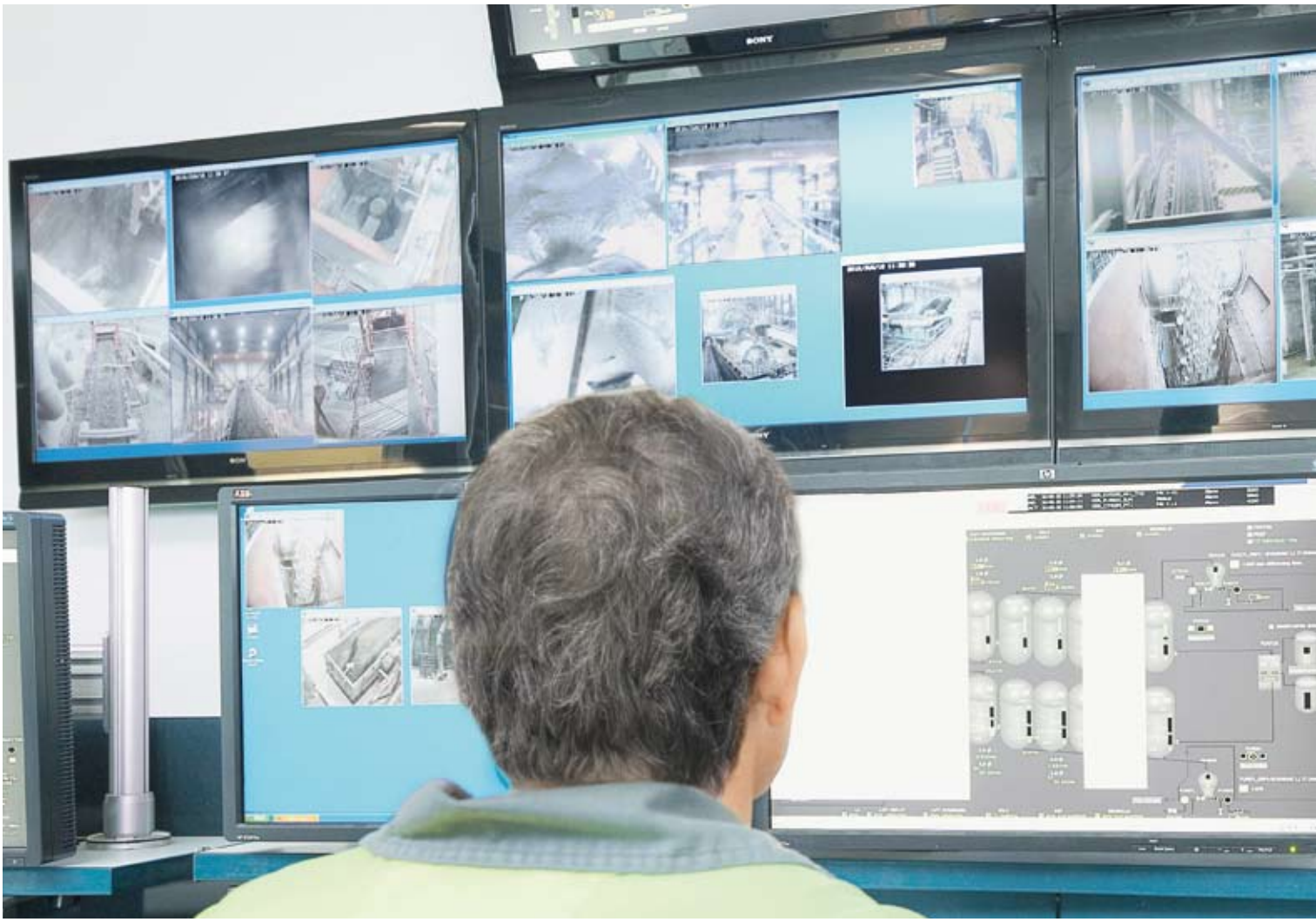


The effective operator

System 800xA ’s operator workplace is ready for the needs of today and tomorrow

HONGYU PEI BREIVOLD, MARTIN OLAUSSON, SUSANNE TIMSJÖ, MAGNUS LARSSON, ROY TANNER – Global process industry losses are estimated at around $20 billion annually, corresponding to five percent of total production[1]. 80 percent of these losses are preventable and 40 percent thereof are primarily due to operator errors. This means that the total improvement potential – if a way can be found to help avoid mistakes – totals $6.4 billion. Operator effectiveness is a fundamental element for sustaining the economic value of process control and management. It can be improved by empowering operators through improved situational awareness and better handling of abnormal conditions. Operators can then make better decisions and so improve process safety and process uptime.

ABB's System 800xA provides customers with the ability to consolidate and rationalize data from various sources seamlessly.

Striving for operator effectiveness implies facing a number of significant challenges regarding both technology and management. For instance, the management and monitoring of industrial processes is characterized by inevitable changes in technology, a diminishing knowledge base due to demographic changes in the workforce, and the ever-increasing complexity of operations. These factors may lead to huge cost escalations if operator effectiveness is not rigorously taken into account.

ABB believes that the development of an effective HMI (human machine interface) needs to look at the operator's workflow and requirements. A recent survey on operator effectiveness shows that this view is also shared by many of ABB's customers.

Four pillars of operator effectiveness

According to the philosophy of ABB's Extended Automation System 800xA, there are four main pillars affecting the performance of the operator. These are:

- Integrated operations
- Design for high-performance
- Attention to human factors
- Operator competence

These are discussed below.

Integrated operations

ABB's System 800xA provides customers with the means to consolidate and rationalize data from various sources seamlessly. It achieves collaboration between different computer programs and systems. Operators are supplied with all necessary information. They have intuitive access to actionable information and can manage views dynamically and effectively. These features reduce the time required to identify necessary actions.

Today, an operating plant may include multiple controller platforms including PLCs (programmable logic controllers), DCS (distributed control systems), safety systems, FASs (facilities automation systems), and ECSs (electrical control systems) to name just a few. In addition, plant information systems such as CMMS (computerized maintenance management systems), ERP (enterprise resource planning), video monitoring systems and data historians are also available and contain valuable information that can support operators in their decision making.

System 800xA's Aspect Object technology allows not only the access and seamless presentation of information from all these sources, but can also filter it based on user roles and responsibilities. For instance, it takes no more than a right mouse click and a selection in the context menu to trace the various data displayed in a graphic to its sources.

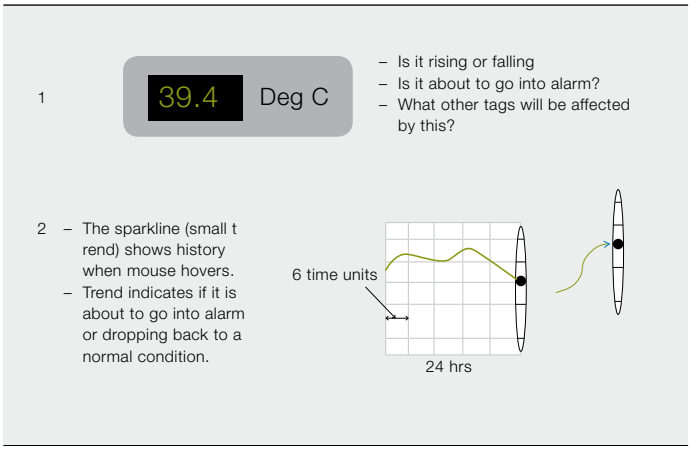
Design for high performance

Many standards organizations and research institutes have made and continue to make valuable contributions to

Footnote

1 Atkinson, T., Hollender, M., 2010, Operator Effectiveness, Collaborative Process Automation Systems, ISBN 978-1-936007-10-3.

1 The traditional versus a customized way of presenting data with different effects on situation awareness



2 ABB's Extended Operator Workplace

With a simulator, process operators and instrument technicians can learn to master the process in a safe and realistic environment.

HMI philosophies. This knowledge has flowed into guidelines for interface design, ergonomics, situation awareness and alarm management. Drawing on this as well as its own extensive expertise, ABB is seeking to support the establishment of good standards through its active participation in the various technical committees, working groups and scientific committees of standards-development organizations.

One key area affecting HMI development is the handling of abnormal situations. Abnormal situations are disturbances or incidents with which the control system is not able to cope of its own accord, and which thus require operator intervention. ABB is active in identifying effective supervision and intervention practices to improve the operator's capability to detect and respond to abnormal situations. The company implements these measures in System 800xA. For example, System 800xA supports customization of the workplace layout based on the end user's operational philosophy, and provides support for the implementation of high-performance alarm-management strategies with features such as alarm shelving (operator-driven alarm suppression) and alarm hiding (condition-based alarm suppression). These features reduce the number of nuisance and non-critical alarms and so help end users meet or exceed current guidelines and standards such as EEMUA 191 [2] and ISA SP 18.2 [3].

Another driving factor of high-performance design for HMIs is situation awareness. According to the abnormal situation management expert, Ian Nimmo (of the company User Centered Design Services and co-author of the High Performance HMI Handbook [4]), "Having good situation awareness means the operator has an accurate perception of the current condition of process and equipment, and an accurate understanding of the meaning of various trends in the unit." Some of the key concepts that situation awareness reflects are color definitions and usage to maximize visibility of abnormal situations. The situation awareness concept is not new. It is, however, still a matter of debate between multiple organizations. One aspect being debated is the use of grayscale or "cool" process graphic schemes. In addition, navigation methodology, graphic-level definition for fast response under abnormal conditions, and presentation of information are used to seek to predict and avert abnormal situations completely.

One good example on situation awareness as described in the High Performance HMI Handbook mentioned above concerns two graphics that both embed the same information, but have totally different effects on situation awareness. The graphic with a black background and an abundance of colors leads to poor situation awareness even in non-abnormal situations, whereas the graphic with gray scales and the sharp color for alarm depiction represents good situation awareness.

Footnotes

2 http://www.eemua.co.uk/ (August 2010)
3 http://www.isa.org/ (August 2010)
4 Hollifield, B., Oliver, D., Nimmo, I., Habibi, E., 2008, The High Performance HMI Handbook, ISBN-10: 0977896919, ISBN-13: 9780977896912, Plant Automation Services.

3 Design for the layout of a control room

Situation awareness can make a huge impact by:
- Increasing the success rate in handling abnormal situations and returning to a normal mode of operation.
- Reducing the time it takes plant operators to complete required tasks during an abnormal situation.
- Leading to a higher incidence of control room operators detecting an abnormal situation prior to alarms even occurring.

An example of a process value being presented in two different ways is shown in → 1. The difference results in different levels of informational knowledge reflecting on situation awareness and an operator's ability to make the right decision quickly.

Attention to human factors

The need to explicitly address attention to human factors is well-recognized by ABB. One main reason is that the company knows that a better working environment can reduce an operator's stress, which in turn substantially increases the operator's performance and effectiveness for handling abnormal situations, as well as reducing health issues and turnover of resources.

A good example of increasing this awareness and thus boosting operator effectiveness is ABB's Extended Operator Workplace → 2. The workplace is equipped with advanced keyboards featuring hotkeys for multi-client handling, an operator desk system with motorized adjustable desk/monitor positioning, a directional sound system and integrated dimmable lighting. Furthermore, a productive design when creating control room environments is of major impact on the performance of operator teams. An example is shown in → 3. All these factors contribute to the enhancement of the operator environment and alertness level of control room operators.

> Abnormal situations are disturbances or incidents with which the control system is not able to cope, and which require operator intervention.

Control room procedures are important to be able to ensure consistency of operation. They can also support an operator in activities that may be performed infrequently. An example of useful supporting mechanisms is the use of checklists to guide operators throughout the required procedures under certain circumstances.

The clear definition of job roles and responsibilities is another vital element that characterizes successful operations. This means that all the tasks that an operator needs to perform should be recognized and documented, including the tasks that go beyond operating in the normal mode.

ABB and System 800xA are defining a new standard for how control rooms (intelligent control centers) should be built with the operator in focus. With the help of the control-room furnisher CGM, ABB is getting involved very early on in projects and can, jointly with the end user, define an optimal control room layout with focus on human factors and ergonomics. The "Future Operations Centre" in Borås, Sweden is the place to visit to get the latest information about how to build the optimal control room. It covers, among others, such topics as sound, noise absorption, floor material, light control and the color status of the process.

Operator competence

When operators interact with processes, their actions often have huge business consequences, especially when the process is in an exceptional situation and operators need to understand and manage complex operations to support recovery. ABB's System 800xA provides a foundation for advanced training for such situations using simulations that feature the exact operator environment (graphics and control logic). The simulator provides a safe and realistic environment in which process operators and instrument technicians can learn how to master the process and increase their confidence → 4.

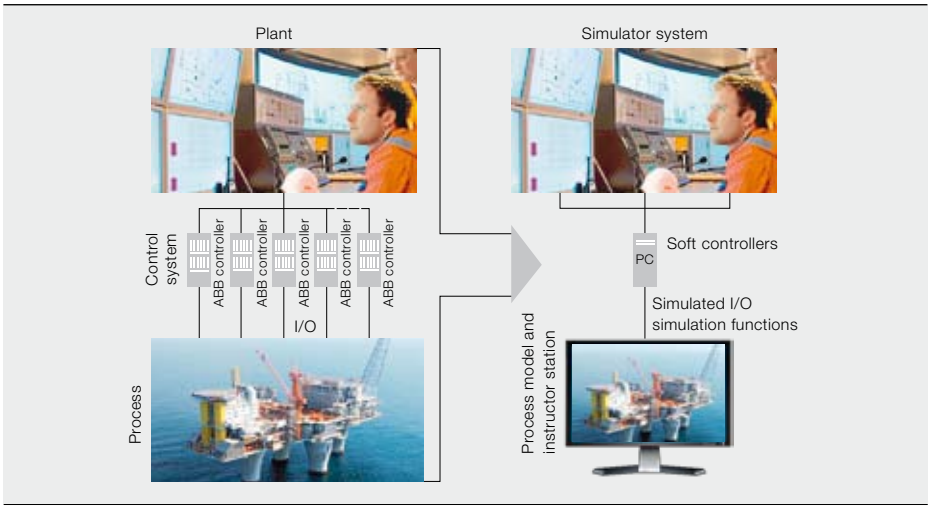
Underlying activities to operator effectiveness

In view of the rapid evolution of technology, generation shifts in workforces and increasing complexity of operations, there is a need to explicitly address operator effectiveness throughout the whole lifecycle of a process-control system. To leverage the four pillars of operator effectiveness, a number of fundamental activities are continuously going on:
- User-centered design
- Looking into the future

User-centered design

The design of an effective HMI requires focus on the control room operator's

4 A System 800xA simulator providing a safe yet realistic environment for training



Another effective way to increase user focus is the establishment of a customer reference group (CRG) comprising customers from various domains. The purpose of the reference group is threefold:

– Provide customers with first-hand information about ongoing and planned development projects
– Permit customers to actively influence ABB's development of System 800xA's operator interface
– Establish a forum for exchanging and testing ideas in user needs, trends and future ventures in order to increase productivity and profits for customers.

Operator feedback was sought on good practices as well as potential areas for improvement with regard to daily tasks.

workflow and tasks. In order to achieve a good understanding of the operators' workflow process and to obtain knowledge on how well the operator manages the significant number of operational tasks, ABB performs operator task analyses together with operators through user studies. The methods for user study include interviews, field studies and observations.

Interview questions are sent to the operators before a planned interview to ensure that the users have the right profile and knowledge, and that they are well-prepared. The interview questions may be structured or unstructured both in the form they are asked and in the way they can be responded to.

Field studies and observations represent a way to identify and prioritize operators' goals and needs. By visiting users in their own working environment and observing how they perform operational tasks, first-hand information is acquired with respect to the operators' challenges and needs. This method is ideal for discovering incorrect or inefficient use that the operators are not aware of. Operators' opinions are also sought and direct feedback collected both for good practices and in areas with potential for improvement.

The collected data is analyzed and synthesized. The data synthesis process includes identification of the main concepts and indications from each user study, and analysis of how they relate to the improvement of operator effectiveness.

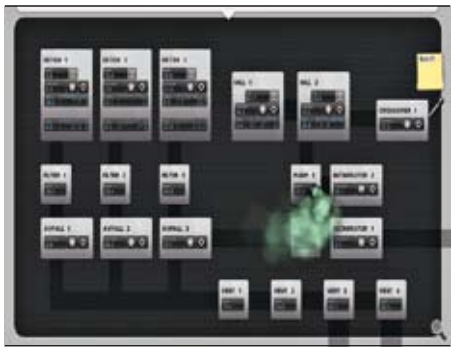
Looking into the future

The continuous progress in software techniques related to user experience and interaction raises the need to permit existing-human machine interface to evolve. ABB has a well-equipped user experience and interaction lab. The researchers look into the future, analyze the impact of emerging technologies, and explore efficient utilization and the reasonable combination of existing and emerging technologies. In particular, ABB has just created a new research area dedicated to operator effectiveness. One of its tasks is to look at new technologies in the market and their applications in industry domains. Examples include interaction techniques, visualization and design techniques.

Many ground-breaking ideas arise from ABB's innovation and development processes. For instance, ➔ 5 illustrates a novel process display that supports operators in abnormal situations, providing intuitive depiction of an alarm that captures an operator's full attention.

Another example of innovative ideas comes from the viewpoint of centering operators' work process and tasks to develop effective HMI. It is common knowledge that process operation is teamwork. Different shifts need to communicate and cooperate with each other. Accordingly, to assist operators in undertaking these activities, one innovative idea from ABB is the emergence of a so called collaboration board, permitting operators to leave messages on process displays ➔ 6, or using a drop-down white board for sketching discussions ➔ 7. This collaboration board is designed for vari-

5 A concept of a process display only viewed during abnormal situations



6 Electronic desktop notes on the collaboration board

7 Drop-down white board screen for discussions

ous roles, including plant management, system management, managers, and maintenance and operation staff.

Operator effectiveness is a timeless characteristic and will always continue to be important. Accordingly, in addition to improving operator effectiveness for the present generation of operators, ABB also takes future generations into account. Some customers are telling ABB that as the current workforce matures, operator expectations are evolving. Many operators being hired today grew up with computers and are “digital natives”. For these new generations, visual learning is an ideal method to teach how the plant behaves. Studies of how such people operate the process show that they have more screens open than older crew. They also ask for more customization of their screens. Newer operators tend to visualize the plant’s behavior graphically whereas older operators seek to understand the plant in a sequential manner. ABB is therefore actively monitoring and applying future technologies and design concepts to address younger generations whose operating skills are different from those of today.

Operator effectiveness is a timeless characteristic and will always continue to be important.

The secret to operator effectiveness

Operator effectiveness is a challenging area. ABB is taking a leading role in facilitating the pillars of operator effectiveness by:

1 Leveraging an automation platform that can natively promote and provide the level of integration and centralization required to promote a collaborative environment.
2 Being an automation supplier that can provide assistance to meet standards and design philosophies in situation awareness and abnormal condition handling, as well as leveraging an automation system that has the flexibility to meet specific customer requirements.
3 Being an automation supplier that has the ability to integrate human factors and best practices in order to provide the best in operator effectiveness.
4 Being an automation supplier that can provide more than operator training but rather an environment that uses the most valuable asset and existing intellectual property to build operator’s confidence and competence.

In addition, ABB is also taking active measures in striving for a process environment that provides operator effectiveness, and conducting continuous activities in, eg, user-centered design, and looking into future technologies and their applications in the area of operator effectiveness. This could reduce the scope for errors, eg, through more efficient use of the operator’s technological experience, quick access to relevant data in every operational situation, and assistance to operators in decision-making processes. All of these imply sustained economic value for customers.

ABB has so far achieved considerable success in boosting operational excellence by truly putting operators in focus and by providing outstanding process control interfaces that facilitate operators to take the right decisions during all modes of operation. ABB is committed to remaining at the forefront of these developments through continued research and development, helping customers achieve operational excellence.

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