Modularizing Emergency Procedures: Increasing Ease of Use and Update

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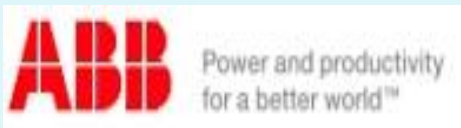
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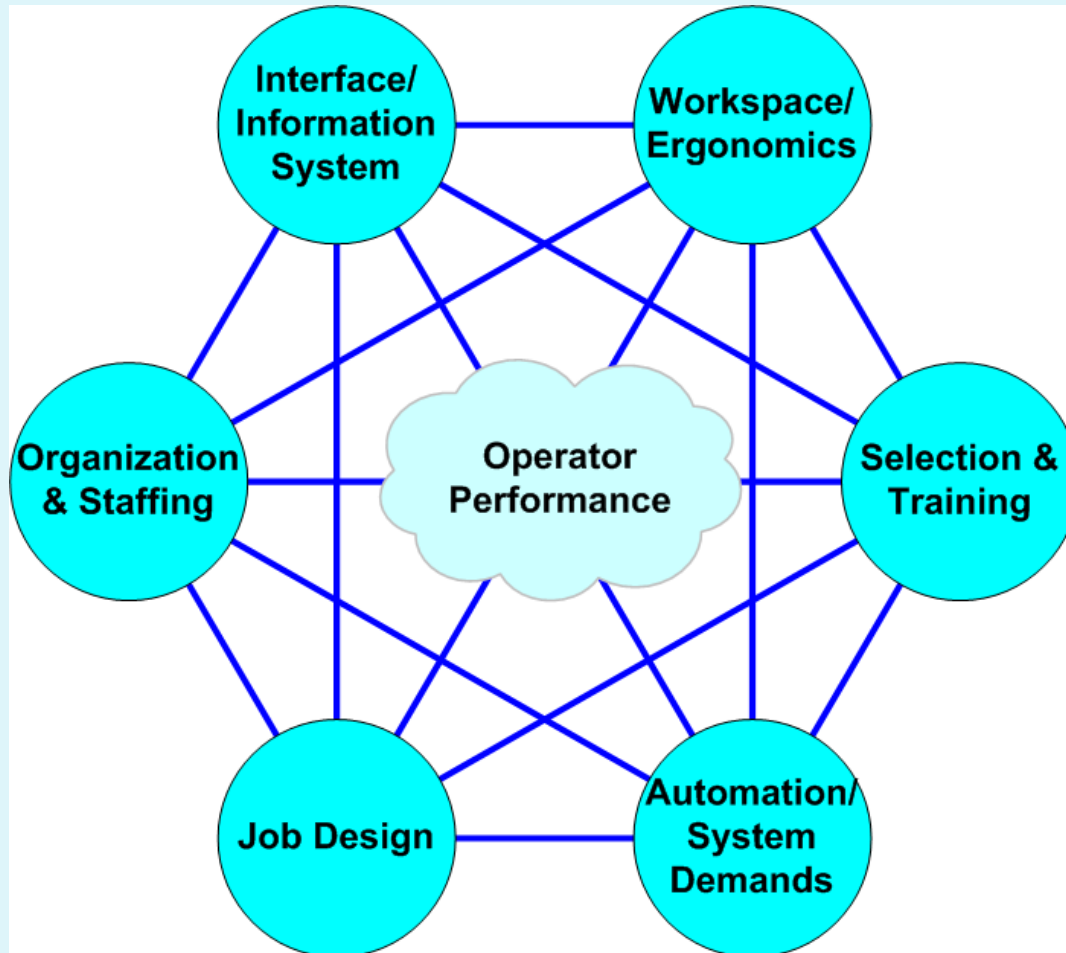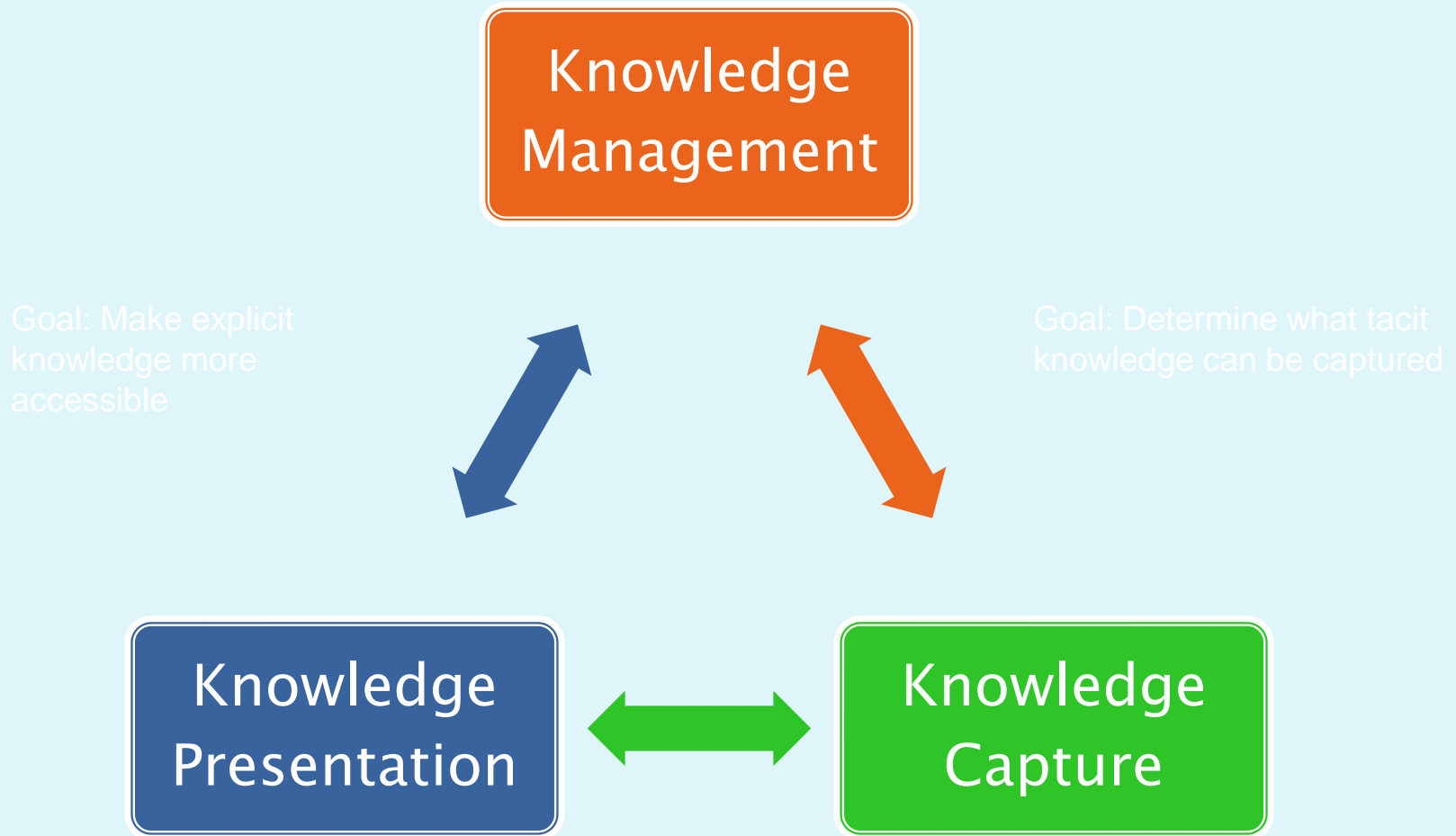
Knowledge Management

▸ Problem Space

▸ Phase 1 – Develop Approach

▸ Phase 2a – Test Approach

▸ Phase 2b – Make implicit explicit

Pending wave of retirements = potential loss of knowledge

NPRA

Knowledge Management

Goal: Make explicit knowledge more accessible

Goal: Determine what tacit knowledge can be captured

Knowledge Presentation

Knowledge Capture

Current Procedures

- Growing in importance and volume
- Used for operation and training
- Organized around units
- Repeated steps

Naphtha Hydrotreater

Event 1		Event 2		Event 3	
Console	**Field**	**Console**	**Field**	**Console**	**Field**
Task	Task	Task θ	Task θ	Task	Task
Step 1	Step 1	Step 1	Step 1	Step 1	Step 1
Step 2	Step 2	Step 2	Step 2	Step 2	Step 2
Step 3	Step 3	Step 3	Step 3	Step 3	Step 3
Task	Task	Task	Task	Task θ	Task θ
Step 1	Step 1	Step 1	Step 1	Step 1	Step 1
Step 2	Step 2	Step 2	Step 2	Step 2	Step 2
Step 3	Step 3	Step 3	Step 3	Step 3	Step 3
Task θ	Task θ	Task	Task	Task	Task
Step 1	Step 1	Step 1	Step 1	Step 1	Step 1
Step 2	Step 2	Step 2	Step 2	Step 2	Step 2
Step 3	Step 3	Step 3	Step 3	Step 3	Step 3

EASY TO USE AND UPDATE?

Naphtha Hydrotreater

Event 1		Event 2		Event 3	
Console	**Field**	**Console**	**Field**	**Console**	**Field**
Task Step 1 Step 2 Step 3	Task Step 1 Step 2 Step 3	Task θ Step 1 Step 2 Step 3	Task θ Step 1 Step 2 Step 3	Task Step 1 Step 2 Step 3	Task Step 1 Step 2 Step 3
Task Step 1 Step 2 Step 3	Task Step 1 Step 2 Step 3	Task Step 1 Step 2 Step 3	Task Step 1 Step 2 Step 3	Task θ Step 1 Step 2 Step 3	Task θ Step 1 Step 2 Step 3
Task θ Step 1 Step 2 Step 3	Task θ Step 1 Step 2 Step 3	Task Step 1 Step 2 Step 3	Task Step 1 Step 2 Step 3	Task Step 1 Step 2 Step 3	Task Step 1 Step 2 Step 3

Reformer

Event 1		Event 2		Event 3	
Console	**Field**	**Console**	**Field**	**Console**	**Field**
Task Step 1 Step 2 Step 3	Task Step 1 Step 2 Step 3	Task β Step 1 Step 2 Step 3	Task β Step 1 Step 2 Step 3	Task Step 1 Step 2 Step 3	Task Step 1 Step 2 Step 3
Task Step 1 Step 2 Step 3	Task Step 1 Step 2 Step 3	Task Step 1 Step 2 Step 3	Task Step 1 Step 2 Step 3	Task β Step 1 Step 2 Step 3	Task β Step 1 Step 2 Step 3
Task β Step 1 Step 2 Step 3	Task β Step 1 Step 2 Step 3	Task Step 1 Step 2 Step 3	Task Step 1 Step 2 Step 3	Task Step 1 Step 2 Step 3	Task Step 1 Step 2 Step 3

Solution

- Break procedures into modules or chunks that can be organized to needs of different users
  - Console versus field
  - Trainee versus qualified operator
- Store task information once
  - Once updated/revised, all relevant documents change

How to implement

Concern	Result
Brute force approach a problem due to scale	Develop set of automatable heuristics
Manual approach a problem due to inconsistencies	Use heuristics to reduce inconsistencies
Variations in formats/conventions may compromise outcome	Use basic assumptions regarding format Ontology of actions, actors, and conditions Typology of target items to reduce decision space

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Phase 1 – Develop Method

- Breakdown each element in procedure to its step
- Pre-processing to identify
  - Verbs
  - Actors (inside vs outside)
  - Action targets (equipment)
  - Conditions (variables)
  - Conjunctions (if, and, or, ..)

Development procedure

STANDING INSTRUCTION NO. DGHE-8

LOSS OF HYDROGEN RECYCLE COMPRESSORS

Feed control valves will close, MA-14 and GH-376 will shut down. Check to see if this has happened.

Close feed control block valve. Also close liquid recycle valve if recycling product.

Fuel gas control valve will close, steam to heater will open.

Shut off makeup hydrogen. Shut down compressor GH-572 if in service.

Start venting plant to H.P. fuel via recycle drip vessel 1252. Notify Cracking.

Start N_2 to plant via suction bottle on compressor GH-504 (open bypass) when plant pressure is 160 psi, close vent to fuel on V-1252 open to flare via LPG Drip 1257. (Close Suction on Com-

Application of Heuristics

Conjunctions and Conditions

if ($\forall k \in Si, \exists conj \in ConjuntionList \mid k == conj,$

and $\forall j \in Si \mid cond \in ConditionList \mid j == cond$)

{conjunction(Si) = k; Condition(Si) = j;}

Conjunction → Continue circulating hydrogen [until] reactor [temperature] is below 500F,

ConditionList

Close hot feed valve to Platformer. Pump striper bottoms to ...
Close off product separato 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	Conjunction	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			
...toms circulation through heate	continue	striper bottom		until	temperature

Procedure Chunking

Procedure Elements for Chunking

Line	Action	Target	Step-Break	Non-Action	Purpose	Conjunction	Condition	Trigger	ChunkBreak By			
									Contiguity	Location	Co-occurrence	Actor
10				NULL				Trigger-Of-Begin				
11	shut	htrs29&30	TRUE									
12	Close	fuel and pilot gas lines										
13	start	htrs29&30	TRUE									
14	open	dampers										
15	cut	feed	TRUE									
16	continue	hydrogen circulation									TRUE	
17	divert	stripper bottoms	TRUE		feed							
18	close	stripping steam				if	open			TRUE	TRUE	
19	start	electric pump	TRUE		circulate							
20	shut	power recovery turbine										
21	shut	feed pump	TRUE			when	450F/200 psig				TRUE	
22	notify	ccu	TRUE			if	feeding					
23	cut	usc	TRUE							TRUE	TRUE	
24	close	annin valve										
25	shut	field feed pump								TRUE		

Note: Actor column — "Not suitable for this case"

Procedure Chunking

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Knowledge Elicitation

	Mind-map Elicited from Expert	Mind-map Codified in the Procedure
Chunk2	- Keep feed unit - SDV-123A shutoff fuel gas and pilot gas to htr19 - *It takes short time to make this happen* ← - Steam enter firebox - *It takes short time to make this happen* ← [Move to DGHE-18 actions on htr18 which is nearby]	- Keep feed in unit - SDV-123A will trip shutting off fuel gas and pilot gas to htr19 -Steam will enter firebox
Chunk3	- Switch htr18 to burning fuel oil - Shutoff gas burners - Reduce feed or reflux if not enough heat from htr18 - *Enough means temp achieve 450F* ← - Check pilot gas - Switch natural gas, if using fuel gas as pilot gas - *It will take some time (2min) for gas replacement* ← [Move back to DGHE-4]	-Switch htr18 to burning fuel oil -Shutoff gas burner -Reduce feed or reflux if not enough heat from htr18 -Check pilot gas -Switch natural gas, if using fuel gas as pilot gas

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