DCS Console Operator Issues In Related Industries

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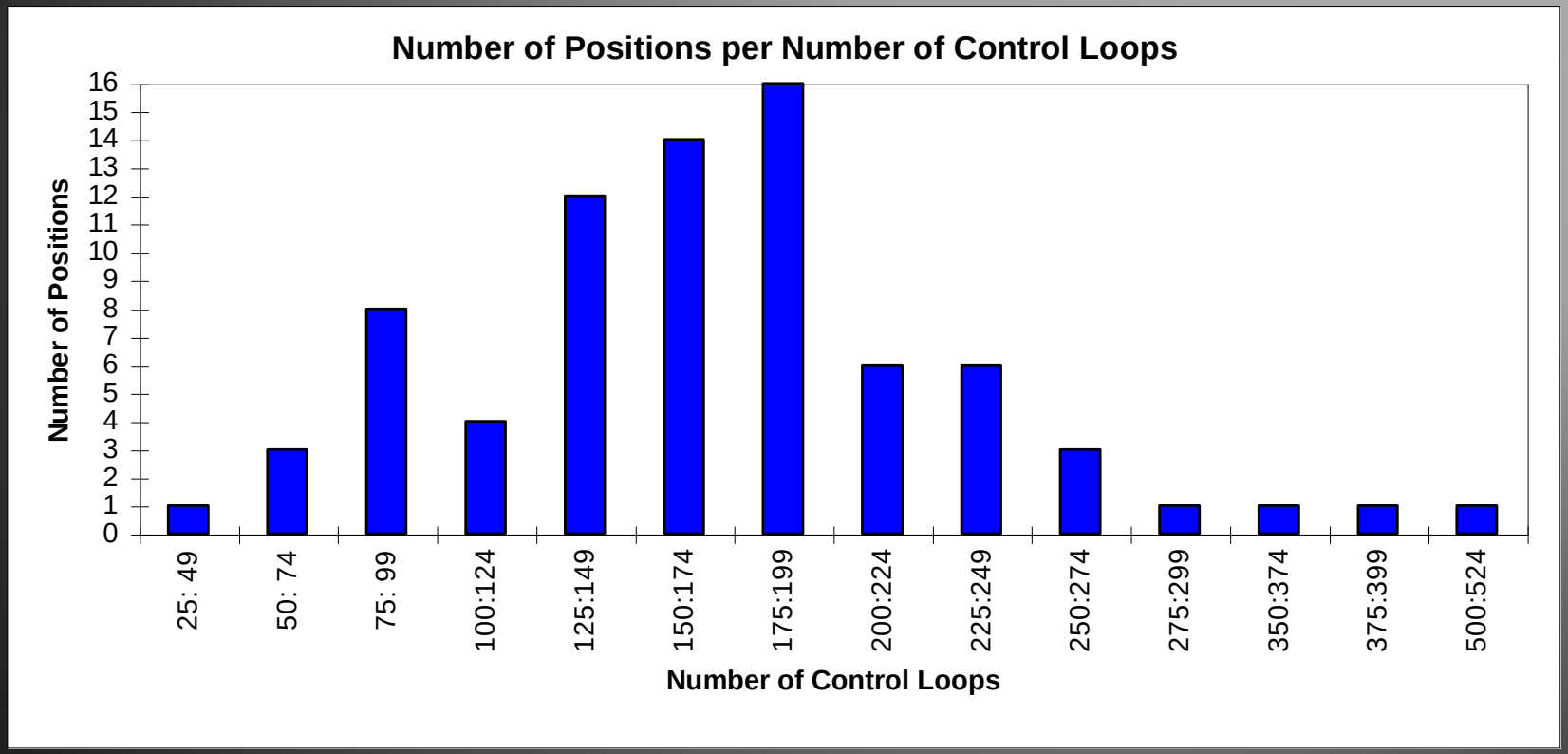
Overview

- Distributed control systems (DCS) have enabled wider spans of control for console operators
- Design of the operator-process system has become increasingly critical to safe and efficient operation
  - Alarms
  - Displays
  - Procedures
  - Decision Making/Training

Current Span of Control



Mean:	172.5
St. Dev:	74.7
Median:	170.0
# of Positions:	77

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Overview of Study

- Approximately 30 operators will run the experiment.
- Two kinds of alarm display's will be used (Chronological and Categorical).
- All treatment simulations are 1 hour and the alarm rates used as below:

Alarms/10 minutes	Chronological	Categorical
15	X	
20	X	X
25	X	X
30		X

- Also running 10-minute simulation similar to student experiments.

Alarms/10 minutes	Chronological	Categorical
10	X	X
20	X	X

RT – Alarm Rates v. Student/Operator

Level							Least Sq Mean (sec)
Student,20	A						93.016354
Operator,20		B					47.676607
Student,10		B					31.785469
Operator,10		B					24.217462

- Students and Operators reaction time for solving an alarm can not be distinguished from one another except at the alarm rate of 20 alarms per 10 minutes
  - Students performed significantly slower than operators at 20 alarms per 10 minutes

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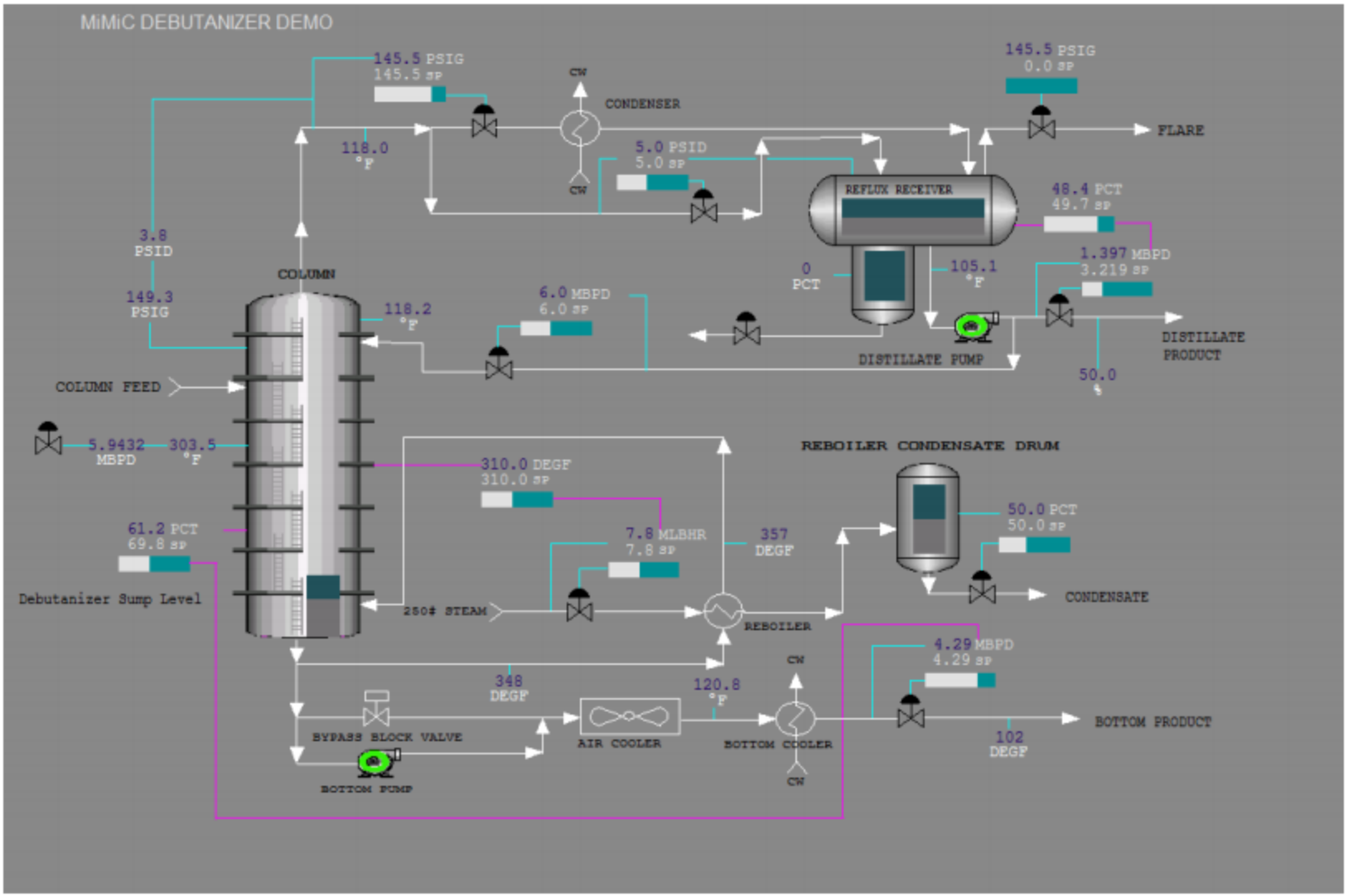
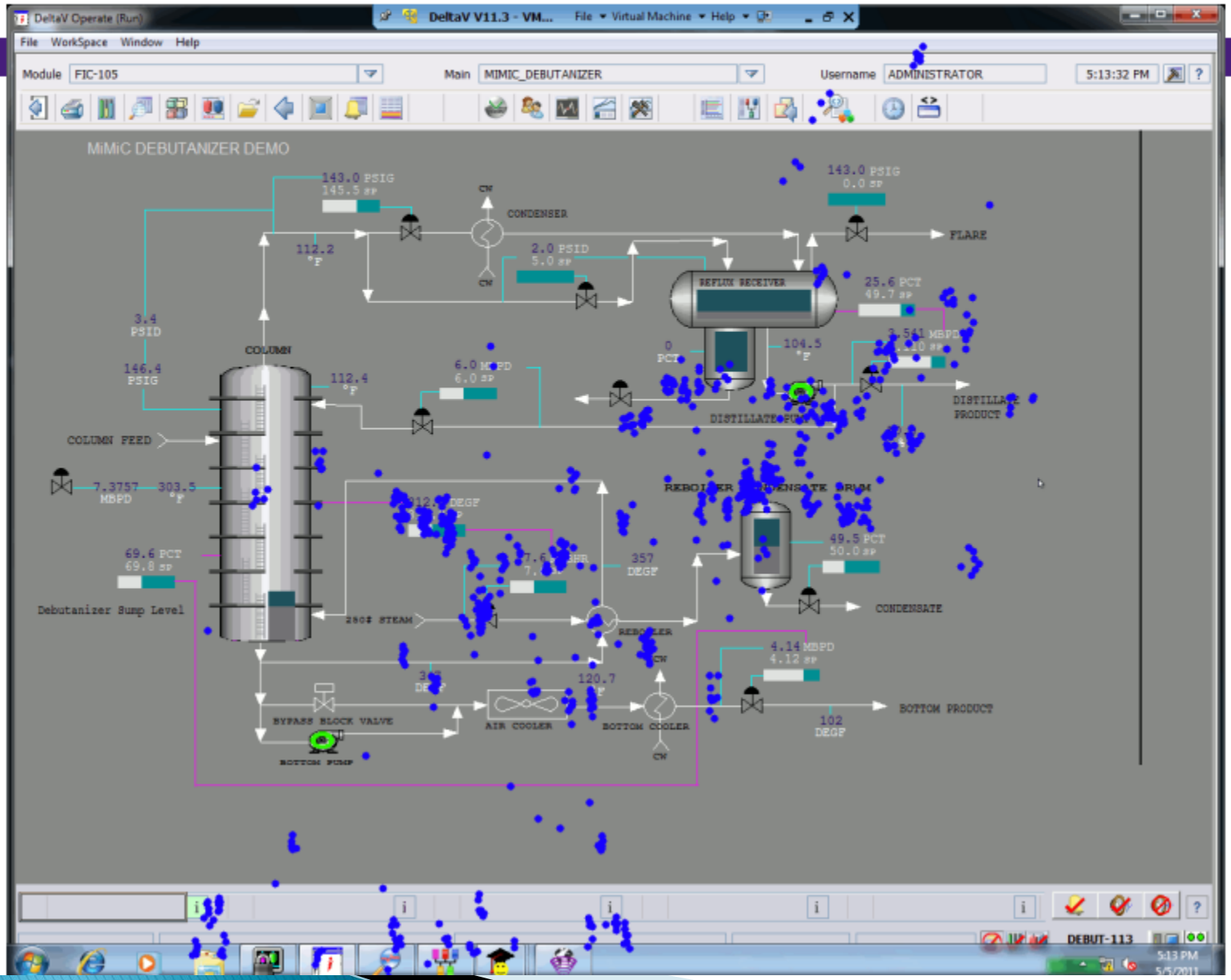
Simulation interface: virtual plant



Eye fixations when everything is calm



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Procedure Assessment

- Issues
  - Same steps in multiple procedures
  - Different levels/types of information (task versus training)
  - Different users
- Improvement option
  - Break procedures into chunks that can be recombined
- Problems
  - Volume
  - Style/format

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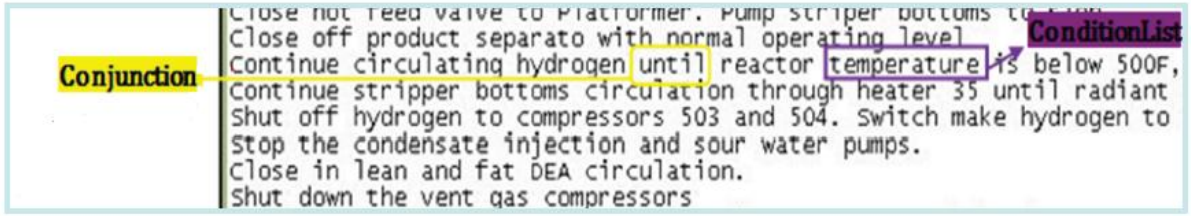
Phase 2 - Heuristic 7

Conjunctions and Conditions

if (∀ k ∈ Si, ∃ conj ∈ ConjuntionList | k == conj,
and ∀ j ∈ Si | cond ∈ ConditionList | j == cond)
{conjunction(Si) = k; Condition(Si) = j;}



Procedure	Action	Target	Step-Break	Conjunctio	Condition
Continue circulating hydrogen until reactor temperat	continue	hydrogen	TRUE	until	temperature
Shut down compressors 503 and 504.	shutdow	compressors 503	TRUE		
Vent system to flare if necessary.	vent	system			
oms circulation through heate	continue	striper bottom		until	temperature

Procedure Chunking

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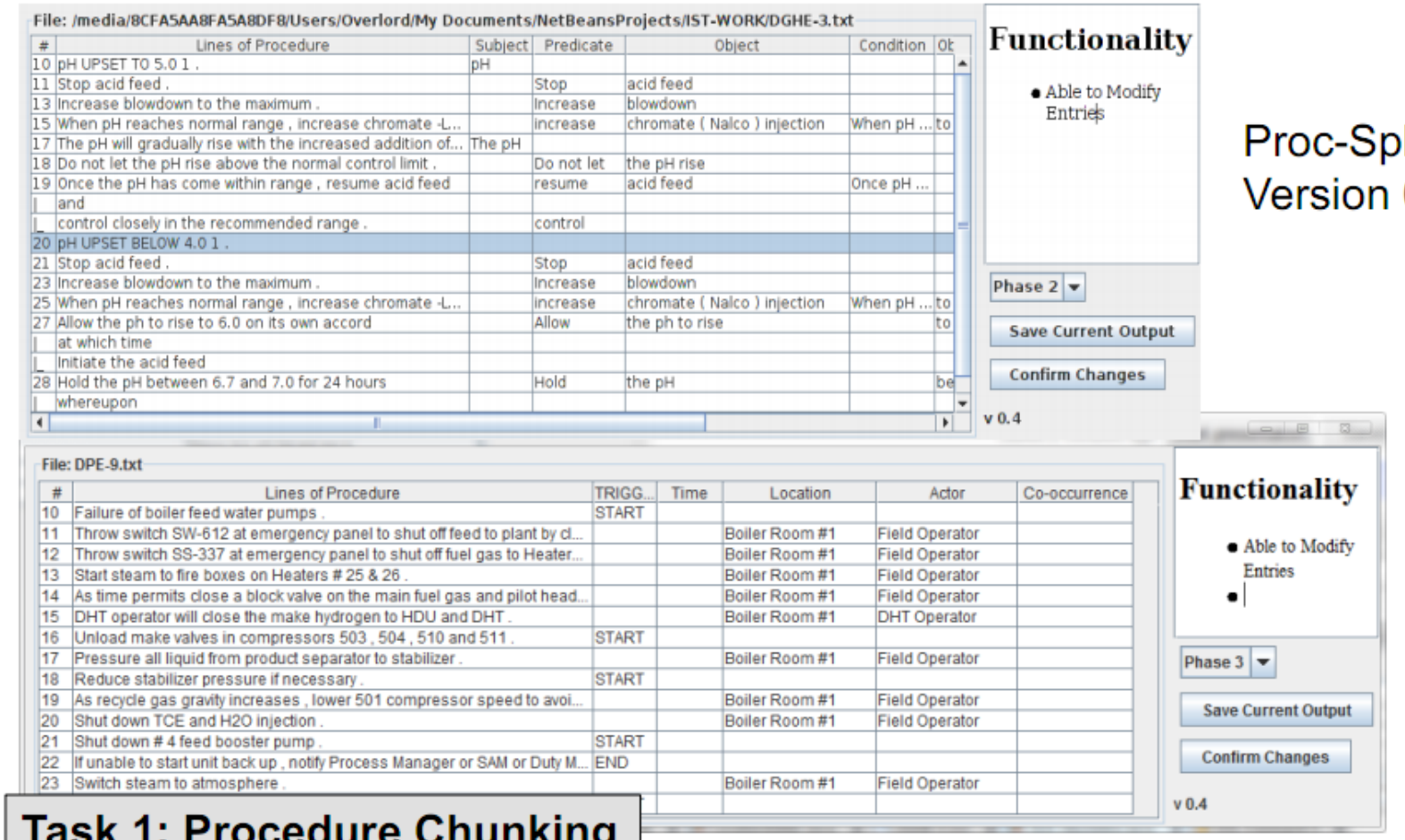
Procedure Splitter Ver. 0.7



Proc-Splitter Version 0.4

Task 1: Procedure Chunking

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Characteristics of Expertise	Crude Unit Operator	Fluid Catalytic Cracker	Pipeline Analyst
1. Form expectancies	√	√	√
2. Monitor cues	√	√	
3. Anticipate team member needs and limitations	√	√	√
4. Know where equipment and human resources can mislead you	√	√	√
5. Seek information to spot opportunities	√		√
6. Adapt the way they perform	√	√	√
7. Describe how events came about and will play out	√		√
8. Utilize time horizons			√
9. Use recall processes to overcome memory limitations	√	√	√
10. Construct mental simulations	√		√
11. Decenter			
12. Engage in deliberate practice	√	√	
13. More recognitional decisions than option comparisons	√	√	√

Decision Making Excercises (DMX)

- Good decision making requires practice
- Adapt military training exercises
- Scenario based
- Time pressure
- Ambiguous
- Low cost
- Easy to apply (< 1 hour before shift)

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