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 DESIGNED FOR SAFETY

# Human factors and their impact on plant safety

Operators in modern plants are tasked with numerous activities, making it difficult for them to handle abnormal process conditions. Research has demonstrated how an intelligent and ergonomic workspace can both mitigate risk and increase productivity.

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The introduction of mission-critical computing systems and automated tasks in manufacturing processes has resulted in increased safety and productivity during normal operation. But what happens when abnormal situations arise? The answer is, of course, that a human must step in →1.

## Human factors and safety culture

The human factor need to be at the center of any safety discussion for many reasons, one of which is that human error is often the cause of incidents

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and accidents in the first place – despite the strict safety culture prevalent in most firms. The consequences of such incidents range from minor injury to headline-making catastrophe. If an organization wants to ensure a successful safety culture, it must have a clear and explicit risk management strategy.

## Understanding and managing risk

To understand and manage risk, plant operators should first carry out a hazard and risk assessment to identify the overall safety requirements. After that, they should focus on proactive measures to ensure, if possible, that a failure does not occur and that negative consequences are minimized if one does. Learning from experience can be an ideal starting point:

- What should be done differently after a certain experience to prevent reoccurrence?
- What can be done to learn more from this experience?
- What should be done differently after a reoccurrence of this experience?

It is important that, rather than be a chore, the company safety culture should provide an opportunity for individuals and organizations to learn from and be motivated by positive change. Employees can thus aspire to a safer and more productive way of working →2.

## Technology as part of the solution

Anticipating failure, engineering best practice allocates risk reduction across different and independent protection layers in the form of multiple independent functions or systems. One such system is a safety instrumented system (SIS), which is based on a concept involving different layers of protection.





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— 01 Ultimately, human operators must step in to rectify many abnormal situations.

— 02 Safety and productivity should be part of company culture.

### Layers of protection

A process control system provides a “layer” that not only assists in the productivity of the process but also helps plant operators keep the process within safe operational boundaries. Today, most process control systems will alert the operator to abnormal conditions and support him by providing real-time access to critical information.

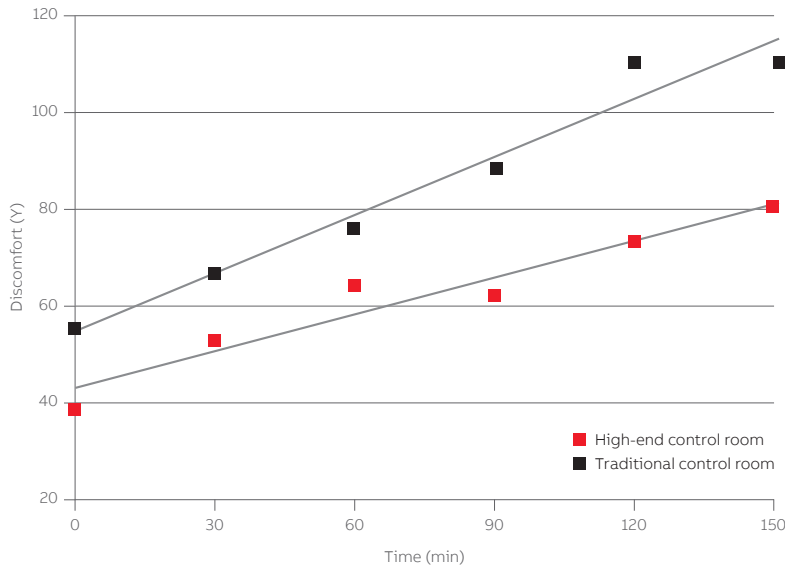
When events develop too rapidly for effective operator intervention, other protection layers, such as an automatic SIS, spring into action to return process conditions to normal.

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Design-for-safety is supported by a series of standards – such as IEC 61508 and IEC 61511 – that aim to establish, and in some cases mandate, the best practices for design, documentation reviews, validation and verification of a safety project.



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If any of these layers (technology or human) fail to prevent the hazard, there are other layers intended to mitigate consequences, such as fire and gas systems or emergency response procedures, which are not discussed here.

However, the reality is that all these technologies are designed and implemented by human beings and, as a result, will not be perfect or 100 percent safe.

**Integration of control and safety systems delivers consistency for the operator**

Integrated control and safety systems provide the enabling technology to drive effective operations and minimize some of the sources of human error. Some benefits of this approach are:

- Common failure modes can be designed out before the product is released.
- The standard product can be made secure to prevent unauthorized access to critical facilities.
- Integrated testing occurs in the product test lab and can be carried out by experts with in-depth domain knowledge of the multiple technologies involved.

**Human-centered design**

Various sources indicate that around 70 percent of reported incidents in the oil and gas industry worldwide are attributable to human error and account for over 90 percent of the financial loss to the industry. This human error challenge can be addressed by matching the control room operator’s psycho-social working environment (WE) with his physical WE. This type of human factor engineering and the use of ergonomic solutions can reduce financial losses.

— Human error can be addressed by matching the control room operator’s psycho-social working environment with his physical working environment.

Designing a control room or control center working environment for humans is challenging yet fundamental. One of the most important quests to reduce human error by matching physical and psycho-social elements in the design. The UK Health and Safety Executive (HSE) formulates the problem thus, “physical match includes the design of the whole workplace and working environment. Mental match involves the individual’s information and decision-making requirements, as well as their perception of the tasks and risks. Mismatches between job requirements and people’s capabilities provide the potential for human error [1].”

— 03 Perceived discomfort in the traditional control room and the high-end control room.

— 04 The flexibility of the Extended Operator Workplace allows a human-centric approach and thus increases efficiency.

There are plenty of guidelines and standards that tackle the design process of a control center or control room – the offshore industry has established ISO 11064 as the main standard worldwide, for example.

— **Health-improvement awareness among operators is one of the main factors driving ABB to develop solutions for the early recognition of adverse stress levels and deteriorating health.**

#### **Developing the control center and control room working environment**

Despite the prevalence and cost of human error, control center and control room design has tended to focus on physical aspects and the process itself, to the detriment of the human angle. Further, with the increasing trend for operators to move from local control rooms to control centers, comes a higher operator workload and attendant increased stress level. Increased stress can lead to depression, anxiety and burnout.

Poor ergonomics, poor lighting and high noise levels that directly cause physical ill health can exacerbate this fundamentally bad situation.

The alignment of psycho-social and physical elements automatically improve health and wellbeing in the control room or center. Organizations should develop stress management and counseling policies to identify and eradicate work practices that cause the most job dissatisfaction. Of course, humans differ very much in cognitive processes and ability to solve problems – for instance, some operators can be skilled in multitasking, some in understanding the complexity of a workload, others in data analysis and yet others in effective leadership. Nevertheless, there is one main value they share: health. Health-improvement awareness among operators is one of the main factors driving ABB to develop further solutions for the early recognition of adverse stress levels and early warnings of deteriorating health status.

Human-centered design is made all the more imperative by the demographic pressure exerted by an aging workforce in the northern hemisphere. To prevent knowledge being lost, young people must be attracted to a career in the industrial world. This can only be done by offering them a workplace in which they are content.







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05 A Best-in-class control room environment reduces the chance of human error.

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**Reference**  
[1] “Reducing error and influencing behavior,” Health and Safety Executive, 1999. Available: <http://www.hse.gov.uk/pubns/priced/hsg48.pdf>

### A holistic approach

Improving only the physical part or the psycho-social part of the control room environment is not a holistic approach – both aspects must be improved in a mutually compatible way. This effect was illustrated by research conducted by ABB and Chalmers University, Sweden in which a traditional control room was compared with a high-end control room. The perceived discomfort increased over time in both, but the increase was lower in the high-end control room. Thus, a more holistic physical and psycho-social environment was provided →3.

### Ways to increase efficiency

One way to influence performance is through varying lighting levels – a high level of illumination increases motivation and reduces errors and accidents. Lighting also has a direct impact on health and well-being since the human circadian rhythm is directly related to ambient light levels. ABB has cooperated with Lund University and others to provide a human-centered lighting platform for operators in a control room. One application of the research so far has been to allow the operator to freely adjust their task area lighting by using cold or warm light →4. The range of illuminance is between 900 to 1800 lux, which exceeds the minimum 500 lux recommended by ISO 11064.

Another way to increase operator efficiency is to simplify the variety of communications possibilities (an operator does not become more efficient by using many different communication tools at the same time.) Instead of a clutter of equipment for VHF/UHF radio, telephony, cell phone, intercom, public address system, etc., all communication can be moved to just one device.

Finally, controlling noise levels by working with directed sound is another way to improve the operator’s workplace experience. Sound showers are especially beneficial as they allow telecommunication, alarms, etc. to take place without disturbing others.

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### Putting people first

Planning for human error is a critical part of control room design. Designers of systems have to be very careful as they can induce human error if they have not identified all operational eventualities and provided a suitable control process or system response to them. These latent failures can lurk unseen until a specific operational constellation appears and an incident occurs. In such situations, the operator is often unprepared and unable to respond appropriately.

As industries continue to invest in new facilities or modernize existing ones, they could profit from directing some of the investments toward reducing the propensity for human error. This can be done by the adoption of human-centered design best practices →5. Consideration of the human elements of the control room will lead to additional benefits and a safer and more productive environment. “Putting people first” is a sound business strategy. ●