

3D Virtual Reality Workforce Enablement Technologies for Safer Oil & Gas Operations

by Charles Mohrmann

Executive summary

Oil & gas production plant operators increasingly lack the tools and “know-how” that enable them to make good decisions quickly when incidents occur. Operator error is the main cause (42%) of unscheduled plant shutdowns. This paper discusses 3D virtual reality training and other Workforce Enablement technologies that can improve real-time operational support and workflow management to allow overwhelmed and inexperienced personnel to make better decisions faster.

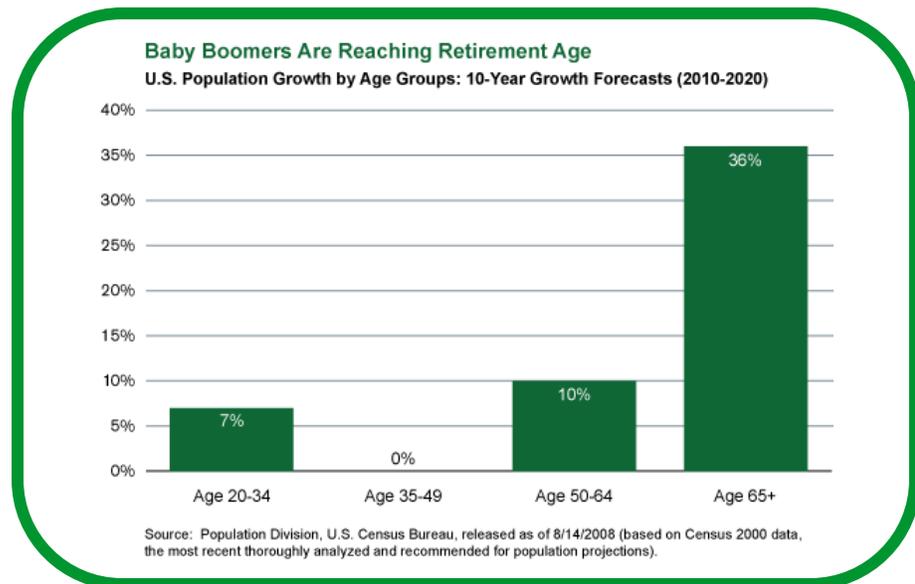
Introduction

Oil & gas production companies today are caught in an operational “crossfire” between an experienced workforce that is rapidly retiring and an increasingly complex process automation environment. Fortunately, new-generation Workforce Enablement tools can improve training, real-time operational support, and workflow management to allow overwhelmed and inexperienced personnel to **make better decisions faster**.

The most experienced and seasoned process operators of the baby boomer generation (those born between 1946 and 1964) are steadily reaching retirement age. The Pew Research Center projects that in the United States alone, 10,000 baby boomers will retire every day from now until 2030.¹ Under today’s economic realities of workforce reductions and shrinking budgets, companies must assimilate newer but fewer operators to handle greater workloads.

Figure 1

On average, today’s most experienced workers will retire at an average rate of 10,000 per day in the USA alone.



The ARC Advisory Group has reported that this downward trend in staffing and the increased demand for accurate, real-time information will translate into the deployment of additional operational systems and higher, more sophisticated levels of automation.²

But more is already demanded of oil & gas production plant operators than ever before. Today’s larger, more complex control systems — with greater volumes of data, increased levels of automation, and expanded use of remote operations — have broadened the scope of responsibility for individual operators. This is further exacerbated by a deluge of new regulatory requirements to address greater environmental, health, and safety concerns.

To solve the paradox of a smaller number of less-seasoned workers operating a larger number of more-sophisticated automation processes, the ARC Advisory Group states that “the smaller, less experienced workforce that will exist in future must be empowered with new technologies and workflows that can transfer knowledge on demand.”³ This paper discusses Workforce Enablement technologies that cost-effectively facilitate this transfer of knowledge so plant operators are able to **make better decisions faster**.

¹ Pew Research Center, “Baby Boomers Retire,” December 29, 2010.

² ARC Advisory Group, “Yokogawa’s Modular Procedural Automation is a Knowledge Preservation Tool for the Process Industries,” January 2010.

³ .Ibid.

Closing the knowledge gap

Too often operators lack the tools and “know-how” that enable them to make good decisions quickly when incidents occur. According to an ARC Advisory Group study, 42% of unscheduled plant shutdowns in process industries are due to operator error (see **Figure 2**).⁴ Further, the average cost per major incident related to operator error exceeds \$80 million (US).⁵

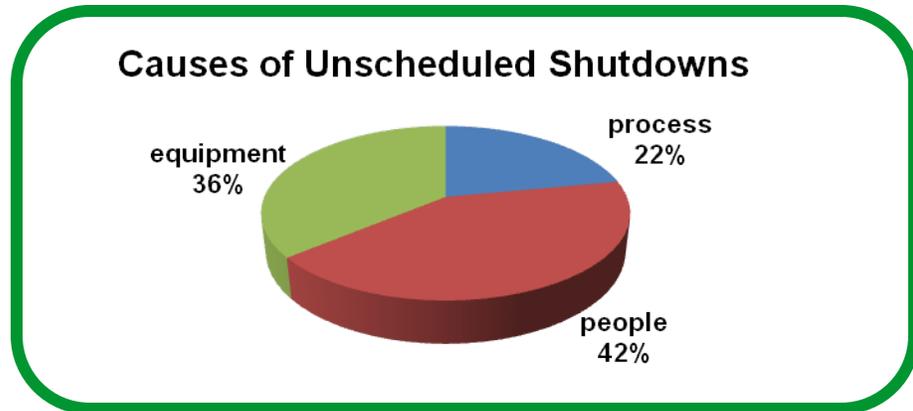
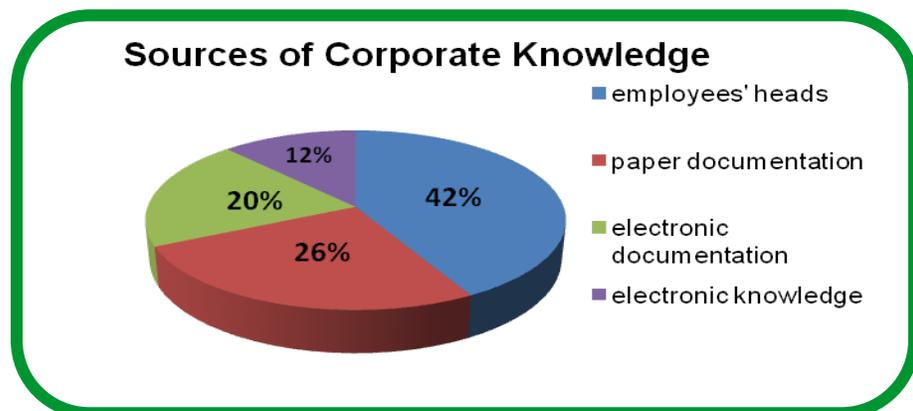


Figure 2
Operator error is the leading cause of unscheduled plant shutdowns.

Most operator errors involve some sort of procedural element.⁶ Sometimes no standard operating procedures are defined for personnel to follow — or the procedures are irrelevant because they have not been updated to reflect the complexity of modern systems. More common, however, is that operators have not adhered to the proper procedures. Newer operators usually have not received adequate training for managing emergency situations. Proper documentation may exist but is difficult to access quickly. Veteran operators may well have the experience to proactively prevent upset conditions from escalating into a full-blown incident, but inexperienced operators lack this level of sufficient situational awareness.

It is crucial that companies transfer knowledge possessed by older workers and properly train new workers. Most critical operational information is actually held by in (older) employees’ heads as personal memory (tacit, or “tribal,” knowledge). See **Figure 3**. According to the ARC Advisory Group, up to 75% of this knowledge — and a higher percentage of operational judgment — will be leaving companies within the next 10 years.⁷ Closing this knowledge gap — so that operations personnel at all levels know how to respond properly and quickly under any given situation — is the one single goal of a Workforce Enablement program

Figure 3
Most critical operational information resides in people’s heads.



⁴ Larry O'Brien, “Why We Need a Better Approach to Procedural Automation,” ARC Advisory Group, September 2010.

⁵ J & H March & McLennan, inc., as cited in ARC report “Why We Need a Better Approach to Procedural Automation.”

⁶ Larry O'Brien, “Minimizing Operational Risk through Procedural Automation,” ARC Advisory Group, February 2014.

⁷ Ibid.

Defining a Workforce Enablement strategy

Workforce Enablement is a combination of training, tools, processes, and system design that empowers plant personnel to **make better decisions faster** in order to run plants as safely and profitably as possible. It encompasses many areas of plant operations, both inside and outside the control room:

- Competency-based training
- Accessibility of information and procedures on demand
- Work processes/workflow decision support systems
- Abnormal situation management (including alarm system effectiveness)
- Effective communications and collaboration
- Human factor issues (situational awareness/responsiveness)
- Control room/system design and environment
- User interface design for relevance
- Automation and control system integrity and reliability
- Asset performance management (mechanical integrity and reliability)
- System data integrity (accuracy, reliability and security)

Workforce Enablement is widely recognized as being one of the most cost-effective ways to improve bottom-line performance. Many oil & gas companies may not need or be able to address all areas listed above. However, every company should evaluate its operations to identify where initiatives could improve decision-making, then prioritize potential improvements within an overall Workforce Enablement strategy.

A successful workforce enablement strategy revolves around three key areas:

- **Content, control, and decision support systems** Operational personnel must be able to access procedural information on demand so they can respond appropriately without relying on personal experience or resorting to ad hoc decisions. Companies must be able to apply “best practices” consistently from shift to shift, and from site to site.
- **Learning** Traditional classroom training can no longer overcome the aging workforce/process complexity crossfire. Experiential training and interaction between board operators, field operators, maintenance technicians, and other plant personnel are critical to the successful dissemination of process knowledge.
- **Business processes and workflow** Software applications can define proper processes, ensure that procedures are up-to-date, help enforce their execution, validate actions, and track events. Workflow tools can ensure that safety permits, work orders, and Management of Change (MOC) procedures are not passed over or disregarded. Mobile technologies facilitate getting the right information to get to the right people immediately.

Any program that implements the strategy should be customized to the company's specific situation. When defining the program, companies must always assess the impact changes will have on people, processes, and assets. It is important to “get it right” by identifying and prioritizing where Workforce Enablement capabilities can most effectively improve operational performance and empower personnel with greater situational awareness.

Many organizations have no idea whether or not they are getting real business value from their Workforce Enablement investments. Companies typically measure the impact of training by conducting surveys of attendees or counting how many employees complete courses rather than assessing whether or not those employees learned anything that improved business performance.

“Situational awareness” and HMI design

“Situational awareness” is a methodology of best practices that provide system operators with the information they need to make effective decisions.

A more comprehensive discussion of “situational awareness” and how sound human machine interface (HMI) design can empower an inexperienced operator to behave more like a experienced operator, and an experienced one to work in a more proactive mode, see Schneider Electric white paper [How Human Machine Interface \(HMI\) Impacts Business Performance in Industrial Sites](#).

“Testing real-world outcomes is crucial.”

—McKinsey & Company

Workforce enablement technologies

A McKinsey Quarterly survey found that 90% of respondent organizations said that building capabilities was a top 10 priority, yet only 25% felt their programs were effective at improving performance measurably and a mere 8% tracked their program’s return on investment (ROI).⁸ The report emphasizes that Workforce Enablement programs generate greater value when they reflect key business performance metrics. That is, testing real-world outcomes is crucial.

There are several tools to enable workers and enhance their operational knowledge and decision-making. These include ultra-realistic training simulation systems to replicate various “what if” scenarios, alarm and event-notification software to alert workers of upset conditions and abnormal situations, workflow software applications for procedure enforcement/tracking and wireless applications that provide a mobile infrastructure for remote data collection, event tracking, procedure execution according to best practices and process validation.

The three key elements — content, control, and decision support systems; learning; and business processes and workflow — can be accelerated and sustained by innovative technologies to achieve the behavioral and culture change required to **make better decisions faster**. The three technologies discussed below help eliminate distractions that operators traditionally face such as alarm storms, manual control of process loops, and tuning/optimizing those loops.

Alarm Management

ARC Advisory Group has identified alarm management as a key process automation system function contributing to an environment of “flawless intervention” — where better decisions are made faster. All modern process control systems provide alarms to assist operators in managing abnormal situations. But an alarm system can be either a help or a hindrance. Many process operators are bombarded with system alarms when an abnormal situation occurs. It is difficult for even experienced operators to filter through hundreds or even thousands of alarms in order to get to the information needed to make a good decision. Nuisance alarms, alarm floods, and improperly prioritized alarms all contribute to operator confusion and actually increase the frequency of accidents and shutdowns. In a recent survey of industrial systems users, nearly 70% of respondents indicated that “alarm overload” impacts their ability to properly operate the production process.⁹ A well-designed alarm management application optimizes alarms to notify operators only when their intervention is required.

“70% of industrial systems users surveyed responded that ‘alarm overload’ impacts their ability to properly operate the production process.”

In short, alarm management provides operators with enough information to prevent abnormal situations from occurring in the first place and to prevent unavoidable abnormal situations from escalating further. A well-designed alarm management application links telecommunications with automation software systems to provide real-time data and immediate notification of high-priority issues requiring operator intervention. Details of the alarm are communicated via multiple means (loudspeakers, intercom systems, radios, and telephones). Operators can monitor the entire network 24x7 and ensure that the right information gets to the right person at the right time in the event of a potential problem. Text messages and/or emails can be sent to the correct employees’ cell phones, handheld computers, and other mobile devices. The technology allows operators to access the proper diagnostics, identify root causes, and/or get a hold of the correct Standard Operating Procedures (SOPs) so they can properly assess and respond to the situation quickly and accurately.

⁸ Jenny Cermak and Monica McGurk, “Putting a value on training,” McKinsey Quarterly, July 2010.

⁹ David Greenfield, “Why Nuisance Alarms Just Won’t Go Away,” Automation World, February 8, 2012.

Operator training simulators (OTS)

With today's oil & gas production control operators running mission-critical processes across multi-billion dollar businesses — where missteps can be very costly in terms of safety, availability, and profitability — the dissemination of process knowledge is crucial. Industry experts estimate that it takes 10,000 hours to develop an employee's expertise.¹⁰ With 30% of plant managers switching sites and/or companies annually, and the impending exodus of veteran personnel with their wealth of experience, companies are challenged to reduce the learning curve.

“OTS can transfer knowledge and develop skills in a matter of months rather than years.”

Operator training simulators (OTS) can transfer knowledge and develop skills in a matter of months rather than years. OTS allow workers to experience and respond to simulated high-risk control room situations in a risk-free virtual-reality environment. Much like they do for airline pilots or astronauts, simulators throw various “failure issues” and problems at trainees to make sure that they know how to cope with malfunctions and upset conditions. Repetitive training on various “what if” scenarios enables employees to respond to those situations with better, faster decisions so that appropriate best-practice procedures become second nature.

This approach improves operator responses in order to:

- Reduce the number of abnormal situations and unplanned shutdowns
- Lower the risk of loss of life, damage to assets and loss of production
- Ensure compliance to statutory and environmental regulations
- Increase operator awareness, skills, and readiness
- Analyze and retain the experience of an aging workforce
- Ensure compliance to “best-practice” procedures

The dynamic control system emulation of today's better OTS solutions not only prepares newer operators quickly and effectively, it enables engineers and managers to test, analyze, validate, and improve process design, engineering workflow, and overall plant operations. In both “greenfield” projects and startups after shutdowns at existing facilities, these systems help ensure faster start-up times, quicker recovery from process upsets with less equipment stresses, and the ability to correct procedure errors prior to online production.



Figure 4

Simulators throw various “what if” scenarios at trainees so proper responses become second nature.

Improving operator training and plant performance reduces capital investment costs, increases process yields, and enhances management decisions while leveraging existing technology investments.

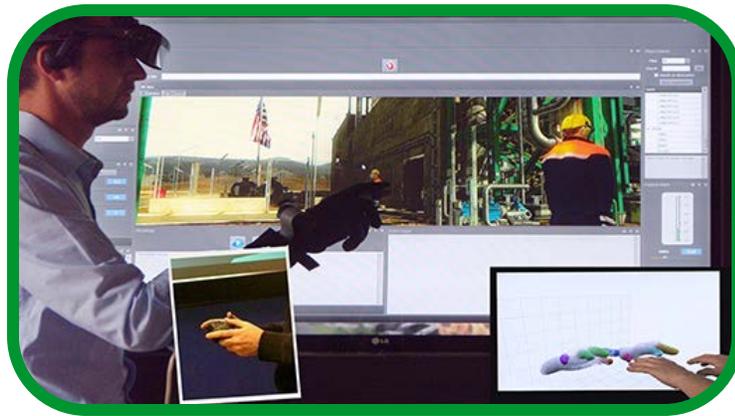
¹⁰ See, e.g., Malcom Gladwell, *Outliers: The Story of Success* (Boston: Little, Brown, 2008).

3D — The Next Generation in OTS

Some applications take simulation one step further by training personnel in a 3D environment. These applications are particularly useful when training field operators working at hazardous or mission-critical locations. Common complaints that Schneider Electric heard during interviews with oil & gas production companies are that “traditional training has moved out of the actual job context and to less and less real situations,” “experts were removed from working with novices,” and that too infrequently could experienced workers “spend time coaching and mentoring others.” Comprehensive 3D OTS link control room operators to field and maintenance operators by means of a high-fidelity process simulation and virtual walk-through plant environment. This type of concurrent training improves communications among different teams, reinforces the use of standardized operational procedures among all employees, and proliferates consistency by shift, by plant, or by site

Figure 4

3D simulation links control room and field personnel in a virtual walk-through plant environment.



Success story: Chevron

Chevron is recognized as a leader in mobile Workforce Enablement for its use of handheld computers with intelligent work process management software.

Chevron identified that more than 50% of most production plant assets are non-instruments. Consequently, data had to be collected manually, which was not timely enough to identify and act upon when issues arose.

Now, engineers are notified of issues immediately. Mobile software and rugged PDAs improved decision-making support by standardizing procedures according to best practices

Wireless

Mobility has become a key enabler for today's workforce. Real-time decision-making has become critical in operating oil & gas production plants. Companies increasingly need actionable, up-to-second, shareable data at any time, from anywhere. Mobile and wireless technology allows decision-making where and when it is needed. A mobile workforce is better equipped to address issues at the actual site of the problem, leverage information from any location in the plant or remote site in the field, and determine the best course of action to resolve the problem.

Mobile technology combined with intelligent workflow capabilities now provides field workers and desk workers with intelligent on-demand dynamic procedures, pushed to the right people based on best practices. These procedures are not “dumb text” documents but instead smart procedures with decision tree logic to ensure proper steps are followed and auditable.

Mobile solutions standardize workflow and “routine tasks” such as equipment monitoring, maintenance, data collection, compliance documentation, and production tracking. Workers can access and log information via cell phone or handheld devices, rather than using clipboards and spreadsheets. Wireless applications connect all wired and stranded assets, enabling even broader visibility into operational performance than ever before.

Conclusion

In today's oil & gas production environment, a team of field and control operators empowered to make informed, real-time decisions about running mission-critical processes is no longer just a competitive advantage — it is a mandatory requirement for staying in business.

Oil & gas production plants today face numerous challenges resulting from the retirement of highly knowledgeable workers, workforce reductions, and the increasingly complex nature of today's process automation technologies. With such resource deficits expected to continue into the foreseeable future, companies must adopt forward-looking strategies that enable workers to operate more efficiently and profitably. Importantly, the tools they use must be focused on specific needs and goals.

Field workers, control room operators, and management are all responsible for running processes to achieve the most important goals: safe and profitable operations. A focus on enabling daily operational decisions through Workforce Enablement technologies is one of the most cost-effective means of maximizing availability, reliability, and throughput.

Fortunately, there are new, constantly evolving technologies designed to address the issues of a changing workforce and increasingly sophisticated automation systems. These solutions empower plant operators with real-time information, highly capable decision support and workflow tools, and ultra-realistic training simulation scenarios designed to test new operations procedures and solutions without impacting safety or budgets.

At the heart of a resilient plant is the workforce. A Workforce Enablement program empowers employees with the tools and “know-how” to make better decisions faster. Developing an effective Workforce Enablement program requires evaluating roles, tools, resources, incentives, knowledge, and skills. An assessment is the first step to target the right objectives and answer basic questions to help set new Workforce Enablement priorities:

- What performance results are expected of the team or individual related to short- and long-term business goals and strategies?
- What competencies are required to meet the target performance results?
- What gaps exist between required practices and current performance of the team?
- How are current work environment factors and programs either encouraging the workforce to perform as needed or discouraging them from doing so?
- What current programs are working and what new programs or content should be made available?

The value of any good technology is determined by its ability to accelerate and sustain process improvements that make operations more safe, reliable, and efficient. When the right Workforce Enablement technologies are in place, they support and enforce situational awareness and proactive behaviors that help deliver a superior culture of safety, efficiency, and profitability.



About the author

Charles Mohrmann was Director of Planning Control & Safety at Invensys (now part of Schneider Electric). With over 30 years experience in business development, marketing, management consulting and sales management, he has expertise in numerous technology areas and markets including mobile solutions, software and IT services, process automation, retail, energy, manufacturing and aerospace.