

## ROBOTICS SAFETY

Written by: George Schuster, Senior Industry Consultant,  
Certified Functional Safety Expert, Rockwell Automation  
and  
Marvin Winrich, Machine Safety Consultant, Rockwell Automation



## **International Safety Standards Keep Pace with Advances in Robotic Technology and Applications**

The robot as a concept dates back to the dawn of civilization. In 322 B.C., Aristotle envisioned an intelligent tool that “when ordered or even of its own accord, could do the work that befits it.”

Until recent decades, however, the history of robots was more science fiction than reality. Even after the 1960s, when the first industrial robots moved onto America’s automobile assembly lines, technical advances and applications lagged behind futurists’ predictions. Futurists foresaw robots assisting people in myriad ways, from handling materials too hazardous for humans to assisting the disabled in performing daily chores.

Today, major technological advances – including the microprocessor, artificial intelligence techniques, and innovations in automation and control systems – have ushered in a new age of robotics, in which once-futuristic visions have either become realities or are on the horizon.

Yet despite breakthrough applications in areas ranging from manufacturing to medicine, robots carry risk. Without the proper precautions in place, a robot experiencing a fault or failure might cause serious injuries to people and damage to capital equipment in or around the work cell.

To address the increasing sophistication, complexity and needs of robotic systems, stakeholders in the robotics and automation industries are working to establish new international safety standards through the International Organization for Standardization (ISO) for robots and robot systems integration. ISO 10218-1 – the initial updated standard, published in 2006 – specifies requirements and provides guidance for the assurance of safety in design and construction of the robot itself, not the entire robot system. Part 2 – or ISO 10218-2, which is undergoing development and is expected to be published in 2011 – covers the integration and installation of a robot system or cell, thereby providing a more comprehensive set of requirements for robot safety.

This white paper examines the major advances in robotics and robotic systems that the new safety standards will address for the first time, and explains how these technologies will help industries better protect workers while helping increase plant efficiency and productivity. It also details the important role of integration technology in helping safeguard robotic systems and provides insight on future trends in robotic applications and associated safety issues.

## **Smarter Robots Help Protect People**

The evolution of robotics has become a revolution in the last decade. Early industrial robots were large, hydraulically powered machines. They boasted significant strength, but no intelligence beyond their human operators. By the 1980s, robots transitioned to become electrically driven units, with improved accuracy and performance.

In the past few years, geometric increases in microprocessing power, and significant strides in automation and control technology made robots mission-critical industrial tools. Robots operate in a spectrum of settings today, including hospitals, warehouses and laboratories, often taking on tasks that can endanger humans, such as manipulating toxic substances and working in extreme temperatures. While much of their role contributes to worker health and safety, two robot fundamental attributes – the power to handle super-human payloads and the flexibility enabled by full range of motion – pose potential dangers to people, especially if a fault or failure occurs.

Those robotic safety issues and many others are addressed in the current U.S. robot safety standard, ANSI/RIA R15.06. But those guidelines were adopted in 1999, and don't cover innovations developed since then. These advances in robotic capabilities and integration technologies offer a range of benefits. Besides helping increase safety and thus worker productivity, they hold the promise of a smaller robot-system footprint than traditional technology, which is based on mechanical safety (hard) stops, or external sensors and controls.

The team of global experts drafting the new international standards includes Americans representing the U.S. Robotic Industries Association (RIA). Once the international standards are confirmed, the RIA is expected to update R15.06 to comply with the new ISO criteria.

Among the many changes to be included in the updated standards are first-time safety requirements for four major new robotic technologies: cableless teach pendants, human-robot collaboration, robot-to-robot synchronization and vision-based safeguarding systems. By establishing guidelines to govern the safe use of these innovations, the ISO standard will open the door for these applications around the world.

### ***Cableless Teach Pendants***

A teach pendant is a hand-held robot control that facilitates programming the robot for a specific task. Traditionally, a cable connected the robot controller to the pendant. New wireless technology eliminates the cable, reducing the risk that operators could trip over the cord or becoming entangled with other equipment in the work cell. Cableless technology permits the teacher to be in close proximity to the robot during the teaching function. Eliminating cables also helps reduce installation and maintenance costs.

To prevent confusion about which pendant controls a specific robot, the new ISO standard includes requirements for unique identification of cableless devices. This means only one cableless pendant can be used per robot to prevent unintended operation of another robot that may result in a hazard to personnel.

## ***Human-Robot Collaboration***

New software and safety system functionality is revolutionizing the way robots and people interact. Traditionally, safety guards or other barriers cordoned robots off from people to prevent injuries from fast-moving robot operations. If an operator needed to interface with the robot – to load or unload parts within the machine’s work space for example – the safety control system would need to help confirm that the robot was in a safe state or safe position, which typically meant safely limiting its motion under certain conditions or bringing it to a full stop and removing its energy source. This approach slowed productivity.

New software-based safety systems can slow a robot to a safe speed or otherwise direct a robot’s motion to a safe position or a safe state, allowing people to share the same workspace with far less risk. Collaborative robots – called “cobots” in the industry – work hand-in-hand and side-by-side with people. For instance, thanks to this new safe-speed core technology, a robot might lift and position a heavy sheet of metal while skilled human hands weld parts onto the larger piece.

In addition, the development of environmental awareness sensors allows collaborative robots to “see” the human co-worker, which triggers the robot to go into a safe position or safe state, and “wait” in safe mode until the human moves out of the range and an operator resets the motion.

## ***Robot-to-Robot Synchronization***

The traditional robot configuration is simple: one arm, one controller and one teach pendant held by a human teacher. In this scenario, robots lack the capability to easily coordinate sophisticated actions with other robots in jobs that require more than one arm.

The result: Even a simple task like wringing out a washcloth becomes complicated. One teacher first must “teach” his robot to perform an action, such as turning one end of the washcloth one way, and then stop. Next, the other teacher instructs her robot to turn the other end of the washcloth in the opposite direction, and then stop. And so on. This process requires a lot of time and resources.

New technology allows one teacher or maintenance person to employ a single controller and a single teach pendant to coordinate the actions of multiple robots, typically four per teach pendant. This ability to teach multiple arms can help significantly increase productivity by reducing commissioning and set-up times and associated costs.

## ***Vision-based Guard Systems***

A new 3-D safety-rated vision intrusion system can keep robots and people separate in the work space without the costs and hazards involved with perimeter fencing. This electronic and programmable perimeter guarding system includes three video cameras mounted overhead in the work cell, which can detect when someone enters

the hazard zone. The system then signals the intruder about the danger by issuing a visual or audio warning.

The system also signals robots in the space to slow down or stop, thus helping reduce risk. Once the hazard zone is clear, the robots are reset and operations can safely resume.

## **Integration Enables Work Zone Protection**

With the growing capabilities and complexities of robotics, integrating the safety data from the work cell is more important than ever. Advanced automation systems help manage and make sense of this data, providing workers with a systemic view of the overall operations within the work cell.

Safety-rated programmable logic controllers (PLCs) play a crucial role in robotic work cells. They collect input data from sensors about the status of a person versus a robot within the space, as well as inputs from safety devices such as e-stops, pendants, position sensors and interlock switches. PLC outputs help control the robot power circuit, robot servos and other servos in the cell, as well as any other present motors, hydraulics or pneumatic devices. Additionally, safety technology that directly connects the robots to the safety bus has the potential to provide more granular data via human-machine interfaces.

With automated safety diagnostics that already exist, users of robotic systems can easily obtain information about the specific component and circuit of the component that is causing a problem, rather than having to manually check each part of the safety system. This reduces troubleshooting, maintenance time and overall operating costs, improving Mean Time to Repair (MTTR) and productivity.

Ultimately, data provided by advanced automated safety systems contributes to continuous improvement initiatives by measuring a robot system's faults and failures on a statistical and historical basis. For example, if managers know that a certain safety component historically fails more often than another, the problem can be corrected to save future maintenance time and money.

## **Industry initiative**

As manufacturers continue to push the boundaries of production speed and efficiency, the robot will play an increasingly important role in helping protect personnel and boost output while reducing operating costs. It is up to the industry to take initiative and help ensure safety standards meet the requirements of today's high-speed, highly accurate manufacturing practices and techniques. The good news is that new robot capabilities and integration technologies are helping extend the speed and efficiency advantages the robot brings to the plant floor without compromising safety.

**[www.rockwellautomation.com](http://www.rockwellautomation.com)**

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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, Vorstlaan/Boulevard du Souverain 36, 1170 Brussels, 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