EXCELLENCE IN DESIGN

Making sense of complexity

Industry 4.0 and associated developments in the digital world are ushering in a new era that promises to reshape process control environments by making a vast range of tasks more manageable and understandable.

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Process control environments are being reshaped by Industry 4.0 – the cyberphysical-systems-based fourth industrial revolution, which is itself being driven by technologies such as digitization, the Internet of Things, Big Data, artificial intelligence and virtual reality. These technologies hold the promise of making many increasingly complex tasks such as fault detection and diagnosis, as well as process optimization, more understandable and manageable.

Inexpensive sensors and AI are already making it possible for a single operator to manage an entire plant section.

What's more, they are opening the door to tomorrow's networked control centers. To be successful, however, these developments will require advanced collaborative work environments and a high-performance workforce.

Just as self-driving cars are set to transform the transportation sector, sophisticated digital automation programs are dramatically changing the operation of industrial processes. Driven by inexpensive sensors and powerful artificial intelligence algorithms capable of image recognition, vibration monitoring and much more, such programs are increasingly replacing human sensing. Indeed, in many cases, they are already making it possible for a single operator to manage an entire plant section.

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01 Modern hydrocarbon processing plants have myriad subsystems that must work together flawlessly. Optimized data management is the key.

Nevertheless, the picture is still far from ideal. Although integrated industrial information systems gather operational data to enable collaboration [1] and make real-time data available to appropriate individuals, McKinsey [2] has shown that in the case of offshore platforms, only a small portion of the resulting data is actually used as a basis for operational decisions →2.

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Why isn't the potential of Industry 4.0 being more fully realized? The answer often boils down to complexity.

Data availability: breaking down information silos
Why is the potential of Industry 4.0 not being more fully realized? The answer often boils down to complexity. Modern process plants are highly interrelated systems. A problem in one part of a process tends to propagate across different sub-systems and plant components. Advanced automation systems add dynamic interactions between these components, making it difficult to obtain a clear assessment of potential problems. Added to this inherent systems complexity is the human element, which may involve the collaboration of a multidisciplinary team and the involvement of specialized expertise, often represented by an external supplier.

		Comment	Source
People and processes	0%	Schedule predominantly based on OEM- recommended maintenance intervals	Interviews with operational staff
Deployment	< 1%	No interface in place to enable real-time analytics to "reach" offshore	
Analytics	< 1%	Reporting limited to a few key performance indicators (KPIs) which are monitored in retrospect	BI and KPI walkthrough
Data management	~ 1%	Data cannot be accessed in real time, enabling only ad hoc analysis	Walkthrough of infrastructure and band-width between off- and onshore
Infrastructure	60%	Only ~ 1% can be streamed onshore for day-to-day use	
Data capture	100%	~ 40% of all data is never stored – remainder is stored locally offshore	Assessment of storage capacity (on the highest capacity asset)

~ 30,000 tags measured

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Unfortunately, collaboration between personnel from different disciplines, locations and organizations →3 is often hindered by the fact that the information needed to solve the problem at hand is hidden within information silos. Many companies also lack the organization and work processes to support multi-disciplinary collaboration, and therefore tend to execute work based on a relay race approach instead of as a collaborative effort. Companies are hardly blind to these challenges.

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The idea is to provide the same level of digital support to the industrial worker as has been available to office workers for years.

In fact, it is clear to most that, because of the trend toward growing levels of digitally-generated data, they need to improve the way they work in order to be competitive.

Progressive companies are responding by improving workforce effectiveness through the introduction of digital technologies. For example, many are introducing bring-your-own-device (BYOD) policies, as well as solutions that enable employees to work effectively wherever they are, whether in the control room, on the shop floor, or working remotely. The idea, in short, is to provide the same level of digital support to the industrial worker as has been available to office workers for years.

Information previously hidden within control systems or proprietary tools is now increasingly made available through improved connectivity and integration across systems and network layers. This trend is, in turn, opening the door to Web-based applications that support consolidation of data from different systems and tools, making these easily accessible from any location. All in all, easy access to data and a common work environment is the first step to enabling effective collaboration to support process operation. Improvements in analytics and visualization techniques also help workers to make sense of increasing amounts of data.

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02 Only a small percentage of the data generated in many industrial processes is being used as the basis of operational decisions.

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03 Collaboration across locations, disciplines and organizations.

Other technology trends are also supporting a new collaborative approach to work. Video conferencing technology has matured, allowing many companies to have remote operation centers that support local control rooms with open video links between locations. High quality video conferencing technology is also available from mobile devices or personal workstations, enabling operators to obtain instant access to remote expertise.

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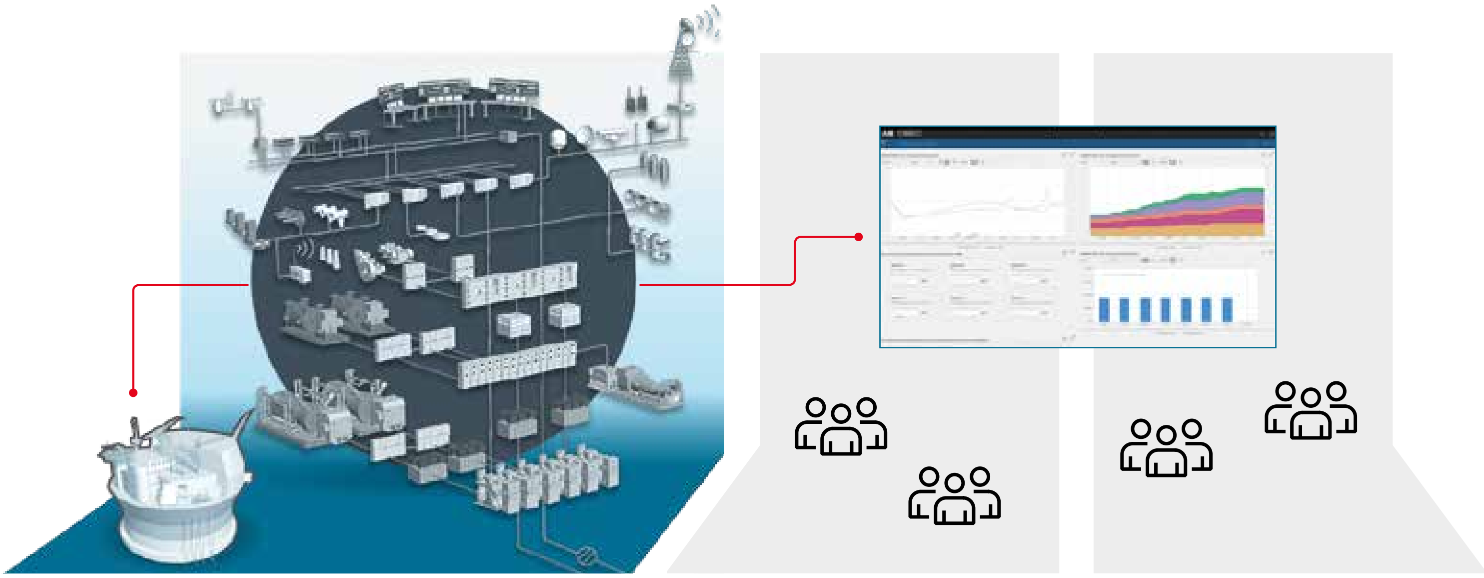
Digital technologies are blurring the boundaries between local and remote operation.

In combination, the introduction of digital technology for easy access to information, independent of location, and the proliferation of video conferencing to support remote collaboration, are blurring the boundaries between local and remote operation.

Insights into process operation

Modern automation systems can cover most aspects of normal operation but also handle many anomalous situations. Advanced control techniques such as model-predictive control (MPC) and state-based control (SBC) [6] allow the automation of very complex tasks, such as the startup of an industrial plant. Indeed, automatic control performs better than typical human operators. As a result, operators are less and less involved in the inner control loops that are directly in contact with processes. Their tasks are increasingly shifting to supervisory control [7], where the operator manages and supervises a large number of control modules. But being less involved in direct process control also means fewer possibilies to develop a feeling for a process by training on the job – a problem that was dramatically illustrated with the loss of flight AF447 [8].



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To be able to take over when automation fails, operators need higher qualifications and a profound understanding of underlying technical processes, automation systems and control modules. Simulator training is necessary to develop a feeling for processes.

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Not only can Industry 4.0 have a profound influence on information flows and availability, it is also set to have a huge impact on industrial quality control.

Operators should also be deeply involved in the optimization of process operations, because this keeps them involved and helps to build up the required knowledge that allows them to take over in case of automation failure.

Not only can Industry 4.0 have a profound influence on information flows and availability, it is also set to have a huge impact on industrial quality control [9]. Big Data techniques make it possible to distill historical process data into algorithms that can predict the quality of production [10]. Developing problems can be detected early and countermeasures can be taken before impact becomes significant. Previously, it took an operator many years to accumulate comparable experience.

Remote expertise can also play a decisive role in failure avoidance. For example, in the case of the Deepwater Horizon oil spill [11], the investigation report clearly states that one major factor contributing to the accident was the incorrect interpretation of available measurements. Quite likely, advice from highly qualified remote experts would have avoided this accident.

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04 An extended operator workplace.

Process performance optimization
Key performance indicators (KPIs) for process operations in areas such as control loop performance, alarm management, energy efficiency and overall equipment efficiency are described in detail in [12]. Managing these KPIs is not a classic operator task but is becoming more and more important in terms of ensuring good production performance. Areas such as operations, maintenance and analytics need to be managed holistically to achieve the best results. Many of the associated tasks can either be performed by centralized internal service centers or outsourced to specialized external service providers.

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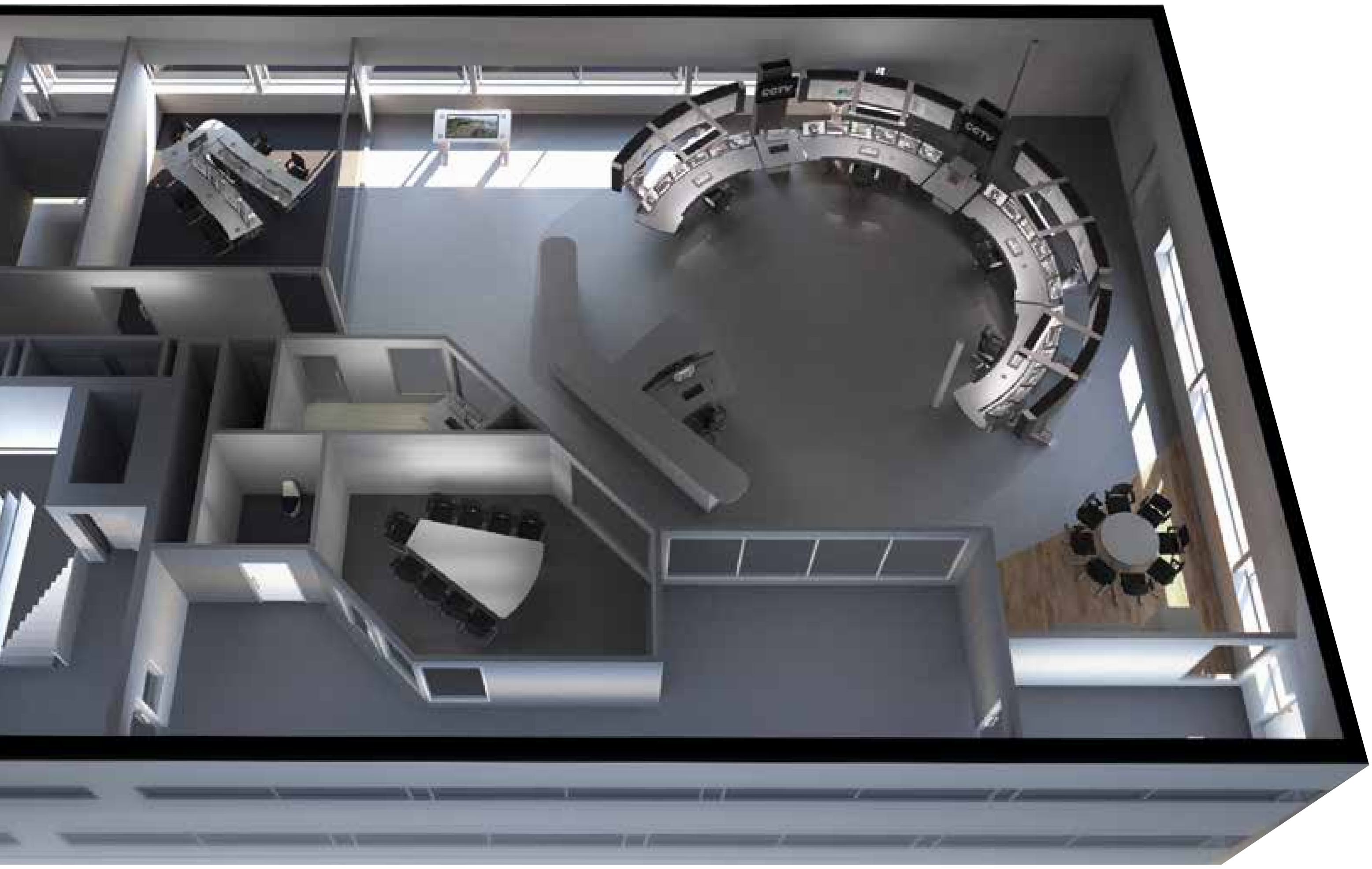
A challenge will be how to design collaborative environments that are integrated with remote service communities.

Typical goals are increased production plant throughput, efficiency, and uptime [13]. These can be achieved through a structured approach to revealing the sources of and responses to process variations and upsets. By reducing process variations, operational flexibility, plant regularity, safety and integrity will be increased, while off-spec production, energy costs, environmental impact, operator stress, and equipment wear will be reduced.

An example is provided by Dow Chemical, which has introduced a global analytics layer that distills vast amounts of data into readily understandable information and metrics [14]. As a result, experts from a centralized analytical technology center can now support plants globally to determine manufacturing obstacles, improve efficiencies and develop best practices.

Tomorrow's control rooms and operators
As mentioned above, most simple parts of traditional operator work have been taken over by automation. Modern operators now have a very different profile from their predecessors. They supervise large numbers of control modules and must be able to quickly diagnose complex situations, collaborate with various support units and coordinate field operators and maintenance personnel. They decide when it is time to bring in external expertise and manage the integration of remote experts. To achieve their full potential, they need a work environment that supports these activities.

In this connection, a challenge will be how to design collaborative environments that will replace traditional control rooms. Often, such centers will not need to be physically close to a process, but will need to be much better integrated with remote service communities in their own company, as well as associated service providers and suppliers.



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The involvement of experienced control room designers from an early stage on will be essential to the design of next-generation collaborative operation centers. Such centers will require a

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In tomorrow's control centers, the roles of operators will evolve from reactive to predictive problem solving and analytics.

totally new approach that takes the full potential of Industry 4.0 into account. As the traditional way of building control rooms becomes obsolete, new best practices will have to be defined.

The new centers will contain fewer operators, while the roles of operators will evolve from reactive to predictive problem solving and analytics. To achieve this, operators will have to be highly qualified and capable of interacting with many other specialized functions, such as IT/OT support, multifunctional support, technical and remote support, asset risk management, alarm handling, safety, cyber security and maintenance management.

Frequent interactive communication with a very broad range of remote service specialists – something that is still rare today, but that will be the norm tomorrow – demands a new look at factors such as room layout, working zones, monitors, cameras, analytical tools and remote collaboration workspaces.

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05 The newly designed collaborative operations center.

Although working in a 24/7 environment can be exciting, it can also lead to reduced life expectancy. In view of this, →4 presents a platform that can be adapted and even automated to meet each user's needs. For example, the distance between eyes and monitors can be automatically adjusted to reduce eye strain, and lighting can shift throughout the day to optimize circadian rhythms. Furthermore, big data analytics makes it possible to create a data-driven "day by day" improvement program for operators.

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Technological development that is driven by operators' needs can be expected to transform tomorrow's working environment.

→5 illustrates the newly designed collaborative operation center for an energy and environment company. Five traditional control rooms with 12 operators will be replaced by a new collaborative operations center hosting two operators who will call in remote expertise on demand.

Next-generation operators

As control centers metamorphose into collaboration centers, a major challenge will be to attract the next generation of operators – a generation for whom the connection between personal ergonomics and health is fundamental. This increasingly important factor calls for workplace designs that not only minimize acoustic disturbances, while optimizing factors such as illumination and air quality, but take into account aspects of the psychosocial working environment such as gamification, collaboration, individual space, flexibility, learning, sustainability, social presence, emotional engagement, and creativity. All in all, Technological development driven by operators' needs can be expected to transform tomorrow's working environment. ●

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