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Winter Newsletter 2010 Editor: David A.Strobhar

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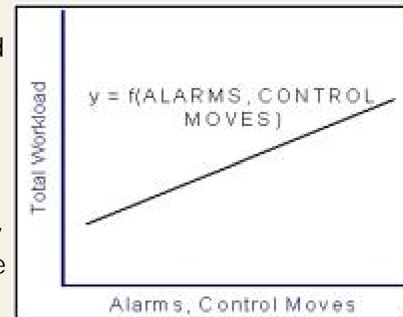
Beville's Non-Intrusive Console Workload Assessment

Beville has documented the activities of nearly 1000 petrochemical plant operators during more than 7000 hours of direct observation. For console operators alone, we have analyzed over 250 positions with more than 2000 hours in control rooms. All of these activities have been recorded and documented in Beville's workload database.

Building on this data, we have developed a method of quickly and non-intrusively providing a general assessment of console operator workload based on DCS data, specifically alarms and control moves (Figure to the right). The technique requires that a company provide one month of control move and alarm data from which an estimate of total current console workload is calculated. An example of the results of this analysis is shown in the table below. (Note: Numbers shown are for illustrative purposes and do not constitute real data or analysis.)



Unit	Control Moves/Hr	Alarms/Hr	Required Staffing (FTE)
Unit 1	4.2	2.5	0.52
Unit 2	6.8	7.5	0.76

In this example, Unit 1 workload requires a little over half of a full time operating position. In addition to providing valuable data on current workload, any disproportionate contributors to workload from either alarms or control actions are identified, providing the necessary information for companies to take concrete actions to

What is the Center for Operator Performance?

The COP is an alliance of academic and process companies to research generic issues in human factors and process operator performance.

The goal is an open and low-cost forum for the identification, analysis, and dissemination of research in such areas as selection/training, interface design, decision aides, automation, procedures, and control room design.

Visit the COP online at: OperatorPerformance.org

Workload Observation Thoughts

Some might argue that mere observation of operators skew their activities, resulting in the appearance of higher than actual workload.

Since we've actually had operators fall asleep during our assessment, we would argue otherwise.

Nevertheless, even if

manage console operator workload. Further, in areas where operators are under-loaded, this analysis provides the data necessary to identify consolidation options.

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Alarms and Staffing

Premise – Staffing of the console position should be based upon steady state workload, with the operator-process system (alarms, displays, training, automation) designed to enable those individuals to be able to handle an upset when it occurs.

A recent Beville project involved a plant with plans to consolidate two board positions into one. An assessment of steady state workload showed that the consolidation was reasonable. An analysis of upset response was conducted, with a recent upset providing actual data on alarms and control moves. The assessment showed some problems, including the operators' ability to manage alarms, and so an alarm response analysis (rationalization) was undertaken. All alarms were reviewed with the operators and significant changes occurred in the total number of alarms and priority distribution. But how much would it help?

The upset event data used in the original analysis was re-examined in light of the new alarm system configuration. No attempt was made to assess the impact of alarm setpoint changes, just what was alarmed before and what would not be alarmed now. The results are shown in the table. Overall, a 40% decline would occur in the number of alarms actuating for that particular upset event, and the combined job would experience fewer alarms than Job B alone had during the initial upset. The total number of alarms is still high and further changes to reduce them are warranted, but this initial change from the upset that was experienced is significant.

	Per Hour		Pct Reduction
	Pre-ARA	Post-ARA	
Job A	18.5	10.9	41%
Job B	41.3	26.1	37%
Total	59.8	37.0	38%

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From the Center for Operator Performance:

The fall meeting of the Center for Operator Performance (www.operatorperformance.org) was hosted by Chevron at their Richmond Research Center. Presentations were made on current projects, but also on other research that would be of interest to the members. Here are some of the interesting topics discussed.

Procedures can result in worse performance

our critics are correct, when using this analysis to potentially reduce the number of operating positions, we'd rather err on the more conservative side (i.e., slightly higher workload projections than may actually exist).

Plant Safety is a Function of Many Different Factors…

We received a call recently from a potential client interested in safety training for operators. My antenna immediately went up (this occurs whenever training or operator error is indicated in an off-normal situation. Training is often used as a last resort to poor design.)

It took some digging, but it finally came to light that a recent incident had resulted in a unit shutdown. A near miss analysis indicated that lack of training was a contributor to the incident. (With companies limiting the addition of alarms due to overload, I'm wondering if we'll see more emphasis on training deficiencies.)

My response to the gentleman was that, while we can certainly provide some input into their training program (the Center for Operator Performance

Dr. Kathleen Mosier of San Francisco State University discussed an experimental electronic checklist that NASA developed, in which completed items were sensed and "checked-off." The idea is that this was to be a procedural aid, a back-up to the crew going through their checklist. A research study found that instead, the electronic checklist became the primary indicator of the event for the crew. During a simulated bird-strike event, the electronic checklist instructed the pilots to shut down the wrong engine, to which five out of eight crews complied. This, despite information in the cockpit that was contrary to what the checklist was showing! Even more amazing, in a similar study involving a false engine fire, 67% of those who shutdown an incorrect engine "remembered" seeing confirmatory data on their instruments where none existed.

So are procedures to be abandoned? A subsequent study showed that part of the bias the electronic procedures created was due to how they were presented. The electronic checklist was given excessive saliency in its presentation – bigger, more centrally located, so the users tended to defer to it. The automation had "authority." When given less saliency, the bias created by the checklist was reduced. So the issue is not procedures per se, but how the procedural information is presented.

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Naïve Realism – Realistic displays can hurt performance

Dr. Harvey Smallman of Pacific Science & Engineering presented some of his work on naïve realism. This is the term the Dr. Smallman uses to describe the false belief that displays should attempt to be a window to the real-world, which, in his studies, is attempting to make aircraft look exactly like aircraft rather than symbols. Performance with the symbols was far superior to either 3D or 2D representations, despite the user preference for the latter.

Naïve realism comes from a failure to understand how humans actually process information, in part because our information processing system has learned how to "trick" us over the course of our evolution. We think we observe everything in our view, which we don't. We think processing visual information is easy, as though our brain were just a screen to project an image on, which it isn't. We think we see the world as it is, when we don't.

Why would people tend to create displays that hamper performance? Spatial ability, measured by such things as being able to mentally rotate an image and describe how it would appear, may provide a clue. A recent study allowed meteorologists to create their own displays. The displays were then examined for what features were actually needed. Those meteorologists who had low spatial ability added more extraneous information than those with high spatial ability.

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has done interesting work in this area), more than likely, there were other human factors issues that needed to be addressed. Training is only one factor which can affect safety and performance.

Organization and staffing, alarm/display design, job design, workspace design, automation and system demands affect it as well.

In this incident, was alarm overload or poor display design an issue? Were the procedures clear and precise? Were there enough operators on hand to respond effectively?

We made arrangements for a site visit to further discuss/define the problem...

Are old solutions the best solutions?

Dr. Kathleen Mosier of San Francisco State University shared this photo of an early vigilance assurance device during her presentation at the Center for Operator Performance's fall meeting. It's a one legged stool for a worker apparently watching some batch process. He falls asleep, he falls off. While she and I share it for the humor, how many managers will think it isn't all that bad of an idea?

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Invitation to 2010 Summer Meeting

The next meeting of the Center for Operator Performance will be June 15-17, 2010 in Dayton, OH. Guests are always welcome. Please contact us at lvia@operatorperformance.org.

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