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EXECUTIVE SUMMARY

Risk Assessment Methods for Machine Safety and Cobots

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KEY TAKEAWAYS

- Companies must establish a standard method for risk assessments and identify cross-functional teams to conduct them.
- A successful risk assessment relies on internal investigation, a robust team, and the right expertise and partners.
- Before conducting risk assessments, it is essential to select a hazard identification standard and use it consistently.
- Firms must also standardize on a method for quantifying risks.
- A full risk assessment includes risk mitigation and quantifying the impact of the control measures.
- Although cobots are designed to work safely among humans, organizations still need to perform risk assessments.

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Risk Assessment Methods for Machine Safety and Cobots

OVERVIEW

When building a machine safety mindset, a fundamental building block is establishing a risk assessment method. Risk assessments must be conducted by cross-functional teams that include operators and other individuals who are knowledgeable about equipment and how it is used on a day-to-day basis. Since risk assessment is subjective, organizations need to standardize on hazard identification and quantification methods. The resulting information will simplify the process of prioritizing and mitigating safety risks. Cobots can't be overlooked during risk assessments. Companies must incorporate Type C standards into their risk assessment templates.

CONTEXT

Peter Rigakos discussed how to create a comprehensive risk assessment program that includes cobots.

KEY TAKEAWAYS

Companies must establish a standard method for risk assessments and identify cross-functional teams to conduct them.

Risk assessment is not a task for one person alone. Multiple disciplines must work together and help each other. The key to success is understanding the equipment and what it does. Although many believe that engineering should be responsible for risk assessments, an article published by the American Society of Mechanical Engineering in 1992 noted that engineers lack the tools and safety theory to understand how to identify hazards and risks. Instead, companies must establish a standard method to define what is safe.

> Risk assessment provides more information than the risks associated with a machine. It trains everyone to understand machines better and, more importantly, to find the risks that are hiding.
>
> *Peter Rigakos, Schmersal*

A successful risk assessment relies on internal investigation, a robust team, and the right expertise and partners.

Four prerequisites for a successful risk assessment are:

1. **Investigation.** The first step is watching the machine in each mode and observing the operator interacting with it. The best way to get up to speed is to talk with multiple operators and maintenance people. The magic question is, "What do you hate about working with this machine?" This dialogue will identify why people are tempted to bypass safety mechanisms.

   The goal of a risk assessment is to identify solutions that mitigate the safety risks. Before deciding what technologies to use, operators must weigh in about whether the solutions are possible and practical. For example, a potential solution might cause slowdowns or production failures. Production and safety must be balanced, so workers don't bypass safety solutions.

2. **The team.** Assemble the right people and ask the right questions. In addition to operators and maintenance, it can be helpful to talk with EH&S, engineering, designers, machine builders, and service technicians. Working with people who know the machines intimately leads to better designed safety features.

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3. **Expertise.** The cross-functional team may not have all the knowledge needed. For example, do they understand safety circuits and safety controls? Many risk assessments fail to review the controls, hydraulics, and pneumatics. It is critical to review the controls that may be hidden hazards.
4. **Partners.** It is fine not to have all the expertise in-house. Companies must identify the partners they want to work with and how those partners will provide the necessary documentation for various portions of the machines.

Before conducting risk assessments, it is essential to select a hazard identification standard and use it consistently.

Risk assessment is subjective, so it is best to standardize as much as possible. A variety of ANSI and ISO standards discuss hazard identification and methods for quantifying the risk associated with hazards. It doesn't matter which standard a company adopts. Once a firm selects a standard, however, it must use it company-wide in a consistent way.

ISO and ANSI Standards Related to Hazard Identification and Quantification

- ISO 31000 Risk management – Guidelines
- ISO 31010 Risk management – Risk assessment techniques
- ISO 12100 Safety of machinery – General principles for design – Risk assessment and risk reduction
- ISO/TR 14121-2, Safety of machinery — Risk assessment — Part 2: Practical guidance and examples of methods
- ANSI Z10 Occupational Health and Safety Management Systems standard
- ANSI B11.0 Safety of Machinery; General Requirements and Risk Assessment

In addition to adopting a hazard identification standard, companies must train teams on how to look for potential hazards. Finding hidden hazards can be difficult. Companies may want to pair employees that are new to hazard identification with a seasoned employee during their initial risk assessments.

Firms must also standardize on a method for quantifying risks.

Once a hazard has been identified, the team must quantify the risk associated with it. Many frameworks

Figure 1: Quantifying Risk Using the Hazard Rating Number (HRN) Method

Likelihood of Occurrence (LO)		Frequency of Exposure (FE)		Degree of Possible Harm (DPH)		# of Persons at Risk (NPE)	
0.033	Almost Impossible	0.1	Infrequently	0.1	Scratch / Bruise	1	1-2
0.5	Highly Unlikely	0.2	Annually	0.5	Laceration / Mild Ill Health	2	3-7
1	Unlikely, but could occur	1	Monthly	1	Break Minor bone	4	8-15
2	Possible, but unusual	1.5	Weekly	2	Break major bone	8	16-50
5	Even chance, could happen	2.5	Daily	4	Loss of 1 limb/eye	12	51+
8	Possible, not surprised	4	Hourly	8	Loss of 2 limbs		
10	Likely, to be expected	5	Constantly	15	Fatality		
15	Certain						

LO		FE		DPH		NPE		HRN
10	x	5	x	8	x	1	=	400

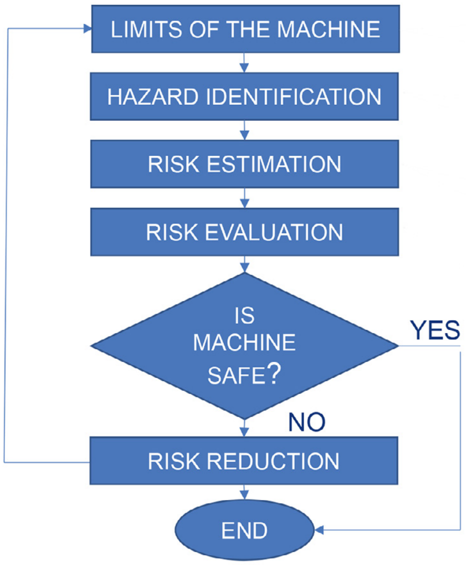
Negligible	Very Low	Low	Significant	High	Very High	Extreme	Unacceptable
0-1	> 1 – 5	> 5 – 10	> 10- 50	> 50 – 100	> 100 – 500	> 500 – 1000	> 1000

exist. One commonly used approach is the Hazard Rating Number (HRN) method. This methodology evaluates the likelihood of a risk occurring, the frequency of exposure to the risk, the degree of possible harm, and the number of people at risk. Quantifying risk is a team exercise. Groups should include an odd number of people, in case they need to vote.

A full risk assessment includes risk mitigation and quantifying the impact of the control measures.

After the team has quantified the safety risks, they must prioritize the risks to identify which they will mitigate first. A full risk assessment quantifies the risk a second time with the safety guarding in place. If the hazard rating decreases, the team knows that it has accomplished its goal.

Figure 2: Risk Assessment Flowchart



Although cobots are designed to work safely among humans, organizations still need to perform risk assessments.

Collaborative robots, or cobots, perform many different functions with different potential hazards. For example, the danger associated with picking and placing products with a suction cup is much lower than opening boxes with a knife or cleaning burrs off a part with a drill.

ISO Type C standards apply to machines including cobots and they include specific things that safety teams should evaluate, such as transient contact or quasi-static contact. A cobot risk assessment follows the basics of any standard risk assessment, but it must also include the Type C standard elements.

One approach is to break risk assessments into two parts:

1. **Task-based risk assessment.** This examines the hazards associated with tasks completed by operators and maintenance staff during setup, cleaning, operation, and more.
2. **Machine-based risk assessment.** This addresses items from the Type C standards.

By using this type of risk assessment template, companies can re-open a risk assessment if they later add a cobot to their operations and address the machine-based risk assessment questions.

Four steps for getting started with risk assessments that include cobots are:

1. **Identify the quantifiable methods that the organization will use for risk assessment.** One example is the HRN methodology, but many other approaches exist.

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2. **Determine the Type C standards used in the facility.** Based on this information, identify the machines that use Type C standards.
3. **Create a risk assessment template.** Teams can do this either in a spreadsheet or with specialized software. Introduce the organization's quantifiable methods and add sections to answer Type C questions.
4. **Remember that you don't have to go it alone.** Third-party companies can help you get started or they can perform the work for you.

> Although cobots are designed to work safely among humans, organizations still need to perform risk assessments. The danger associated with picking and placing products with a suction cup is much lower, for example, than opening boxes with a knife or cleaning burrs off a part with a drill.
>
> *Peter Rigakos, Schmersal*

BIOGRAPHY

Peter Rigakos
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Peter is a licensed Professional Engineer; he holds a Bachelor of Science in Electrical Engineering from Saginaw Valley State University and an MBA from Purdue University West Lafayette.

Peter started his career as an Electrical Engineer designing and reviewing automated safety systems primarily for automotive manufacturing facilities. Since that time, Peter has gained extensive knowledge in machine safety for various industries, allowing him to obtain his TUV Functional Engineering certification.

Before joining Schmersal in 2012, Peter worked for a diverse range of organizations, including consulting, integration, and engineering design, all within the industrial automation industry. Each of these roles prepared him to understand the industrial machine safety industry.

Peter also supports technical colleges by offering a strategic plan for instructors to implement topics related to machine safety automation into their curriculum. The safety curriculum includes hands-on workshops and lectures on issues related to machine safety automation.