Visionary

3-D visualization enhances production operations

MARIA RALPH, ALVARO ARANDA MUÑOZ, SUSANNE TIMSJÖ, MATS LUNDEMALM – Despite the changes in the industrial landscape that have been brought about by the IT revolution, many production operations are still predominantly paper-based. Communicating information via paper is time-consuming and ineffective for many production teams as keeping track of issues and maintaining an up-to-date overview of the production status in this way can be challenging. ABB has developed a prototype 3-D visualization tool that helps production teams overcome these challenges and improve efficiency. The prototype mitigates the limits of paper-based operations and enhances production capability by providing a digital means of accessing and interpreting vital information.
In production processes, time is of the essence: Products have to be delivered on time and within budget. To achieve this objective, production personnel must have ready access to the right information so they can quickly understand any situation that may arise and intervene effectively and promptly to mitigate any issues. Enhancing situational awareness is, therefore, crucial.

Technology can be exploited to provide this awareness, but to build such technology, an in-depth understanding of the production process itself first needs to be established. To achieve this, ABB uses interviews and observations to examine how people perform their work. The resulting information gives a valuable insight into the challenges, goals, needs and concerns relating to daily tasks and informs the key design considerations for the creation of any human-machine interface (HMI). For the 3-D prototype presented here, various production personnel were interviewed and observed, including production managers and factory floor workers. These interviews and observation sessions led to the identification of high-level requirements. In short, the production personnel need to have:

- The ability to quickly and accurately understand and interpret the production flow (e.g., the logical relationship between different production lines)
- Access to key production status information at each step of the process
- A facility to detect, understand and resolve issues quickly (e.g., identify and resolve bottlenecks)
- Information on, and awareness of, the current day’s production and shift situation (e.g., pacing information, throughput information)
- Enhanced information mobility (tablet, smartphone, etc.)
- An effective production order tracking system
- A supply of support data for the morning tours (during which the day’s production is discussed)
- A visualization of progress toward meeting the different goals of production

Design concepts

With these key items identified, an initial 3-D prototype – based on a Unity 3-D gaming engine – was developed to assist personnel in their efforts to enhance the production process. The prototype was used to capture important information – such as the number of parts coming into and out of a certain production line in the production flow. The prototype also presents a high-level map that gives an overview of the entire production process as well as possible bottleneck locations so these can be easily identified and quickly dealt with to mitigate production stalls or stoppages.

The design of the prototype is closely related to the ABB Collaboration Table that connects to and interacts with ABB’s Extended Automation System 800xA – an arrangement that features an integrated 3-D KPI (key performance indicator).
Personnel can visualize production progress in relation to goals for the shift, day and week for each production line.

interface. Taking inspiration from the ABB Collaboration Table, the proposed prototype has a similar look and feel and also runs on a large touch screen; the difference is in the production process details. The 3-D prototype presents the user with many options:

3 A data historian tracks the progress of KPIs – in this case, the current number of orders, models and customers for a certain country selected.

4 Detailed information of work progress

It is easy to navigate between different levels of information – from a high-level overview to detailed information about each production line and buffer.

Easy navigation
It is easy to navigate between different levels of information – from a high-level overview to detailed information about each production line and buffer. This allows production personnel to accurately track the progress of each customer order until it is completed and shipped. They can also search and filter on customer orders, trend views over time for specific KPIs and so on.

Color-coded visualization
Information is color-coded based on predefined threshold levels that are tailored for each specific KPI. These thresholds are visualized in such a way as to quickly identify warnings and critical situations as they arise during production.

Color-coded 3-D bars grow and shrink to represent the production progress, the quality of the orders that are being produced, the safety levels of the factory and the planning of coming orders. These 3-D visualizations can help managers to quickly identify current or potential issues. They also give information on items such as KPI trends and

Holistic view
The user is presented with a holistic view that contains all the vital production information and the relationship between the production lines in terms of buffers and work in progress. This helps the operators to interpret the work flow quickly and get a summary of the current production status on the factory floor.

Customer orders can be filtered by country, customer name and model or order identifier. The result of this filtering is visualized in the production flow, showing the order identifier and in which production line or buffer the order is currently located. The filtering can be refined to retrieve more information about a specific order.

Personnel can also visualize production progress in relation to goals for the shift, day and week for each production line.
production history so they can understand the cause of any problems and react accordingly.

Communication
The prototype encourages and supports communication and collaboration between factory personnel. As an example, different filters allow data to be displayed that supports morning meeting tours in which the production of the day is discussed based on the safety, quality, progress and planning KPI values of previous shifts.

Issue resolution
The resolution of issues such as bottlenecks is facilitated by the inclusion of markers that can be placed in different parts of the flow to allow the personnel to indicate where the cause of the problem might lie.

Data mobility
Mobility is also facilitated: The application has been designed to run both on personal computers and tablets, which presents the ability to access live factory data from any place with an Internet connection and the right security settings.

Production management benefits
Only a subset of features from the prototype have, so far, been incorporated into a real production process. These features include a visualization of where each part of a customer order is in the production flow and the tracking of customer orders. At present, the project is still an ongoing endeavor, in which new features from the prototype are iteratively integrated into a real production process and evaluated.

The 3-D prototype provides a holistic view of the production process and improves overall awareness of the current production status. Providing production personnel on the factory floor with the right information at the right time in an intuitive and easy-to-understand format enables them to more effectively understand the current production status. Also, they can more easily identify which parts of the production process need immediate attention, thus allowing for timely intervention.