Operator Performance – A Holistic View

A highly performant operator is essential to safe and effective plant operations. This whitepaper provides an overview of the essential elements of operator performance and Emerson's approach to addressing them in an effective, consistent and coordinated manner.

Build an effective operator performance program that optimizes people, assets, safety and profitability.

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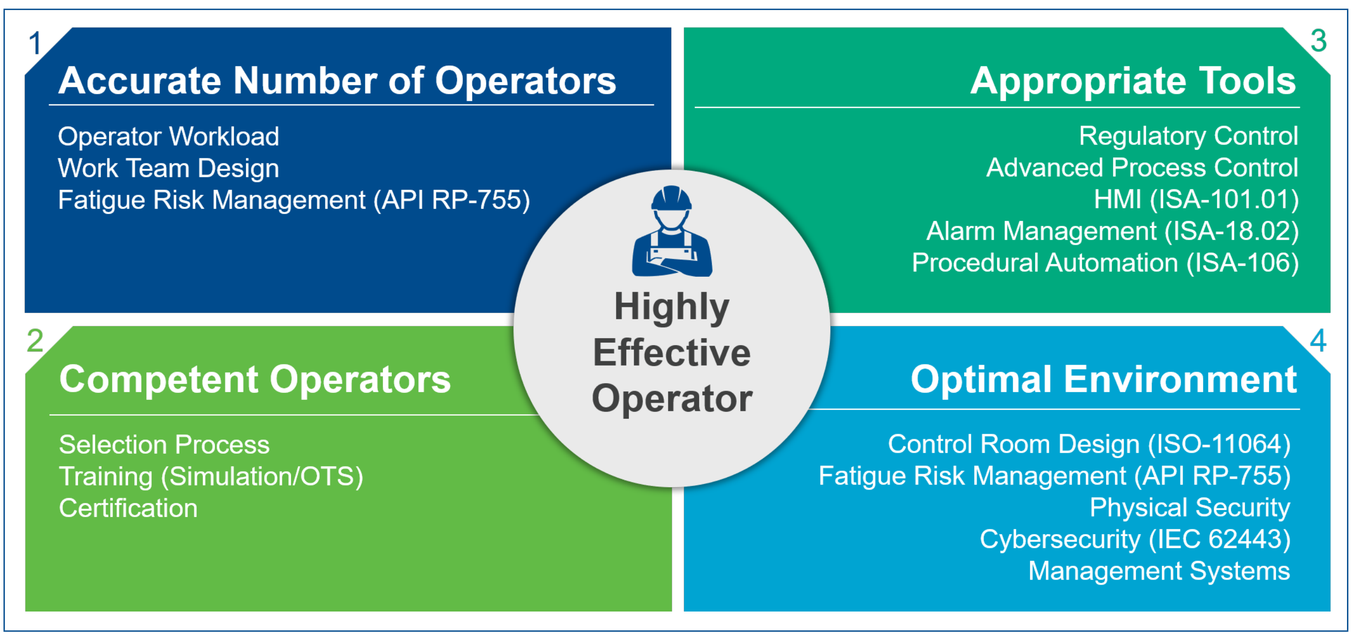
Introduction

This document describes an approach to ensure that control room operators are able to perform at their highest level, allowing them to move from a typical reactive operating stance to a proactive one, and ultimately a performance optimizing one.

Why is this important? As mentioned above it is typical for today's control room operators to react to abnormal operations, rather than anticipating process deviations and preventing these abnormal conditions. This is important as these abnormal conditions by definition are undesirable and consequently have a cost associated with them such as:

- Loss of production throughput.
- Loss of quality – possibly leading to off-spec material that is lost or must be reworked.
- Potential environmental excursions.
- Reliability – the abnormal condition often puts equipment under stress leading to short term failure or long-term wear and reduced lifespan.
- Potential safety incidents – at a minimum ultimately exercises and relies on a safety system to mitigate risk.
  Emerson's holistic approach to this is to address the four pillars of Operator Performance by ensuring:
  - There are the correct number of people to do the work.
  - These people are competent to do the work.
  - They have the appropriate tools to do the work.
  - They have the optimal environment in which to perform the work.



4 Pillars of Operator Performance

A failure to address any one of these pillars will either lead to project failure or, even worse, expose the plant to unnecessary operating risk. To illustrate this below are a couple of real-life examples:

- A plant invests a significant amount in building a brand-new state of the art control room, but they don't account for operator workload where some operators are overwhelmed with their span of control, whilst others are very lightly loaded. On average the workload is perhaps manageable with the number of operators and reassignment may fix the issue, but if the number is wrong and additional operators are needed, then there may not be space for additional consoles.
- A plant implements an alarm rationalization project and HMI redesign as part of a control system upgrade. However, they did not consider who would be running the console. As is often the case today, experienced operators are retiring, and less experienced operators are being fast tracked through their position progression through field positions onto the console. Under normal operating conditions, on the job training prepares them for their job, however, when things start to deviate, they are often unprepared or unable to respond appropriately, even though they have all the information they need.
- A plant invests heavily in training and a state of the art, best practice control system, but they do not bring the control room design along with those best practices, leaving the operators in a noisy, dark, fatigue inducing environment. At 3am, the operator is sits there with his eyes open but drifting off, and he misses the process starting to go out of control, or worse misses an important alarm.

This document expands on these pillars and how Emerson ensures that each is adequately addressed in projects ranging from large greenfield ones to smaller brownfield upgrades.

Accurate Number of Operators

It is fundamental that the correct deployment of resources is considered, ensuring, not only that there are the right number of people to be able to execute the work under all operating conditions (normal, abnormal and emergency), but also that the workload is correctly balanced across the various positions.

Traditionally, there have been different ways people have tried to do this, from simple management best judgement, through time and motion studies to simple loop counts. However, each of these has inherent weaknesses that result in flawed workload determination. Obviously, the first one has no sound basis for assessing workload other than historical performance and tribal knowledge and has no way of determining the impact of changes to the operators span of control, for example adding a new process unit. Time and motion studies are challenged by a position that does not have sequential discrete tasks. It is obviously possible to count number of operator moves, or graphic changes, but a well-trained operator may be constantly changing graphics, especially if he does not have a best practice HMI design, to ascertain the state of the plant, even when the process is stable. The loop count method is also inherently flawed in that it does not consider the type of loop. For example, a slow acting level control on an effluent tank cannot be compared to a fast-acting feed control loop on a highly reactive system, however, some have used the rule of thumb of 250 – 400 loops as a good target.

Emerson can provide a more robust and accurate assessment of workload through the use of a workload model that takes into account the complexity of the process under control, the complexity and performance of the control system and process interactions. Once developed, to determine current or base case workload, the model can be used to predict workload for other staffing alignments or for changes to the process. The model can be used for brownfield projects, but also for greenfield projects using design information such as P&IDs and process and control narratives. Designed for workload under normal operating conditions, the model can be also be adjusted to consider workload under abnormal and emergency conditions.

It is also important to consider the design of the entire work team. There are key interrelationships with, for example, field operators, supervision, management and maintenance that can impact workload. A good example of this is work permitting, where best practice is for field operators to perform this function, but it is still common to find console operators performing this duty, which has a significant impact on workload, especially on heavy maintenance days.

An additional, often overlooked, factor that impacts workload is operator fatigue. The capacity of an operator to perform his duties whilst fatigued is diminished and effectively increases actual workload. Based on a recommendation from the BP Texas City Baker Report, guidance, in the form of API RP-755 was published. This recommended practice provides guidance on, among other things, hours of service and shift work patterns. Other factors, such as fatigue, countermeasures in control room design are discussed below.

Competent Operators

There are two main elements of operator competency that should be considered. The first is the selection of operators that have the necessary inherent abilities to allow them, with the correct training to be competent, in the performance of their duties. This is true for both new hires into a company and for position progression. Traditional seniority-based progression seldom considers the underlying abilities of operators to be able to transition to a control room operator position, from a field position. The best field operators, who have the hands-on skills required to work on physical equipment, may not have the same propensity for a job that requires sitting at a computer for extended periods of time. Moving them to the control room position may not be good for the individual nor for the plant. Unfortunately, this often goes unnoticed until there is an incident where the operator does not perform well under pressure. There is often also a boredom factor for someone that enjoys the hands-on work where they are kept busy. The second element is training, both initial and continuing to become, or maintain, certified for a position. Traditional book based and on the job training, is effective, if the program is well constructed, but often focuses on normal operations, and reactive response to abnormal situations.

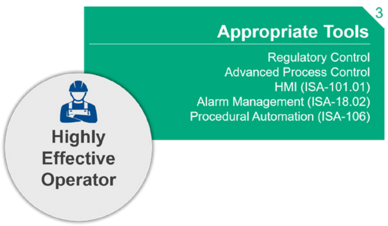
For the selection element, there are many tools to help the hiring team determine a candidate's competency to do the job and is often left for HR departments to administer. For operators, it is important to understand where their potential lies, and not just their current abilities. Knowing that a particular operator is not suited as a board operator but would make a tremendous field operator, and vis versa, enables customized training and progression planning to be optimized to ensure a good fit for the individual and the plant. Testing for operators who may become control room operators in the future should include hands on evaluation that can be facilitated by a good process simulator, such as those discussed below.

Initial and continuous training is a fundamental requirement for all operators, if they are to perform at the highest level. Emerson offers a full range of operator training through its educational services group and this is a great way to supplement initial training, especially when migrating control systems. This training can also be customized to be part of a plant's training certification program. However, best in class training programs, include the use of a Digital Twin (or dynamic process simulator) to allow the operator to get risk free, hands on training and practice, before going live and to have an offline tool where they can practice scenarios and drills as part of refresher training or test plant changes as part of the management of change process. With the advance of technology and software tools, it is now possible to model the process under control to a very high level of fidelity to the point where we can engineer a digital twin that can be used for operator training as well as testing, commissioning, startup and other engineering activities. The key to the successful deployment of such as a simulator depends on a couple of key factors:

- **The location of the simulator** – the more convenient it is to the operators, the more likely it is to be used by them, placing it in a training center somewhere remote from the control room reduces its effectiveness and use. Virtual On-premise and cloud hosted simulators provide ultimate flexibility in operator training by allowing operator training on the Digital Twin in multiple locations with only the investment in a thin client.
- **Maintenance of the simulation** – a simulator is a significant investment, and many fall out of use because they are not maintained. This can become a significant role for someone on site, so it is highly recommended that maintenance of the simulator is an assigned responsibility to an individual. Virtual On-premise and cloud hosted simulators also help reduce simulator updates and maintenance and allow global experts access to the simulator quickly for resolving issues.

- **Cost** – while the decision of simulator investments often focus on initial procurements costs, life cycle costs considerations are more critical to keep the simulator relevant and useful for the life of the plant. Digital Twin, operator training systems that use virtual on-premise and cloud hosted architectures provide the greatest opportunity to control lifecycle costs while providing the greatest long-term operational benefits.

Appropriate Tools



Under normal circumstances, the control system should control the process to desired process conditions and, typically the safety system, acts to prevent process excursions that could lead to a safety incident, such as a release of hazardous materials or a catastrophic event such as the rupture of a vessel. Between these two limits of operation, the control room, as part of the control loop, is required to act to prevent the situation escalating and bring the process back under control. Often, this is a critical period during which the operator must act quickly, decisively and accurately. This is where the tools provided must be robust, reliable, accurate, and support optimal situation awareness, i.e. to support the operator in detecting, diagnosing and responding to an event. There are two main tools that the operator must rely on:

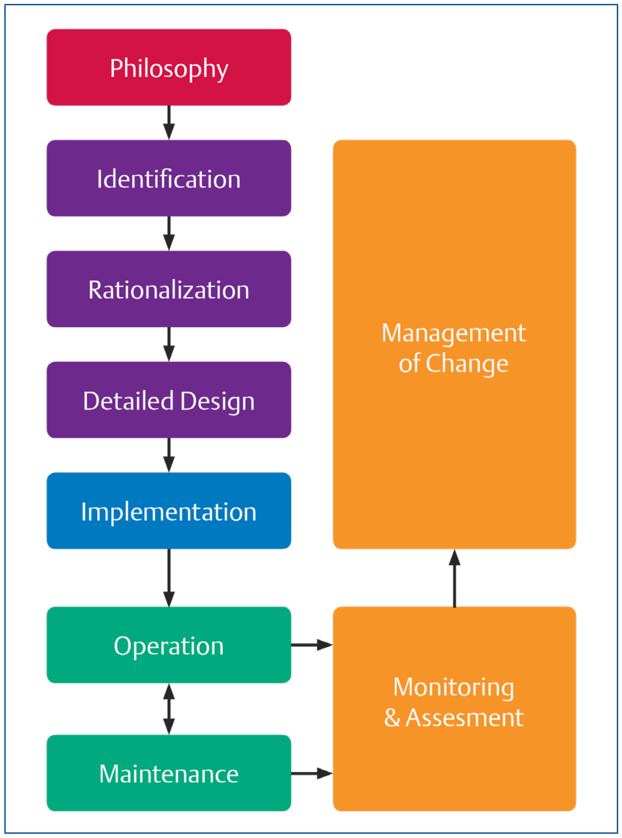
- Alarm Management System (both software and hardwired)
- Human Machine Interface

These will be discussed in more detail below.

There are also tools that can have a significant impact on process control, operator workload and safety, such as advanced process control, batch control and procedure automation. The application of advanced process control can yield tremendous benefits by applying a coordinated control layer that sits above the regulatory controls to ensure that process conditions that are highly dependent on each other are controlled to a common goal or goals. For example, rather than individually controlling all the flows, temperatures and pressure on a crude column, the total product flow and quality could be controlled by an APC strategy that manipulates all those process variables in a single controller. Emerson can provide a full set of software solutions from built in DeltaV Predict and Predict Pro function blocks to full blown APC solutions, along with the consulting services to identify, build and configure strategies.

Similarly, the application of batch control or procedural automation, can have a significant impact on operator workload and improved abnormal situation response. There is good guidance for the implementation of these in the ISA-88 set of standards and the ISA-106 technical reports. In both cases, critical decisions are taken out of the hands of the operator enabling systems to 'take care of themselves'. For example, with full batch operation the operator does not have to change equipment states, process conditions, or even alarm settings, as a batch progresses from one step or phase to the next. If things go wrong, a good batch automation implementation should define exception handling logic that will bring the process to a safe state without intervention from the operator. Similarly, with procedural automation discrete operating modes can be transitioned between automatically with little of no input from the operator. This is extremely useful in complex startups, shutdowns and grade changes. As with batch automation, good procedural automation has built in exception handling to bring the process to a safe state when needed. Support for these techniques is fully integrated into DeltaV and Emerson provides a full range of services from identifying opportunities to effectively apply these techniques, build and then configure the strategies.

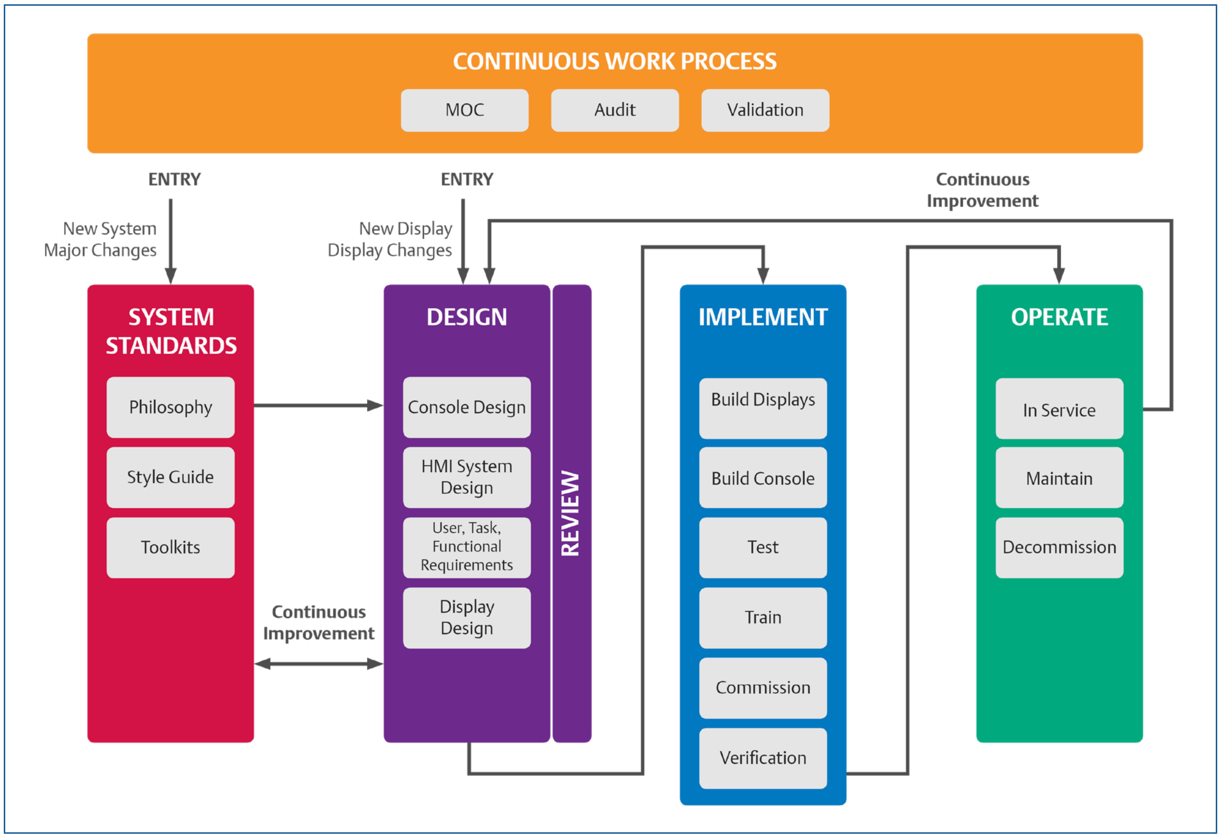
Alarm Management



Alarm Management Lifecycle Model

Much effort has been expended over the last 10-15 years to ensure the alarm management system provides the operator with timely, actionable warnings that indicate the onset of an abnormal situation. This is often referred to as situation awareness. Current best practice is captured in ANSI/ISA-18.2 (and complementary international standard IEC 62682) and Emerson provides a set of tools and services to help clients configure their systems to meet this standard. Standard alarm tools are provided natively to Emerson's DeltaV platform and an extended tool set through the AgileOps™ application. Typically, alarm system design using traditional rationalization techniques have resulted in a significant reduction in normal alarm rates, however, these techniques often result in no reduction in the magnitude of alarm flood events, leading to clients having to reinvest in applying advanced alarm management techniques such as suppression by design, e.g. dynamic, state-based alarm suppression. Emerson's rationalization process considers dynamic alarm design from the beginning, ensuring that the end result is a rationalized system that addresses both normal and flood alarm rates. The integrated AgileOps software is built with this in mind and seamlessly manages dynamic alarm suppression and shelving. With the native DeltaV functionality, AgileOps alarm management software (Master Control System Database, EventKPI, Dynamic Alarm Management and List Management) and complementary services such as training, standards development, gap assessments and rationalization, Emerson can provide solutions for all steps in the ANSI/ISA-18.2 lifecycle model.

Human Machine Interface

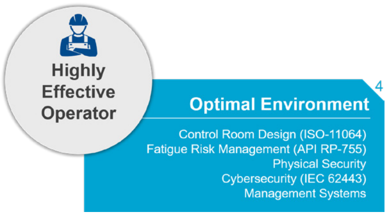


HMI Lifecycle Model

The other essential element in providing the operator with situation awareness is the human machine interface (HMI). An alarm management system that meets best practice is next to useless if the alarms are not presented to the operator in a manner that helps them detect the alarm, diagnose what that alarm is telling them and then have the appropriate tools, such as alarm help, to aid in their response. However, alarm presentation is just one aspect of HMI design and supports a reactive operating stance. The HMI must go further to enable the operator to be proactive or optimizing. Best practice on HMI design is captured in ANSI/ISA-101.01 and its associated technical reports, currently under development.

Emerson provides two HMI platforms with DeltaV Operate and DeltaV Live. Through the use of the available Emerson's human centered design object libraries, each can be configured to meet the principles of best practice design. However, the library and the HMI environment itself does not ensure compliance, they just provide the canvas and the tools with which to start. This is where the expertise of Emerson's consultants and the client's process knowledge combine to create graphics that support operator situation awareness. Regardless of control system platform, Emerson offers a full range of services to support the client in this area including training, standards development, gap assessments, task analysis and complete engineering solutions.

Optimal Environment



The final pillar that must be considered is the environment in which the operator has to perform. It is easy to think of this as just the physical environment, but there is a work process environment that also must be considered, both are equally as important.

Physical Environment

The physical environment in which an operator has to work has a significant impact on their performance. Many control rooms in use today have evolved to their current state with little thought to purposeful design, whereas others were built constrained by space or technology. As such, there are many control rooms that have operators located in rooms that are noisy, cramped and dark at consoles that do not consider ergonomics or human limitations. Furthermore, the provision and location of essential facilities, such as restrooms and breakrooms, has not been a considered. There are other aspects to the control room design such as a design that supports the other tools of situation awareness including alarm management and HMI design. For example, a noisy control room with multiple consoles may make it difficult to hear an alarm and identify to which console it belongs. Similarly, in a dark control room, the use of light graphic backgrounds will not work.

Guidance for best practice in control room design can be found in the 7-part international standard ISO-11064. As mentioned above the environment is also a key factor relating to operator fatigue and API RP-755 provides guidance on fatigue countermeasures that should be considered in the design of any control space.

Emerson offers a full range of services to support the client in this area including training, standards development, gap assessments, task analysis, conceptual design and complete engineering solutions. In addition, Emerson can provide the technology to support a fully integrated operations environment, including standard workstations.

Work Process Environment

As in important as the physical environment is the work process environment usually defined in policies and procedures (management systems) and heavily influenced by company culture. This has often been referred to as Operational Excellence (OpEx) and has an impact far beyond that on the console operator. Changes to the culture of a company can be very difficult to influence, however, other important management systems that can be influenced include training and management of change.

Emerson’s many years of operational experience, coupled with a deep knowledge of current best practices, allows us to provide a full range of consultancy services to guide and help our clients navigate changes to this environment.

References

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