THE OPERATOR OF THE FUTURE … IS HERE NOW!

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Abstract

Most companies acknowledge the fact that the operator is crucial to their business. They spend a lot of time and money on training operators to enhance their skills. This paper will explore the next level of enhancements that Worsley Alumina Pty Ltd has implemented to support the control room operator in his situational awareness. Aspects that will be covered include Control room design incorporating human factors, the importance of alarm management and the most effective way to display relevant information in the design of the operator displays. Worsley recently built a new Central Control Room endeavouring to utilise best practises in the design of the whole control room environment and the graphical displays. We will share some of the positive business outcomes and point out some of the learnings obtained

Notation and units

ASM - Abnormal Situation Management
APM - Advanced Process Management Project
CCR - Central Control Room
DCS - Distributed Control System
P&ID - Piping and Instrumentation Diagrams
SAP - Systems, Applications and Processes, an ERP System
SCADA - Supervisory Control and Data Acquisition

1. Introduction

Today, more than ever we are surrounded by technology. We walk around with pagers, mobile phones, personal digital assistants and pocket PC's. At home we use the VCR, Plasma TV, Microwave oven and broadband. All this development is meant to make life easier…. but does it? No matter how many users' manuals we read, we just can't seem to keep up.

This is especially true in the environment the Control Room Operator finds himself. There are so many systems to "support" him. Often this proves to confuse rather than being helpful.

Worsley realised this in 2002. Management challenged the Process Control Group to formulate a strategy for the future to address issues such as future plant expansions, control system component obsolescence, deployment and exploitation of advanced control techniques and how to change to a CCR based operation.

A comprehensive study was conducted and results presented to management. The decision was made to set up a project to action the recommendations. The APM project included moving the 6 current control rooms into a Central facility, look into training simulators, enhance control equipment reliability and address operator effectiveness. This paper will report on the Central Control Room and the changes we made to enhance operator effectiveness.

2. Central Control Room

"Centralized control rooms have been popular since the early 80's. However, the initial ones made a few mistakes…" (Nimmo 2004, p1) Issues such as poor lighting, poor heating and ventilation systems, poor acoustic qualities and poor people movement in the buildings contributed to operator fatigue and bad situational awareness.

During the prefeasibility of the APM project a substantial portion of time was allocated to research new trends. Worsley's intent was to design the control room so that the environment assists operator comfort and process awareness so that he can perform his duties optimally.

We chose the Theatre Style Control Room to be able to exploit modern user interface concepts to focus operator attention on situational awareness. This style of control room lays the consoles out in a line or arc, corresponding to the interactions between areas. This supports better communication during upset conditions. A video wall is set up in the same arc as the consoles.

The video wall is a flexible tool for displaying any electronic information to control room operators and engineers. The wall allows freedom of movement for the control room operator enabling operator fatigue counter measures such as short breaks in adjacent rooms while still monitoring the console. This is essential for the 12-hour shift system. With the multiple large video-screens, information is easily distributed across the control room improving response time to disruptions and potential incidents and also enables collaboration between areas. Our philosophy is based on fault propagation avoidance from one poorly handled disturbance that can cancel all the benefits achieved from advanced control, refinery optimization, and other strategies.

The operating consoles are height adjustable to suite each operator. The four control screens, one closed circuit TV screen and SAP screen enables the operator to complete any required task from the same position.

The room is designed to eliminate any sound propagation. Carpets on the floor, acoustic tiles around the large screens and double glazed window panels achieve maximum sound absorption.

The lighting is designed to minimise glare on screens. "UP"-lighting is used to create a general wash of luminance. Each console has a dimmer panel to allow adjustment for each area.

The room is adequately air conditioned. The design of the building allowed for essential facilities to be adjacent to the Control Room. The lunch room, Gymnasium and meeting room is available behind a double glazed wall. This allows operators to move around freely and still keep an eye on the large screen.

3. Operator Effectiveness

It is important to understand what are the main contributors to control room operator workload. An operator on a daily basis has to cope with radio and telephone traffic, react to console alarms, interact with control screens and deal with manual changes. Although all of the above needs consideration when assessing operator performance, we will have a closer look at the alarm system and the way information is displayed to the operator.

3.1 Alarm management

"No doubt everyone who has a distributed control system (DCS) has encountered alarm management issues. The reason is simple: A DCS makes over-alarming all too easy" (Nimmo 2005, p.1).

We expect an operator to be pro-active… and at the same time the system bombards him with alarms every 10 to 60 seconds. In a central control room this problem escalates into a confusion of alarm sounds together with all the other sound sources.

In a bid to minimise this effect Worsley set up an Alarm Management initiative. We started by defining an Alarm Management Philosophy. The intent is to get all stakeholders to agree on the process and end goal of Alarm Management. One of the Worsley Philosophy principles is: An alarm requires operator action – if not, it is not an alarm. This helped when team members struggled to let go of an alarm.

The Alarm Management process started by working through the existing alarm system applying the philosophy, documenting causes, determined what happens if an alarm is ignored and what steps an operator can take to address the process issue alarmed.

A full time team was set up in each area consisting of a Process Control Engineer, a Process Engineer and an Operations Supervisor/Knowledgeable Operator with an Electrical Technician on a part time basis. They worked through the alarm database and implemented the changes. Figure 1 shows the pre and post performance of one of the areas.

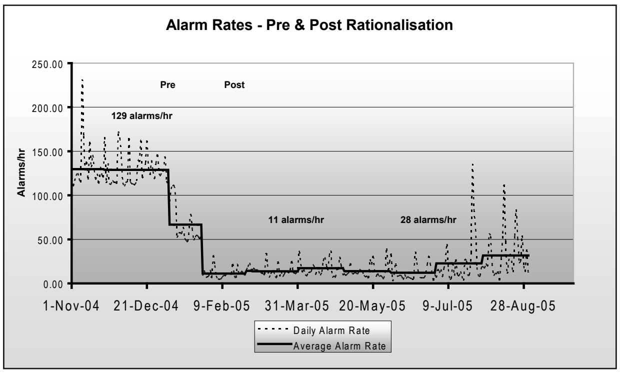

Figure 1.

Alarm Management is not a once off event. You have to constantly review the performance. On the graph (Figure 1) you can see the performance deteriorating over time. A single person was made responsible for the Alarm system. On a daily basis he discusses the top 10 alarms with the area to eliminate the causes. The trend is now back on track.

3.2 Human Machine Interface (HMI)

"Having good situation awareness means that the operator has an accurate perception of the current condition of the process and equipment, and an accurate understanding of the meaning of various trends in the unit. "(Nimmo 2004, p5)

The control room must enhance the operational awareness of the Operator. Twenty to thirty years ago, the panels of dials, charts and mimics in the control room achieved this. The processes the operator was responsible for were less complex. Advances in Technology and Processes brought about more complexity.

"The problem was that the plant designers hadn't paid enough attention to the human factor…" (Vicente 2003, p11).

The result was that the operator lost the "big picture" awareness. A group of companies realised this and set up the Abnormal Situation Management® consortium. Their vision is:

"Operating teams empowered and enabled to proactively manage their plants to maximize safety and minimize environmental impact while allowing the processes to be pushed to their optimal limits." (Abnormal Situation Management® 1992)

A number of research projects have been completed by the consortium. They have recommended to do away with the black background displays and use grey scale backgrounds on screen displays utilising colour only when operator focus is required (e.g. Alarms).

Some industries quickly adopted the new interface with varying success. During a particular study on the effectiveness of the new style the following was found:

"…operators…discovered that problems were solved 40% faster using new operator interface…..The operators using the ASM-style interface out-performed their counterparts."(Errington 2006).

Worsley bought into this concept and set about to find a solution. The first step was to establish a style guide. This describes how the interface displays information, how operators interact with the interface and what behaviours the objects will display.

None of the standard SCADA and DCS systems offered a solution that we needed. We decided to contract a software house to develop a display system to suit our needs.

The most important step in this journey was to focus on Human Factors in the design of the layouts. We used Human Factors specialists to design the top level layouts. The project intended to use knowledgeable operators to design the next level of displays. These operators were trained by the Human Factors specialists in identifying the best way to match display layouts with human strengths.

The display system is set up in four levels. A level one layout displays information of the whole area of an operator's responsibility on a large screen (video wall). This display is always up there. Level two displays show information about facilities within the area on screens on the operator console. Level three (detail information on equipment) and level four (help screens) can be displayed on the operator consoles. Operators mainly use the level two displays to control and normally use level three for specific tasks (e.g. Tank swaps).

Using operators to design the layouts had the good result that displays were built around tasks rather than a P&ID representation. This supports the operator in his work by not having to navigate through multiple screens to complete a single task. This also enhances training of new personnel.

Due to the radical change to the graphics, the change over to the new system was phased to make the operator more comfortable before the old is switched off. This allowed the designers to do comprehensive testing on the live system.

Operators now prefer the new graphics due to the ease of use, less navigation and they find that the system supports them in their daily tasks.

4. Conclusions

The Operator of the Past:

A person sitting behind a desk with a few computer screens in a dimly lit office. The noise of the adjacent process drowns the critical alarm that he misses. He is struggling to get hold of the next unit to allow him to cut flow.

The Operator of the Future:

Working in a purpose built environment a person is sitting behind a console where he can adjust the heights of his work area and chair. He turns up the lights. He senses that the area feeding material to him is struggling with an upset and he starts to change the flow in his area to help minimise the effect of the upset. When all is stable, he is able to stretch his legs, go and make a cup of coffee while he considers an optimisation possibility. The work place is comfortable, inviting and a great place to be.

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