The control room levels up

A convergence of technologies and a better understanding of human factors is driving a new generation of control room workstations.

According to industry analysts, 70% of process disruption incidents in the oil and gas industry can be attributed to human error, which also accounts for 90% of the associated financial loss. But don't be tempted to blame the operator. The research also makes it clear that most major incidents are the result of a combination of factors, many of which are systemic in nature.

Now, a new generation of control systems, designed with human factors at the fore, is being adopted by the industry. The following sections put this trend in context to explore how the control system interface and the physical environment of the workstation itself can make O&G operations safer and more productive.

Operators and their roles are changing

Like many industrial sectors, the oil and gas industry is experiencing a graying of its workforce. This is as visible in the control room as it is on the drilling rig or plant floor. At the same time, the role of the control system operator is changing, expanding in breadth but shrinking in depth as operators increasingly rely on automated systems to handle low-level operational tasks while they take on supervision of more parts of the process.

Collaborative technologies like remote monitoring and video conferencing play a supporting role, making it possible for operators to draw on experts in other locations for questions. The result is that control room operators are working more pro-actively, at a higher level across a wider range of processes. Productivity thus increases, but one downside of this shift is that operators have less opportunity to develop an intimate knowledge of the processes they are responsible for. Building that knowledge has now become something that O&G businesses must do deliberately, for example by involving operators in process optimization.

Shell's Nyhamna gas processing facility, for example, has two simulators that replicate the process control and safety systems at the site. These are used for operator training, engineering and testing. Every single change to the automation system is first tested in a simulator before its implementation is approved by

an ABB technical account manager and Shell, thus minimizing the risk of error. The simulators played a major role in enabling the Nyhamna facility to start production ahead of schedule.

The number of control rooms is decreasing, not only in O&G but in other process industries and manufacturing as well. The availability of cheap sensors and the analytics to leverage the data they generate has allowed firms to reduce cost at the same time they improve productivity and avoid downtime. Where previously we might have seen standalone plants with dedicated control rooms, now we find integrated mega-plants with intricate interdependencies, all controlled and optimized in real time from a single facility.

—

Where previously we might have seen standalone plants with dedicated control rooms, now we find integrated mega-plants with intricate interdependencies, all controlled and optimized in real time from a single facility.

So, while the processes get ever more efficient and the control systems more sophisticated, the control operator finds him- or herself more and more removed from the ground level of the operation. This can create the potential for mistakes with far-reaching consequences.

Understanding "human error" and "human factors"

The term "human error" is a bit of a misnomer because it hides the true scope of the problem. Writing in the Journal of Safety Engineering in 2006, University of Southern California professor Najmedin Meshkati summarizes the issue as follows:

"As research has shown, in most cases, operator error is an attribute of the whole technological (plant) system.... The most important lesson to be learned from past accidents is that the principal cause tends to be neither the isolated malfunctioning of a major component nor a single gross blunder, but the unanticipated and largely unforeseeable concatenation of several small failures, both engineered and human.... [Human] error and the resulting accidents are, to a large extent, both the attribute and the effect of a multitude of factors such as poor workstation and workplace designs...."

Meshkati goes on to cite numerous other potential contributors to process disruption. It's important to understand, then, that human factors—and specifically the design of control systems and control rooms—are part of a larger system of inter-related factors all having an influence on process continuity.

Safety engineering expert Nancy Leveson, MIT professor and consultant on both the Columbia Accident Investigation Board and the Presidential Oil Spill Commission, highlighted another important distinction when discussing human error during her 2011 testimony before the US Senate Committee on Energy and Natural Resources:

"Occupational safety focuses on controlling injuries to employees at work by changing individual behavior. System safety puts an emphasis on designing the system, including the engineered and operational components, to prevent hazardous system states and thus losses. Confusion between these two very different problems and solutions can lead to overemphasis on only one type of safety, usually occupational or personal safety, while thinking that the other types of accidents or losses will also be prevented—which they will not."

So, when we consider operator effectiveness, it's important to keep in mind what we're really talking about. People are the most important component in a highly complex system made up of many other components and subsystems, and their "operating constraints" must be accommodated within the control environment in order to ensure safe, reliable and effective operations.

—

People are the most important component in a highly complex system made up of many other components and subsystems

Designing for people

The UK Health and Safety Executive (HSE) provided a useful framework for considering human factors in control system design in a 1999 paper entitled "Reducing error and influencing behavior." The agency split the problem into "physical match" and "mental match" components, the former referring to the operator's immediate physical surroundings and the latter to "the individual's information and decision-making requirements, as well as their perception of the tasks and risks." A mismatch on either dimension, the authors write, is a recipe for error.

The HSE model takes into consideration a wide range of aspects of the psychosocial working environment such as collaboration, emotional engagement, creativity, learning and social presence. In a design context, these map to usability goals such as safety, satisfaction, entertainment, helpfulness and motivation that are also tightly connected to the psychosocial and physical working environment. The objective is to optimize both physical and psychological factors to create not only a user interface but a complete working environment that supports the operator's performance on every level.

One example of this in practice is to involve control room operators in the layout of the control room itself. HSE suggests attributes include:

- Dedicated operations space that is free from distractions and a separate area for visitors
- Dedicated collaboration space for meetings and group troubleshooting, with A/V tied to control center visualization
- A relaxation area nearby to help operators not actively engaged in operational duties to recharge without distracting on duty personnel

These are good basic guidelines. The heart of any control room, though, is the operator workstation and that is where decades of research are being applied most visibly.

The effective operator's workplace
In applying the recommendations of researchers like those quoted above, control system suppliers have redefined what a "workstation" is. To begin with the user interface itself, the main guiding principle should be simplify, simplify, simplify. It is no longer necessary for multiple systems to be monitored via their own screen and keyboard. Instead, PLCs, DCS, safety, electrical, ERP and other systems should all be readily accessible from a single interface.

Integrating systems in this way yields a number of benefits. Combining control, safety, power and training systems, for example, allows common failure modes to be designed out before the control system is even released to the user.

The supplier can also ensure that there is consistency between applications in terms of look and feel so that operators can move seamlessly between them. Consolidated communications from different applications also increase efficiency and the likelihood that alarms will be met appropriately regardless of what subsystem initiates them.

The modern operator workstation considers every aspect of the user experience:

- **Ergonomics.** Desk height, monitor angle, screen distance, operator posture—all of these things should be customizable. It's also now possible to alter some elements dynamically, for example by varying monitor distance imperceptibly over time in order to reduce eye strain. Personalized settings can also "follow" the operator from one workstation to another.
- **Lighting.** Fluorescent lights have given way to dimmable, adjustable lighting that is always centered over the work area with no reflection from monitors. Modern workstations can even be configured to change color temperature over the course of the day to stay in sync with the operator's circadian rhythms.
- **Sound.** In larger control rooms with more staff present, sound can become an issue. The use of "sound showers" that direct alarms and other system communications to the operator and minimize noise at other locations help keep operators on task.
- **Video.** Improvements in communications and monitor resolution have made face-to-face communication with remote colleagues easy. This is increasingly important as operators collaborate more with off-site experts.
- **Gamification.** This is currently a buzzword, but it is important not only with regard to attracting younger workers to the industry, but in motivating and engaging operators to optimize their processes and increase their awareness of personal health and well-being.

—

The modern operator workstation considers every aspect of the user experience

All of this functionality is packaged into a movable unit that is easy to set up, which delivers cost savings in both brownfield and greenfield projects.

Looking ahead to the collaborative control room
Given the trend toward fewer control operators working in fewer control rooms, it's simply unrealistic to expect even the most seasoned operator to know everything. He or she must rely on others for help, so collaboration, both within the control room and between locations, is likely to increase going forward. The control system must not just support it, but encourage it.

Industry research provides some compelling reasons as to why. ARC Advisory Group, for example, finds that collaborative control systems reduce downtime (40% - 50%), improve energy utilization (15-20%), increase asset utilization (10%) and increase personnel productivity (10%) compared to legacy systems.

With decades of workplace research and a bette understanding of human needs at their disposal, O&G players are better equipped than they have ever been to create control environments that set operators up for success. Given where the industry and the control room itself are headed, this will only become more important in the future.

—