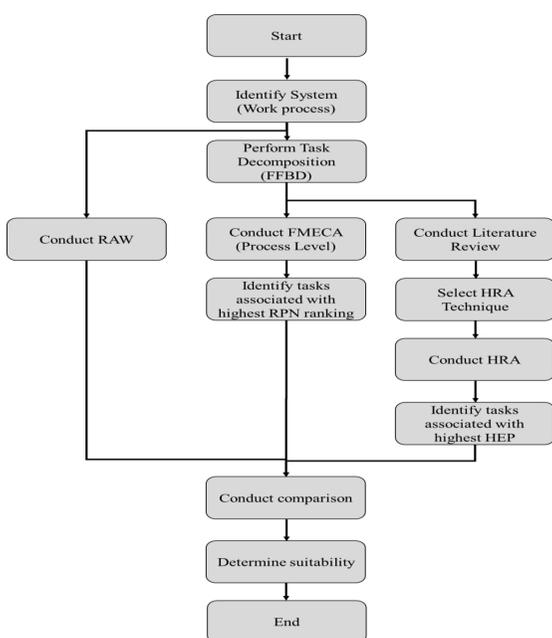


### 4. Selected Work Process



The selected system is a work process within the maintenance arm of the SAF. This work process describes the activity of replacing one side of an Armored Fighting Vehicle (AFV) track in the workshop. Pictures taken from M2 AFV Operator Manual (BAE, 1982)

### 3. Thesis Methodology



### 5. Results

		SAF Current Technique RAW	PFMECA	HEART
Executing Technique	Task Decomposition	<b>Not detailed:</b> 5 operational activities	<b>Detailed:</b> 13 operational activities, 53 Level 2 tasks and 175 Level 3 tasks	
	Generate Hazards	<b>Not thorough:</b> 25	<b>Very thorough:</b> 200	<b>Thorough:</b> 43
	Hazard Risk levels	<b>Low resolution:</b> 3 risk levels 85% had the same risk levels	<b>High resolution:</b> 58 different risk levels	<b>High resolution:</b> 34 different risk levels
Case study	Findings	1. Failed to identify task. 2. Able to identify failure cause (although it was classified under a generic operational activity - difficult for planner/supervisor to pinpoint)	1. Was able to identify task. 2. Was able to identify failure mode and cause 3. Ranked identified failure cause within the top 10 risks.	1. Was able to identify task. 2. Ranked identified task as the top risk. 3. Failure cause was hidden within the workings (only the final HEP was shown).
	Benefits	1. Scalable to all spectrums of work processes (suitable for time-constrained activities)	1. Logical flow in deriving failures modes and causes 2. Thought process clearly stated 3. Commonality with technical system's FMECA (Scalable)	1. Provides reference lists of human error producing conditions, useful for largely human-intensive work processes
Overall	Cons	1. Generic and vague 2. Thought process may be hidden within workings	1. Requires SME input 2. Time consuming	1. Requires SME input 2. Thought process hidden within workings and not shown in the end results. 3. Require additional reference tables 4. Reference tables have hidden assumptions that are not revealed

### • Conclusion:

- PFMECA is more effective than the current SAF risk assessment technique.
- PFMECA is more user-friendly than HEART technique.

### • Recommendations for future research:

- Incorporate hardware FMECA with work process PFMECA
- Expand research to more accident case studies for further validation

**Reference:**  
BAE, 1982. Operator's Manual: Fighting Vehicle, Infantry, M2 (2350-01-048-5920) and Fighting Vehicle, Cavalry, M3 (2350-01-049-2659) Hull. Washington, DC: Headquarters, Dept. of the Army.