Design Your Safety System for Improved Uptime

Chris Brogli - Manager, Safety Business Development

Incorporating integrated safety technologies in the design stage can increase machinery availability, reduce MTTR and improve productivity.

It's a belief that has persisted for decades – safety and productivity are squarely at odds with each other in the manufacturing environment. Safety has traditionally been associated with compliance while productivity has been associated with competitiveness – both with separate, sometimes competing, paths to meet their individual goals.

"There's not a day that goes by that I don't equate a savings in some shape or form with our safety systems."

Mike Douglas, senior manager of health, safety and engineering for General Motors

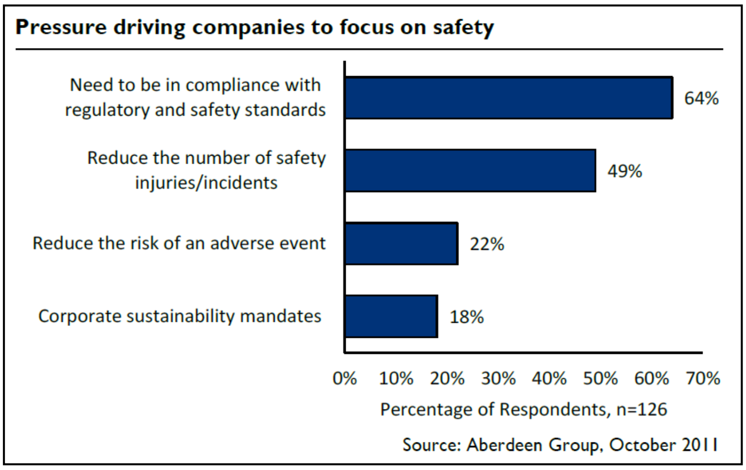
However top-performing manufacturers are showing this age-old notion the door with their use of contemporary approaches to safety. These leaders are using a combination of integrated safety solutions and new international standards to optimize their machinery uptime and plant productivity. Simply put, safety is no longer just about safety. It's also about minimizing the safety-related downtime events that hinder your ability to be more productive.

The key is to expect safety events – which inevitably occur when someone is in danger – and to utilize safety technologies that can minimize the length of those events. This begins in the design stage. Designing safety into your machinery upfront, with an architectural view rather than a bolt-on solution, can result in a more holistic system that can be optimized for faster recovery.

Understanding the standards that apply to your various machinery designs and applications – and when they make allowances for the latest safety technologies – is also crucial. A recent Control Design magazine survey found that the top safety-design headache (52 percent) for machinery builders was determining what standards and regulations apply. Similarly, an Aberdeen report found that nearly two-thirds of manufacturers said "compliance with regulatory and safety standards" is the top driver behind their improved safety practices.

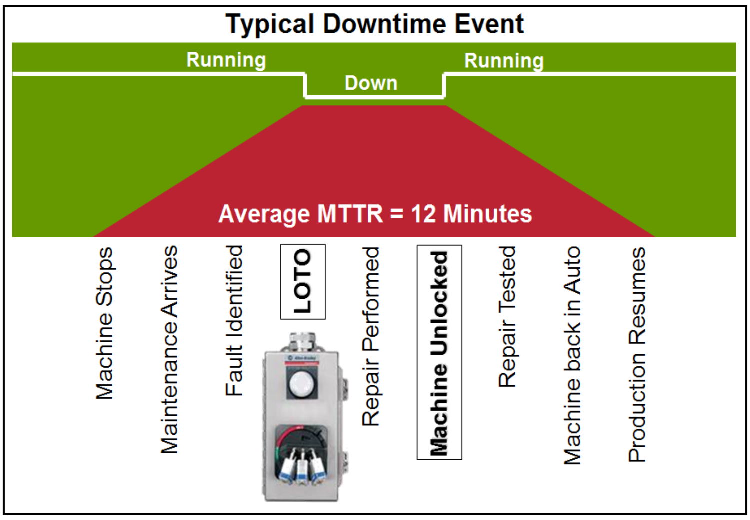
This paper will guide you through some of the core contemporary safety technologies, relevant standards and industry application examples – all with the goal of maximizing safety while enhancing machinery uptime.

Safety and Productivity: The New Normal



The advent of integrated safety – technologies that connect and/or combine your safety and standard control systems – has opened new doors to productivity. Integrated safety helps ensure your safety system has a far lower impact on productivity by improving machinery availability, reducing mean time to repair (MTTR), and streamlining maintenance.

Integrated safety is at the core of what's known as a design-for-recovery strategy, which requires that you treat safety events as normal, expected events and design your machinery to recover as quickly as possible. That recovered downtime translates to more production time for your plant, which accumulates throughout the year and can add up to significant profit improvements.



Consider a typical lock-out/tag-out downtime event, as illustrated:

A safety system that is designed for recovery can speed up or perhaps even eliminate some of the processes within a lock-out/tag-out event. In this example, consider an improvement of just one minute to an entire lock-out/tag-out process that averages 12 minutes. This improvement is about eight percent of the current MTTR – but the savings add up over time. If the production value per minute equals $1,000 and you have an average of 8 downtime events per day in 350 production days per year, your savings would amount to $2.8 million annually.

1 minute of gained uptime per event
$1,000 production value per minute
2,800 downtime events per year

1 minute x $1,000 x 2,800 events = **$2.8 million improved profit annually**

So how do you realize these savings? Four key enablers:

- Lock-out/Tag-out: Minor Service Exceptions
- Safe Speed
- Zone Control
- Diagnostics

Lock-out/Tag-out: Minor Service Exceptions

OSHA 1910.147
Minor Servicing Exception

"Minor tool changes and adjustments, and other minor servicing activities, which take place during normal production operations, are not covered by this standard if they are routine, repetitive and integral to the use of the equipment for production, provided that the work is performed using alternative measures which provide effective protection."

Both U.S. and Canadian standards require lock-out/tag-out during machinery servicing to prevent unexpected start-up, energization or release of stored energy that could cause injury. That often means performing the exhaustive lock-out/tag-out process several times per day for servicing events, such as regular cleaning and maintenance, making machinery adjustments, clearing jams, etc.

The standards, however, do provide exceptions for minor tool changes and adjustments, and other minor-servicing activities. Guidance for developing safety systems for these alternative measures is available in the standards ANSI/ASSE Z244.1 and CSA Z460. In the U.S., for example, the minor-service exception only applies if the alternative measures provide protection equivalent to lock-out/tag-out and if the machine-servicing activities are "routine, repetitive and integral."

These activities typically exhibit all or most of the following characteristics:

- Short in duration
- Minor in nature
- Occur frequently
- Performed by operators or maintenance personnel
- Require minimal disassembly
- Represent predetermined cyclical activities
- Minimal interruption to production
- Occur even at optimal operating levels
- Require task-specific personnel training

The minor-service exception should never be used as a safety workaround that seeks to improve productivity at the expense of safety. Plan to conduct a risk assessment, document the reliability and equivalent safety of your alternative measure, and provide training to your employees to ensure compliance.

If used according to the letter and intent of the standards, alternative measures can provide significant productivity gains, as identified in the lock-out/tag-out example. Alternative measures include the safety technologies discussed in the following sections of this paper.

Key Standards:

- ANSI/ASSE Z244.1 – Control of Hazardous Energy – Lockout/Tagout and Alternative Methods
- CSA Z460 – Control of Hazardous Energy – Lockout and Other Methods

Safe Speed

Machinery servicing functions, such as cleaning, can be dangerous if they're carried out when machinery is operating, but they also are time consuming when machinery must be shutdown. Because of this, plant-floor personnel will too often find a workaround to a machinery safeguard and service the machinery while it's running in an effort to save time – a recipe for disaster.

A safe-speed monitor device, part of your safety motion control system, allows you to bring machinery to a safe speed so operators or maintenance technicians can carry out tasks without completely stopping the machinery.

In some instances, a worker may need to service, inspect or interact with machinery, and safe speed can keep production running while this happens. For example, when a Toyota vehicle plant in the United Kingdom replaced its automated guided vehicle system that serviced the plant's presses with rail-guided trolleys, it also upgraded to a programmable automation controller (PAC) with safe-speed capabilities. This kept the trolleys moving at a designated safe speed when workers entered production areas equipped with guard screens.

In other instances, safe speed can help speed up tasks, such as regular cleaning, that might take longer if the machinery must go through the lock-out/tag-out cycle several times.

Safe-speed technology can be deployed through a dedicated speed-monitoring relay or embedded into drives and control modules, with no need for additional wiring, making it easy to implement. The technology also uses common configuration tools for easier diagnostics and troubleshooting.

Application Examples:

- *Printing Industry*: Safe speed can help an operator more quickly and safely clean the rolls on a printing press by reducing the speed and even the direction of the rolls. This helps shorten the duration of the cleaning process because the rolls can be cleaned continuously while they turn. It also can improve safety because the rolls are operating at a decreased speed and are now turning outward, away from the machine, instead of inward.
- *Food Industry*: In the event of a production issue, safe-speed monitoring can allow an operator or maintenance technician to open a safety door and make adjustments – such as correcting a dispensing nozzle – while production continues at a reduced rate. This can allow the operator or technician to monitor his or her adjustments as they're made, eliminating the need to continually shut down and restart the machinery for each adjustment until the issue is resolved.

Key Standards:

- IEC 61800 5-2 – Adjustable Speed Electrical Power Drive Systems: Safety Requirements – Functional
- NFPA 79 – Electrical Standard for Industrial Machinery
- IEC 60204-1 – Safety of Machinery – Electrical Equipment of Machines

Zone Control

Similar to safe speed, zone control maintains worker safety while limiting machinery downtime to help optimize productivity.

Using zone control, a specific area of your production process can stop or slow down while other zones continue to run at normal speed. This allows operators or maintenance personnel to safely enter a zone to clear a jam, make a machinery adjustment or carry out other tasks while the rest of your production processes continue as normal.

The safety control system is responsible for providing protection for workers within the different zones, and interfacing between the different zones.

A simple and low-cost safety relay architecture can suffice for two- or three-zone machinery configurations. For larger, more sophisticated configurations, such as a production process that requires tight coordination between the safety and control systems, a safety PAC should be used to ease implementation and recovery.

Application Example:

- *Packaging*: Packaging areas can present significant safety challenges given the size and speed of the heavy equipment moving around on the floor. Using zone control, you can designate specific areas for operators or robot palletizers to work in, and allow robot palletizers and other machinery to stop or slow down when operators enter their zone.

Key Enabling Standards:

- ANSI B11.20 – Safety Requirements for Integrated Manufacturing Systems
- ISO 11161 – Safety of Machinery – Integrated Manufacturing Systems – Basic Requirements

Diagnostics

Like any other part of machinery, safety systems are subject to wiring faults, open gates or other machinery events that require maintenance or repairs and lead to downtime. When these events occur, they can send operators and maintenance technicians into a scurry of trying to fix the machinery – and that begins with identifying the root of the problem.

Integrated safety system helps food manufacturer reduce downtime, cut costs

MOM Brands produces over 100 hot and cold cereal brands at it four U.S. plants. The company was looking to upgrade its relay-based safety system, which was cumbersome to install because it was wire intensive and difficult to troubleshoot because operators had to decipher a series of 12 light-based warnings.

MOM Brands chose to replace the system with an integrated safety system that provides safety and standard control in a single package. The company also upgraded its motor control solution to an intelligent motor control solution with integrated safety, including drives with a safe-off function.

The new safety system runs on an EtherNet/IP™ network, making it easier and less costly to implement. It also provides operators and maintenance engineers with greater machine-health visibility for faster troubleshooting.

“With the relay-based system, we had to rely on a series of lights to identify and solve issues,” said Scott Kluegel, manager of corporate electrical engineering at MOM Brands. “With the new machine, all alerts and operational data are plainly available on the operator interface, which significantly reduces the amount of time it takes to diagnose and fix any problems that arise.”

Diagnostics play a critical role in your design-for-recovery strategy. Controlled from a safety PAC, distributed safety I/O modules can be located on the machinery close to sensors and actuators. These modules do more than ensure safety functions are operating correctly – they also pinpoint the source of a stoppage on your safety system and more quickly guide technicians to an effective restart.

The best approach to integrating safety systems for faster recovery is to connect each individual gate interlock to the safety logic device. This allows safety logic devices to communicate critical detailed information to the machinery control system so operators can stay informed of diagnostics, such as specific gate statuses or fault locations within the safety circuit.

If you choose to connect interlocked guards in a series – with wires running from a safety logic device (e.g., a relay) through all of the interlocks and then back to the safety interlock device – a machinery operator may not know which gates are open or closed in the event that one of them doesn't close. He or she then needs to walk to each gate to manually inspect them. Additionally, problems occurring in the interlocks can be difficult and time-consuming to locate, diagnose and resolve.

Diagnostics also are crucial on the actuator side (for example, contactors and drives). Contactors are important because they perform high-current switching and are often cited as having the highest failure rate. Additionally, recovering from a fault becomes more difficult as your number of actuators grows because troubleshooting takes longer.

If you monitor your actuators in a series design approach, you're relying on one safety relay to monitor multiple contactors. When machinery can't start due to a contactor fault, you won't know which contactor in the series faulted – requiring you to spend more time troubleshooting.

A better approach is to wire each contactor back to a safety I/O block. Because each contactor is individually monitored, the safety PAC knows which contactor faulted. That information can immediately be displayed on a terminal so maintenance technicians can skip the troubleshooting and focus on repairing or replacing the device.

A Safer Future

When you look at where manufacturing is headed – specifically with people and machinery working together in increasingly collaborative ways – the use of integrated safety is only becoming more important.

> "Since robots first started appearing in factories 50 years ago, they have operated autonomously. But recent safety standards and technological advancements have allowed engineers to implement friendly features that promise to improve productivity and increase the use of robots."
>
> *Assembly Magazine, February 2014*

Integrated safety also is the key enabler in streamlining robotics, which is in the early-adopter phase in the automotive industry. New standards – such as ANSI/RIA R15.06 and ISO 10218 – also have emerged to provide guidance for safety requirements for this next-generation technology.

Ultimately, whether you're implementing robotics tomorrow or working to shorten your downtime events today, designing your machinery for the fastest possible recovery using contemporary safety technologies will translate to greater productivity and a stronger bottom line.

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Power, Control and Information Solutions Headquarters

Americas: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444
Europe/Middle East/Africa: Rockwell Automation NV, Pegasus Park, De Kleetlaan 12a, 1831 Diegem, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640
Asia Pacific: Rockwell Automation, Level 14, Core F, Cyberport 3, 100 Cyberport Road, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846

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