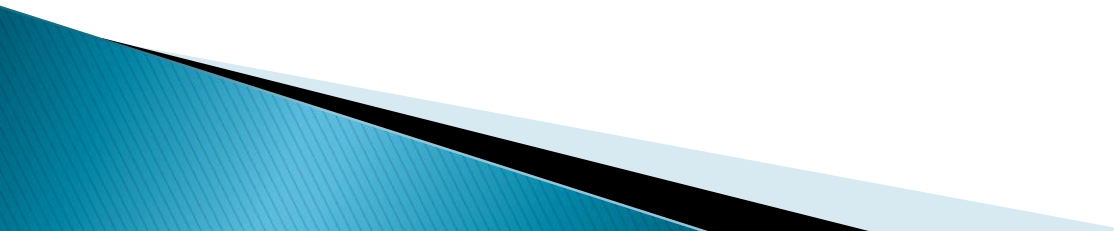


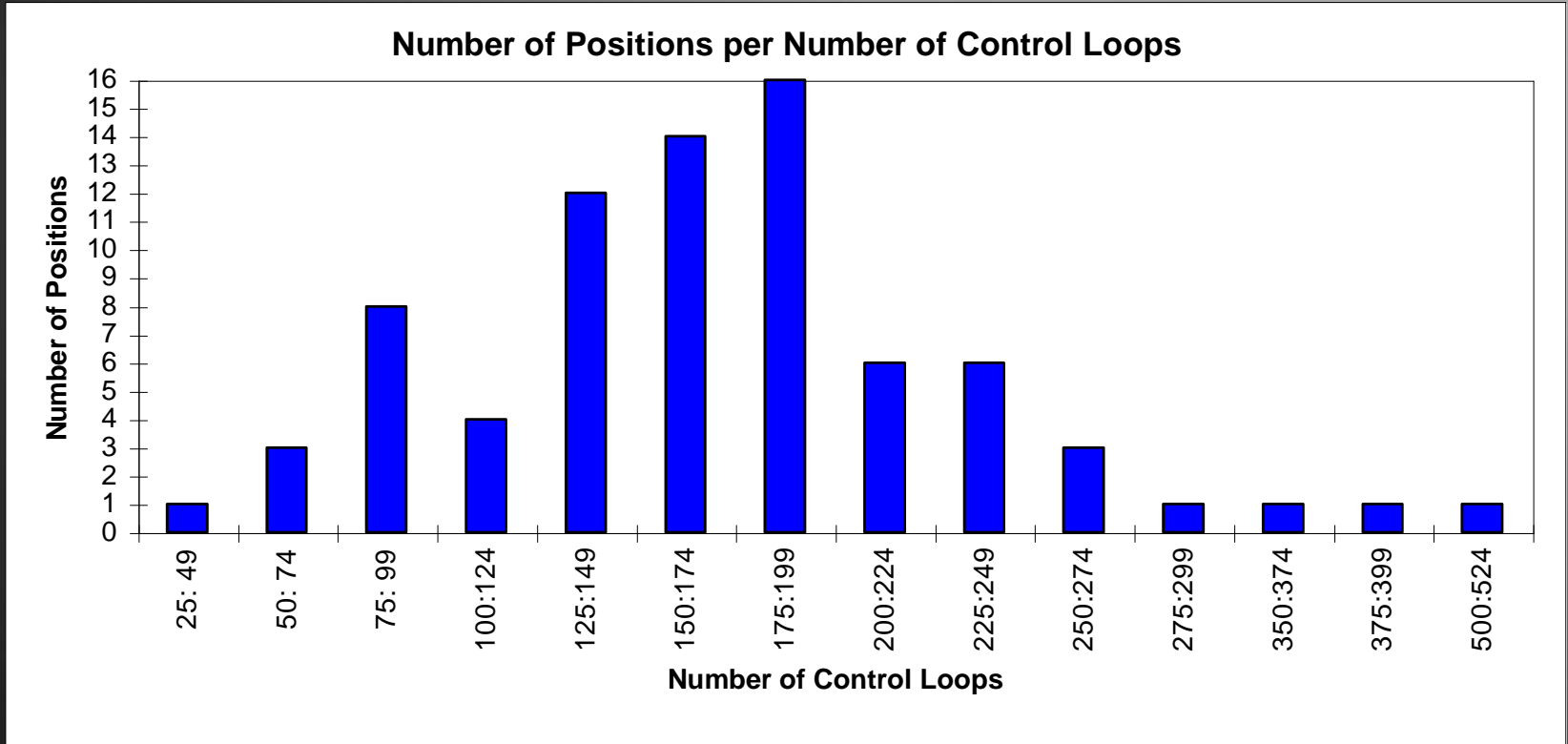
DCS Console Operator Issues In Related Industries

David A Strobhar, PE
Beville Engineering, Inc
Center for Operator Performance

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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Center for Operator Performance

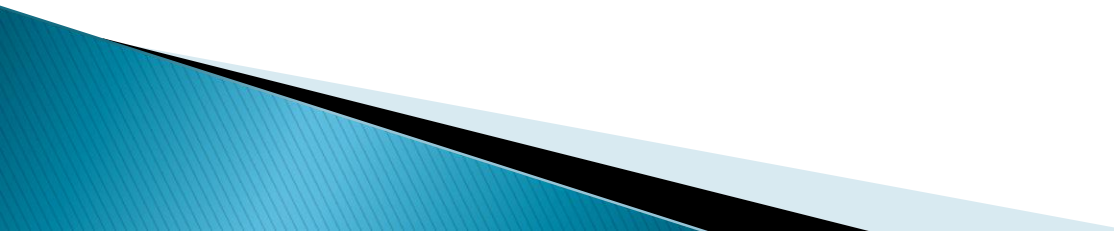


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Overview of Study

- 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.

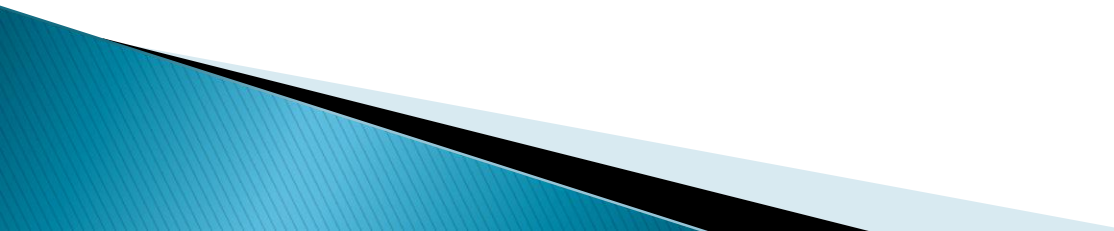
Alarms/10 minutes	Chronological	Categorical
10	X	X
20	X	X

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

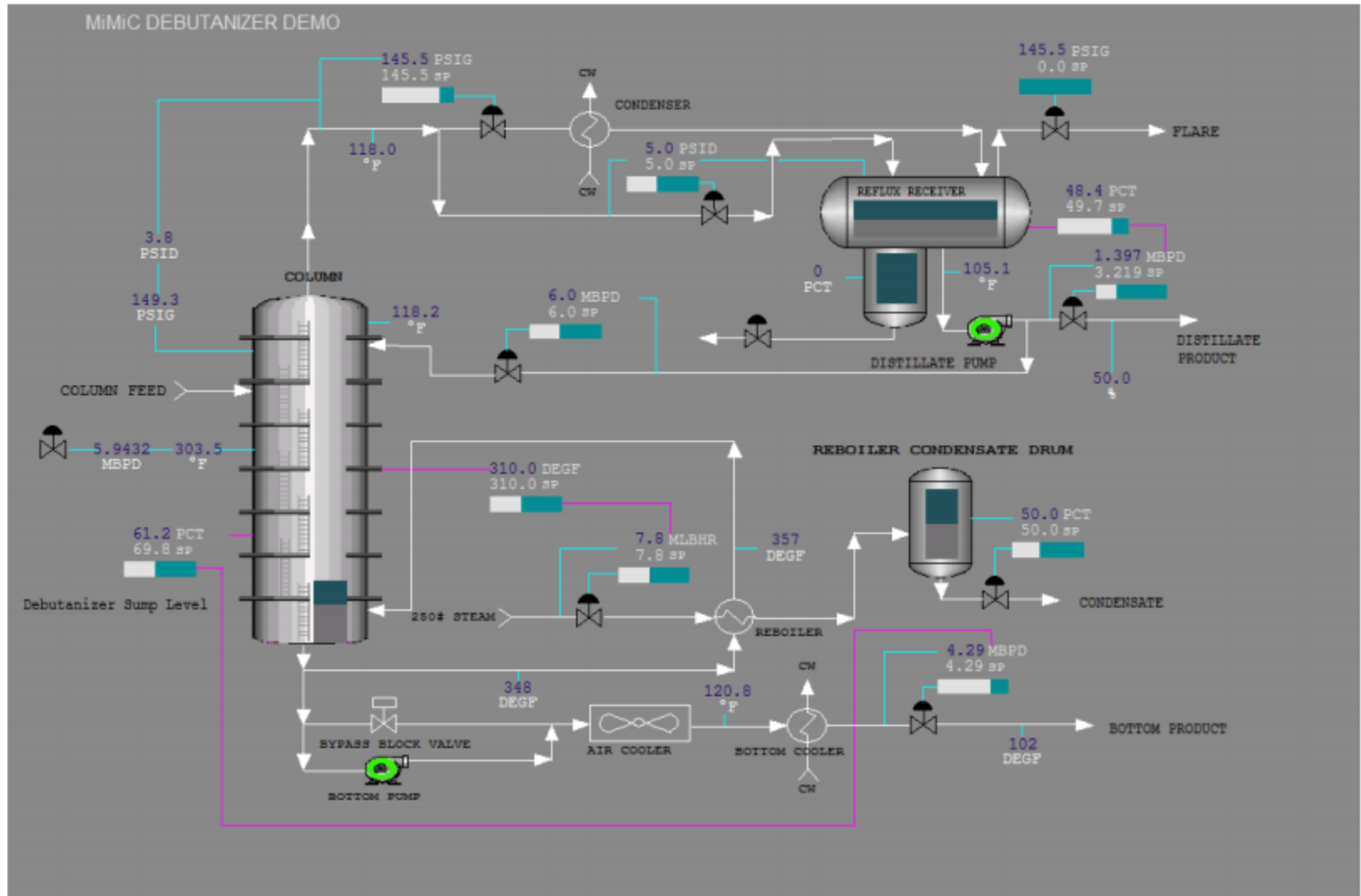
- ▶ Students and Operators reaction time for solving an alarm can not be distinguished from one another except at the alarm rate of 20 alarms per 10 minutes
 - Students performed significantly slower than operators at 20 alarms per 10 minutes

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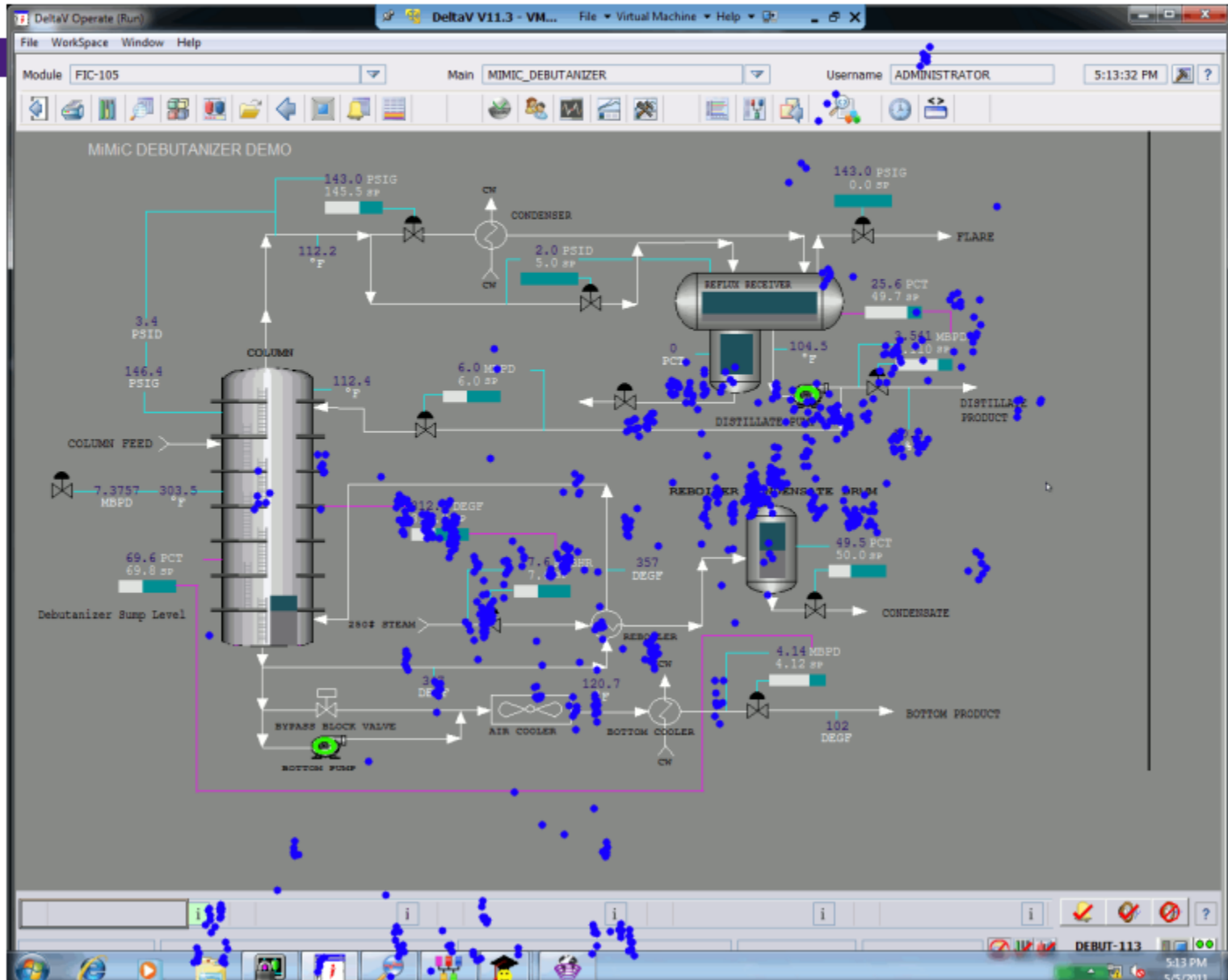
Simulation interface: virtual plant

4

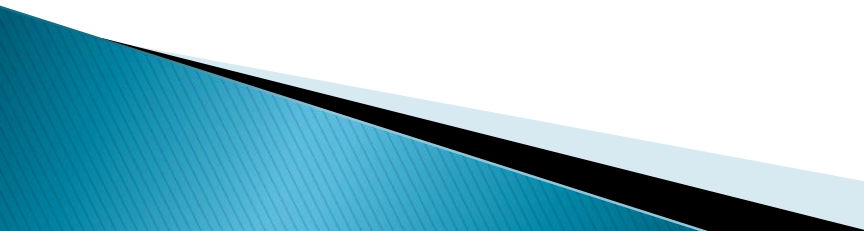


Eye fixations when everything is calm

22



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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
- 

Phase 2 - Heuristic 7

Conjunctions and Conditions

if ($\forall k \in S_i, \exists \text{conj} \in \text{ConjunctionList} \mid k == \text{conj}$,
 and $\forall j \in S_i \mid \text{cond} \in \text{ConditionList} \mid j == \text{cond}$)
 {conjunction(S_i) = k ; Condition(S_i) = j ;}

Conjunction **ConditionList**

Close not feed valve to Platformer. Pump stripper bottoms to 1000.
 Close off product separator with normal operating level.
 Continue circulating hydrogen until reactor temperature is below 500F,
 Continue stripper bottoms circulation through heater 35 until radiant
 Shut off hydrogen to compressors 503 and 504. Switch make hydrogen to
 Stop the condensate injection and sour water pumps.
 Close in lean and fat DEA circulation.
 Shut down the vent gas compressors

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

Procedure Chunking

Procedure Splitter Ver. 0.7

File: /media/8CFASAA8FAS8DF8/Users/Overlord/My Documents/NetBeansProjects/IST-WORK/DGHE-3.txt

#	Lines of Procedure	Subject	Predicate	Object	Condition	Ok
10	pH UPSET TO 5.0 1 .	pH				
11	Stop acid feed .		Stop	acid feed		
13	Increase blowdown to the maximum .		Increase	blowdown		
15	When pH reaches normal range , increase chromate -L...		increase	chromate (Nalco) injection	When pH ...to	
17	The pH will gradually rise with the increased addition of...	The pH				
18	Do not let the pH rise above the normal control limit .		Do not let	the pH rise		
19	Once the pH has come within range , resume acid feed		resume	acid feed	Once pH ...	
	and					
	control closely in the recommended range .		control			
20	pH UPSET BELOW 4.0 1 .					
21	Stop acid feed .		Stop	acid feed		
23	Increase blowdown to the maximum .		Increase	blowdown		
25	When pH reaches normal range , increase chromate -L...		increase	chromate (Nalco) injection	When pH ...to	
27	Allow the ph to rise to 6.0 on its own accord		Allow	the ph to rise	to	
	at which time					
	Initiate the acid feed					
28	Hold the pH between 6.7 and 7.0 for 24 hours		Hold	the pH	be	
	whereupon					

Functionality

- Able to Modify Entries

Phase 2 ▼

Save Current Output

Confirm Changes

v 0.4

Proc-Splitter
Version 0.4

File: DPE-9.txt

#	Lines of Procedure	TRIGG...	Time	Location	Actor	Co-occurrence
10	Failure of boiler feed water pumps .	START				
11	Throw switch SW-612 at emergency panel to shut off feed to plant by cl...			Boiler Room #1	Field Operator	
12	Throw switch SS-337 at emergency panel to shut off fuel gas to Heater...			Boiler Room #1	Field Operator	
13	Start steam to fire boxes on Heaters # 25 & 26 .			Boiler Room #1	Field Operator	
14	As time permits close a block valve on the main fuel gas and pilot head...			Boiler Room #1	Field Operator	
15	DHT operator will close the make hydrogen to HDU and DHT .			Boiler Room #1	DHT Operator	
16	Unload make valves in compressors 503 , 504 , 510 and 511 .	START				
17	Pressure all liquid from product separator to stabilizer .			Boiler Room #1	Field Operator	
18	Reduce stabilizer pressure if necessary .	START				
19	As recycle gas gravity increases , lower 501 compressor speed to avoi...			Boiler Room #1	Field Operator	
20	Shut down TCE and H2O injection .			Boiler Room #1	Field Operator	
21	Shut down # 4 feed booster pump .	START				
22	If unable to start unit back up , notify Process Manager or SAM or Duty M...	END				
23	Switch steam to atmosphere .			Boiler Room #1	Field Operator	

Functionality

- Able to Modify Entries
-

Phase 3 ▼

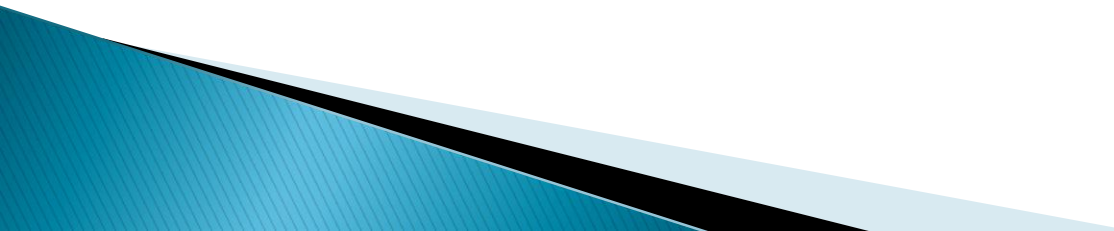
Save Current Output

Confirm Changes

v 0.4

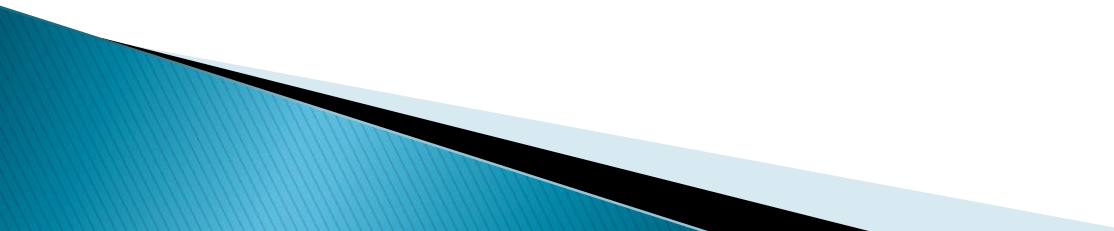
Task 1: Procedure Chunking

Overview

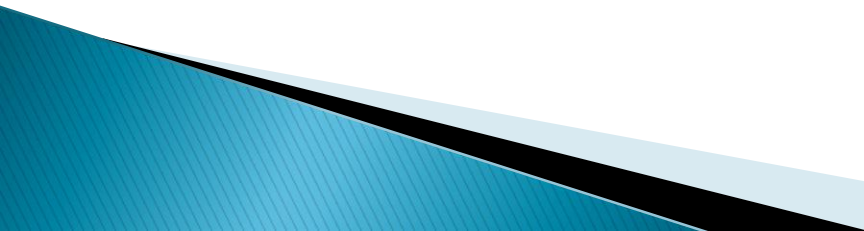
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Characteristics of Expertise	Crude Unit Operator	Fluid Catalytic Cracker	Pipeline Analyst
1. Form expectancies	√	√	√
2. Monitor cues	√	√	
3. Anticipate team member needs and limitations	√	√	√
4. Know where equipment and human resources can mislead 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 Exercises (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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