Modularizing emergency procedures for increased ease of use and updating

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Abstract

Current procedural information on emergency actions is generally organized along two dimensions: (1) unit and (2) upset type. In some cases, there may be a distinction on board versus field actions within the procedures. This can lead to cases where an operator whose responsibility covers multiple units is expected to simultaneously utilize multiple procedures during an upset. The actions specified in each of the procedures is often the same, either because one procedure is a subset of another (e.g., loss of compressor is a subset of power failure) and/or the procedures eventually converge on a common set of tasks (e.g., shutdown unit). The industry is rapidly increasing an emphasis on procedures, expanding both depth and breadth of procedure coverage. The result is a large volume of information that at times is unwieldy and hard to keep current.

The Center for Operator Performance commissioned a study at Penn State University to examine new options to improve emergency procedures. Heuristics were developed to enable automatic chunking and grouping of emergency procedures into a modular format. The procedure modules or elements can be recombined in various arrangements to match user needs, such as multiple units in one procedure for operators with multiple units or expanded detail for training versus normal use. Since the modules are used in multiple procedures, updating the information only needs to be done once and all associated procedures automatically compliant. Methods to extract and codify tacit information on procedure use (e.g., "shutdown fin fans as needed) are being evaluated and tested.

Issue

Many companies are facing a large number of retirements in the near future as those workers who started up units in the 70's are approaching retirement. This potential loss of knowledge prompted the Center for Operator Performance (www.operatorperformance.org) to undertake an investigation into knowledge management, utilizing researchers at Penn State University. As knowledge management entails two key facets, knowledge presentation and knowledge elicitation/capture, one facet needed to be the initial focus of the investigation. The decision was to focus on emergency procedures as it presented the greatest opportunity to quickly improve operator performance through real-time assistance.

Emergency procedures can be characterized as the tasks and steps required for each operator on a specific unit in response to a given abnormal situation. This creates a set of procedures for a given unit covering multiple abnormal situations or upsets. Within each procedure are the tasks and steps for the console and field operator(s).This seems both simple and logical.

Several problems exist. Console operators in particular may be responsible for multiple units. A given upset may require them to access two or three notebooks with a procedure for each unit. Procedures are often used to train new operators and contain a level of detail needed for the training, but not for operation. Add to this conundrum the increased reliance on procedures and need to ensure their accuracy. Procedures are becoming more voluminous and the task of updating ever more daunting. Since many emergency procedures ultimately end up in the same place, that being the shutdown of the unit, many of the tasks and their steps are duplicated in each procedure. The amount of unique information in any given procedure is relatively low.

Approach

An obvious solution to the problem would be to capture key procedural “chunks”, related tasks and supporting steps/information, in a central database that could be used to populate different procedures. However, there are problems in implementing this solution. First, the volume of procedure information that exists makes going through each to identify chunks in a brute force approach a daunting task. Second, the procedures themselves vary in format, content, and style, creating potential problems in attempting to create common “chunks.” Third, efficient algorithms for creating chunks can be difficult to obtain because of the inherent richness of natural language descriptions in procedures.

The solution developed by Penn State was to create a set of automatable heuristics (rules of thumb) that can speed the chunking process. A set of procedures could then be processed to aid in development of the necessary chunks or procedural elements, drastically reducing the level of effort required. In addition, the heuristics can easily handle and flag inconsistencies in procedure style, format, and content. Development of the heuristics started with a set of emergency procedures from a hydro-processing area of a refinery, with an example portion shown in Figure 1.

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-

Figure 1 - Example of Current Procedure

Two distinct sets of heuristics were initially created. The first recognized “boiler-plate” or meta-information in the procedures, such as titles, authors, approvals, etc. The second set of heuristics focused upon processing the content of the procedures. This flagged key actors (operators), actions (verbs), conditionals (conjunctions), process variables, and targets (equipment). The result is that a procedure was quickly converted into a table based upon these key attributes (Figure 2).

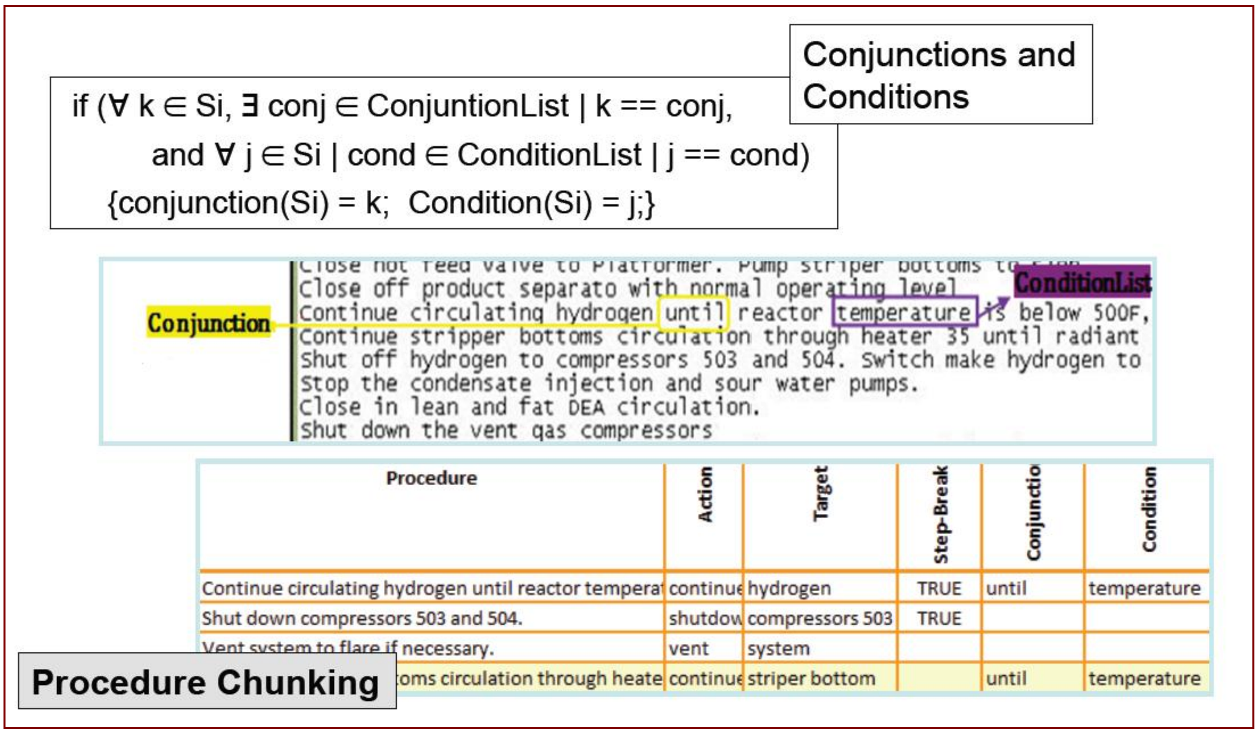

Figure 2 - Example of Heuristic Application

From this tabular format, the procedural elements can be encoded as to who needs this information (board/field), is it tasks or steps, and critical or supporting (Figure 3). This becomes the basis by which the different elements can be grouped or chunked.

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									Not suitable for this case
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		

Procedure Chunking

Figure 3 - Table of procedure elements

Next Steps

The next phase and current activity is to test the heuristics on a different set of procedures. Emergency procedures from different locations have been supplied that will undergo processing with the heuristics. This will enable fine-tuning of the heuristics and development of the chunks, which can be combined for greatest assistance to the user and need be updated only in one location.

Part of the second phase will be to expand the Knowledge Management effort into the knowledge capture and elicitation process. It was clear from the procedures that tacit knowledge was required in their use, with phrase such as “when needed”, “long enough”, and “when able”. Expert operators from one of the units that have supplied the second set of procedures will be interviewed to determine the knowledge that an expert adds to use of the procedure. The goal is to determine how this tacit knowledge can be codified into the procedures for use by the newer operators.