DCS Console Operator Issues in Related Industries

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ABSTRACT

Distributed control systems have become ubiquitous in process control. One of the larger installations of DCS is in the oil and chemical processing industries, with early systems installed over 25 years ago. These industries have discovered that console operator performance can be a major factor in overall plant safety and operability. This paper describes some of the key finding in these industries related to what is needed to maximize operator performance. Research findings from the Center for Operator Performance related to console operator will be detailed.

INTRODUCTION

Distributed control systems have proven to be a major boon for process control companies. In addition to the control advantages of DCS, they can serve as a platform for advanced control and improved flow of process data to other business applications. Without the distance limitation of pneumatic controls, DCS also facilitates the ability to increase the span of control of the operator controlling the process.

With the length of pneumatic tubing and length of the panel board no longer a constraint on how many instruments could be made available to an operator; questions arose as to how to determine the number of console operators required. An early metric was 200 analog outputs (AO) per console operator. While analog outputs is still used as a measure for span of control, most new units see 300 or more AO per console operator, with some operators having over 400. Beville Engineering has determined, from over 2000 hours of observations on different console operators, that the limitation is in the number of alarms and control moves to which the console operator must attend to over a period of time and the degree to which the operator-process system has been designed to enable upsets to be managed.

As this span of control has increased, with board operators controlling more and more equipment, the console operator has proven in many cases to be the limiting factor or key constraint in ensuring safe and efficient plant operation. Numerous examples abound in the oil and chemical industry of the inability of the operator to detect, identify, and/or properly compensate for process disturbances. The result has been off-spec products, unnecessary shutdowns, excessive emissions, and in several tragic cases, the loss of life. As a result, these industries have begun to investigate methods to minimize the potential for “operator error” and maximize operator performance. They follow several other industries in understanding that the human factor must be considered in the operation of advanced technology. The defense industry began to study the role of the human in complex systems during the Second World War when pilots were found to be the limiting factors in aircraft performance. The US nuclear power industry made a similar discovery after the accident at the Three Mile Island nuclear generating station.

The Center for Operator Performance is a collaboration of oil/chemical companies and DCS vendors founded to research methods to create better operators, specifically console operators. All have seen similar problems with console operators, including

- being overwhelmed with alarms,
- graphics that make the job harder rather than easier,
- an explosion of hard to use procedures, and
- high variability in the quality of operator decisions.

As a result, research has been instituted to determine how to address these issues.

ALARM RESEARCH

Alarm floods have been synonymous with distributed control. Sufficient incidents have occurred in the past two decades to result in several documents/standards for alarm management. Targets for alarm actuation rate are provided in these documents, but the targets are acknowledged to be based upon an "analysis of operating experience" and not a systematic study of operators' response to alarms. As a result, Louisiana State University was contracted to study the ability of an operator to handle different alarm rates with different display formats. It was found that operators can handle far higher alarm rates than the targets would indicate and how alarms are presented (arranged by time versus priority) impacted the operator's performance only for high alarm rate conditions.

DISPLAY RESEARCH

In the early days of distributed control, the only decision the display designer had was what eight instruments should be grouped together on a display. Now the world of interface design options has exploded, with thousands of color options and few limitations on what can go on the screen. Despite this, most displays in refineries and chemical plants look like colorful piping and instrumentation drawings. Initial research into color use revealed that color was less of a problem than content, having the right information together on a screen. A subsequent project conducted by Wright State University developed a systematic method to create a hierarchical display structure by asking operators to rank the value of different process parameters for making key decisions.

PROCEDURE RESEARCH

While the use and importance of procedures had been growing in the petrochemical industry over the past few decades, an explosion at BP's Texas City Refinery in 2005 in which poor procedures were identified as a contributing factor has resulted in an even greater emphasis on their use. In refineries, it is not unusual for a single DCS operator to have control of multiple processing units. Since procedures are generally written for each unit, the console operator may be required to simultaneously access multiple procedures in a major utility loss. A means to make the procedures easier to use, as well as easier to manage was desired. Penn State University embarked on a project to facilitate modularization of emergency procedures. Each module (set of tasks) would only need to be updated in one location, and the modules could be recombined to meet the needs of different users. An application was developed to automate the modularization process.

DECISION RESEARCH

Refineries and chemical plants are facing a wave of retirements over the next decade. Speeding the process to create expert console operators is a major objective of most companies. Klein Associates is a leader in decision research and was hired to investigate what constituted an expert operator. Their results defined differences in expertise for different types of processes, but also pointed out the need for operators to practice making decisions. In a follow-on project, Klein adapted scenario-based training exercises, used to improve decision making of combat commanders, for process control operators. These low-cost exercises were tested at several facilities and have proven to not only enhance decision making, but identify gaps in training and procedures.

CONCLUSION

Distributed Control Systems have increased the performance and profitability of oil refineries and chemical plants. Tighter and more advanced control strategies have combined with increasing spans of control to result in fewer operators providing better control of process units. An unintended consequence is that the console operator's job has become more complex and critical to the safe operation of the plants. The Center for Operator Performance (www.operatorperformance.org) was founded by oil and chemical plant companies in partnership with DCS manufacturers to research easy ways to enhance console operation. Research to date has investigated the impact of alarm rate and presentation, developed methods to determine display content and modularize procedures, and adapted military training exercises to improve console operator decision making.