RISK MANAGEMENT

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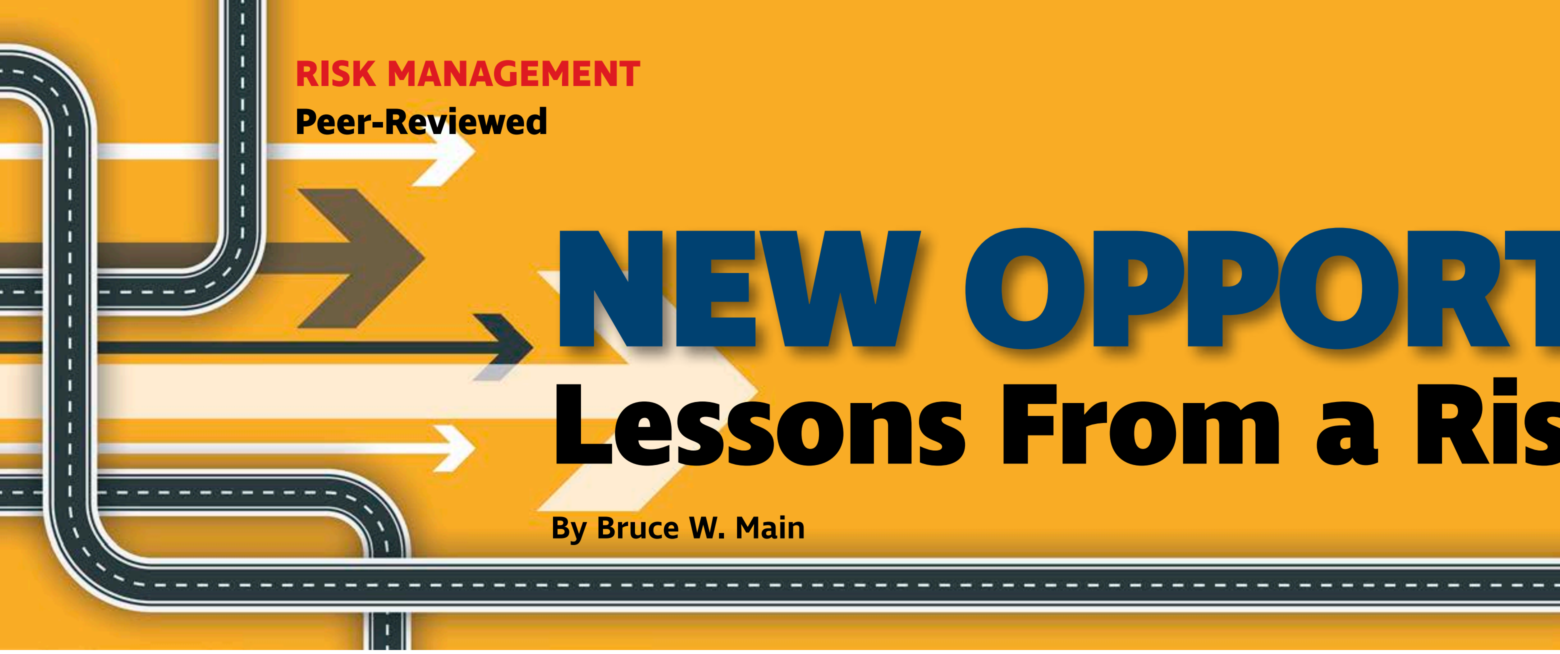


NEW OPPORT

Lessons From a Ris

By Bruce W. Main

PERFORMING SAFETY FIXES ON BRAND NEW MACHINERY to correct unsafe situations is often necessary, usually not very effective or efficient, and often stressful and accompanied by blame and finger-pointing. The risk assessment process is the vehicle for safety professionals to affect the safety of machinery and equipment before it is built or installed. Getting it right the first time can have positive effects for many years. Unfortunately, few safety professionals become engaged in new machinery purchases until late in the process, often not until the equipment is on the factory floor.

Safety professionals have new opportunities to make significant contributions in keeping people from harm. This article shares a perspective on some exciting opportunities available and how safety professionals can get involved.

3D Modeling

One interesting and exciting advance in conducting risk assessments is working with 3D software models of machinery, equipment and processes before the physical systems are actually built. Solidworks, Autocad and similar software 3D modeling tools provide a rendering of the finished product that can be viewed from any perspective with different layers or parts exposed or hidden. A sample 3D model for a machine is shown in Photos 1 to 3.

Conducting risk assessments on 3D models allows analyses of the systems to be conducted when changes are easy and inexpensive to make, and the positive impacts can be significant. Retrofitting is difficult, expensive and sometimes impossible.

For example, on a risk assessment of a prototype eyeglass lens coating machine, the engineers had developed a 3D model that included the lenses entering the machine, exiting the machine and a chute for rejected lenses. During the risk assessment, the team realized that the chute ended in the center of the machine with no available access. Had this machine been built at that time, the operators would have had to lockout the machine, remove guards and crawl under the machine to remove the rejected lenses, or, more likely, the guard would be removed and not reinstalled. Identifying this task and associated hazards with the 3D model allowed redirecting the reject chute in a way that enabled lens removal without having to stop operations. Small differences can have big impacts.

Another interesting aspect of this risk assessment was the engineers' reaction and nervous laughter when this situation was identified. Since the issue was identified before the machine was built, it was a funny oversight that everyone enjoyed. No harm, no foul, no blame. Had this machine been built and the problem identified on the factory floor, there would have been little humor, as safety professionals well know.

Safety professionals do not need to be adept at creating or manipulating the 3D models; engineers can do that. Safety professionals can offer safety perspectives and insights to identify tasks and hazards using the 3D models, just as they can with equipment after it is built and on the factory floor.

Lesson: Risk assessments can be and increasingly are being conducted on 3D models of machines, equipment and processes before the designs are finalized. This allows changes to be made to the design for safety considerations rather than trying to fix safety problems after the systems are built. This is the essence of prevention through design (PTD). Make use of the technology available.

Alternative Methods: The Future of Lockout

Controlling hazardous energy is critical to worker safety. OSHA has required lockout as its preferred/only method to control energy under 29 CFR 1910.147 since it was first published in 1989. Lockout is effective in this regard, but some tasks cannot be performed under lockout. OSHA is considering modifying its requirements for the control of hazardous energy, and this standard is currently on the regulatory agenda. However, the process will take years. Until OSHA decides what to do and implements its response according to the rulemaking process, employers and OSHA must deal with the current requirements under 29 CFR 1910.147.

Conversely, new technology offers options that allow for the control of hazardous energy in lieu of lockout. This situation is termed *alternative methods* in the industry standard ANSI/

KEY TAKEAWAYS

- **Safety professionals need to learn the risk assessment process and become capable in applying it to workplaces, machinery, equipment and processes; those who do will add value to any organization and help move safety into design, which is the essence of prevention through design.**
- **Lessons learned from a risk assessment journey provide important guidance for safety professionals seeking the ability to influence safety in the workplace.**
- **Risk assessment presents an opportunity for growth and improved understanding to become a better safety professional.**

ZMICIERKAVABATA/ISTOCK/GETTY IMAGES PLUS

TUNITIES IN SAFETY
sk Assessment Journey

ASSP Z244.1, The Control of Hazardous Energy Lockout, Tagout and Alternative Methods.

Alternative methods are means of controlling hazardous energy other than energy isolation to reduce risk to an acceptable level. Alternative methods tend to use engineering controls that are more reliable than administrative procedures such as lockout (Table 3 of ANSI, 2020).

Typically, alternative methods include multiple engineered controls and procedural steps to ensure that no unexpected motion occurs when performing a task. Examples of alternative methods used in industry include:

•interlocked guard door panels on many machines for clearing jams (prevents motion when door is open);

•interlocked access gates surrounding robotic systems for setup tasks (prevents motion);

•hold-to-run control devices for cleaning and sanitizing food or bottling processing lines (enables safe motion);

•light curtains on presses used for jam clearing (prevents motion);

•safety-rated valves for hydraulic or pneumatic applications (prevents flow or motion).

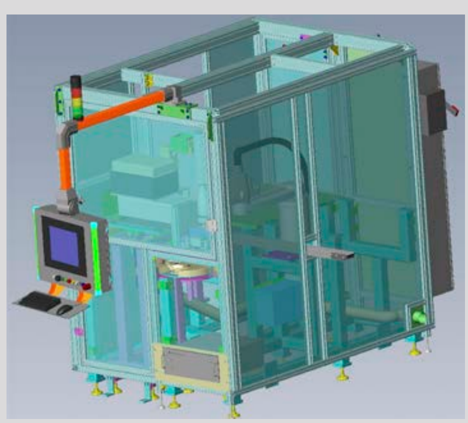
If properly designed, alternative methods can provide workers with better, safer, faster, more productive, more reliable and easier means to complete tasks as compared with lockout.

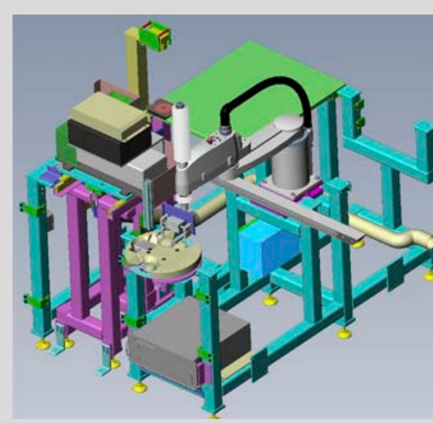
At one manufacturing facility, the day shift supervisor shared that about 85% of the lockout violations were simple human errors, such as not locking out all energy sources, failing to verify or not documenting procedures properly. Most lockout violations were not intentional acts to circumvent or defeat lockout requirements. This speaks to the importance and potential advantages of using properly designed and implemented engineering controls rather than relying on administrative procedures.

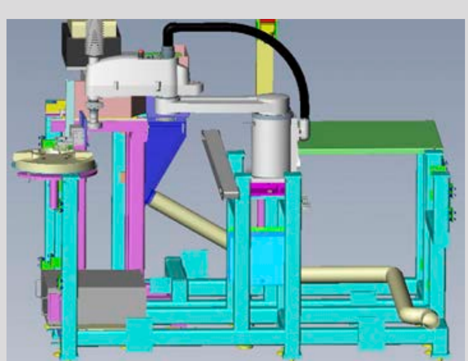
However, improperly designed control systems can be hazardous. Alternative methods must be done correctly in accordance with ANSI/ASSP Z244.1.

Taking advantage of alternative methods requires completing a documented risk assessment as required under ANSI/ASSP Z244.1. In addition, using alternative methods may run counter to OSHA's requirements now and for the foreseeable future. Being able to demonstrate compliance with ANSI/ASSP Z244.1 will be helpful if OSHA conducts an inspection of a workplace and takes issue with an alternative method being used in lieu of locking out.

Lesson: Significant opportunities for improvements exist in using alternative methods to control hazardous energy versus lockout. Making use of these methods requires a documented risk assessment. Safety practitioners skilled in risk assessment will be able to add value in this regard. This is a major area of growth going forward.







(Clockwise from top left) Photo 1: Machine with guard package shown.

Photo 2: 3D model of machine with robot and machine structure (guard package and above structure hidden).

Photo 3: Machine with robot and ventilation system highlighted (guard package hidden).

Existing/Legacy Machinery Risk Assessments

Risk assessments are most easily conducted on existing machinery and equipment on the plant floor. For example, Photos 4 to 6 depict hazards that are readily identifiable. The risk assessment process must be both practical and scalable. Risk assessments can be conducted for a single hazard on one machine or for all hazards on all equipment in a facility. The hazards can be identified, and appropriate risk reduction measures developed. This same methodology can be scaled up to an entire facility with the appropriate staffing and tools.

The risk assessment process should apply to both new and existing or legacy machinery, equipment and processes. ANSI B11.0, Safety of Machinery, states the following regarding existing (legacy) equipment:

> When evaluating existing machinery, the risk assessment process shall include but not be limited to the following:
> - experience in the field;
> - history of past incidents;
> - similar machinery and processes;
> - reports of near misses;
> - number of machines in the field;
> - lifespan of the equipment;
> - new information regarding hazards;
> - internal safety audits or regulatory visits.
>
> ***Informative Note 1:*** ANSI B11.0 presents a standardized risk assessment process that can be used to evaluate existing machines and/or systems. The supplier and/or user should decide when and what existing machinery should be evaluated.
>
> The requirements for risk assessment and applicable standard for machinery shall be determined by Table 1. (ANSI/B11 Standards Inc., 2020)

Table 1 shows the requirements for new and existing machinery stipulated by ANSI B11.0-2020.

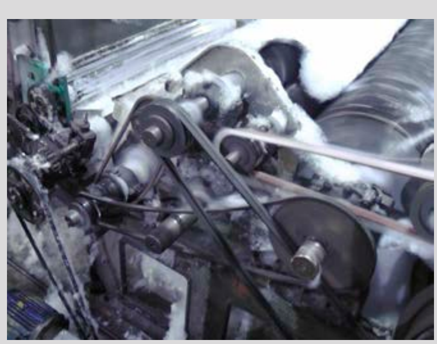
Unfortunately, the ability to make changes when machinery or equipment is already on the floor is the most challenging. Since safety improvements and enhancements often result from the risk assessment effort, usually with potential productivity improvements, the risk assessment process is naturally driven further upstream in product design before construction even begins.

For example, a risk assessment was conducted for a machine user on a machine that was being built by the supplier. The machine was still being constructed at the time. One result of the risk assessment identified the need for Category 2 emergency stops, which requires redundant architecture per ISO 13849-1 (2015). The supplier had only wired the machine for Category 1 emergency stops (single channel), which presented a significant problem. The contract between the supplier and user was reviewed and, ultimately, the machine supplier had to rewire the machine to achieve the safety performance requirements.

Pulling wires on a partially assembled machine is rework and costly, certainly not as costly as having to do so on the customer's factory floor, but still wasteful. Had this situation been identified earlier in the design process, the correction cost would have been trivial.

Lessons: Properly applied, the risk assessment process is both practical and scalable, and can be applied to single hazards or entire systems including existing/legacy equipment. Not only can risk assessment be conducted from 3D models and before the first screw is tightened on a machine, but it can also be used for legacy equipment on the floor.

Risk assessments conducted after machinery construction has started can be expensive when corrections are required. Start risk assessment early in the design process because spending the time up front can allow for the savings of time and money down the road and will better keep people from harm.



(Clockwise from top left) Photo 4: Aluminum die casting. Identified hazards include pinch points from die closing; tripping on debris on floor; impacts from turntable motion; and heat from molten aluminum and dies.

Photo 5: Flour bag conveyors. Identified hazards include nip points.

Photo 6: Polyester combing gin. Identified hazards include pinch points at belts; rotating shafts; and nip points at drive chains.

Checking Self-Certification

On many occasions, European manufacturers import equipment into the U.S. and seek assistance complying with U.S. requirements. The machinery suppliers from the EU frequently claim that the machine is safe, that it meets all the requirements under the EN or ISO standards, and that no changes are needed for use in the U.S. marketplace. Sometimes this is true. More often, the situation is rife with problems. In those circumstances, the machine typically does not meet the standards claimed and needs improvements to be acceptable for use in the U.S.

One example occurred on a CE-marked machine imported from the EU. The CE mark is used to indicate that the machine complies with the applicable requirements in European laws, in particular, the Machinery Directive (EU, 2006). By placing the CE mark on this machine, the manufacturer represents that the machine complies with the applicable EU requirements and that it is safe for use.

Yet, during the risk assessment, a task involving threading the machine was identified that required maintenance personnel to enter the machine with another person outside the perimeter fencing operating the machine. That is correct, the machine was being operated with a person inside the machine. This clearly violates several ANSI, OSHA, EU and ISO machinery safety standards.

The facility personnel knew this was how the task had to be performed because the machinery supplier's field service personnel performed the thread-up task in this way while commissioning the machine. Indeed, this was the only way to thread the machine and get it running.

This demonstrated that the thread-up task was not identified or appropriately considered during the design of the machinery. There was no way to perform this task with acceptable risk other than to rely on the maintenance personnel to look after each other and be lucky.

Employing inherently safe design and PTD are the best means for preventing injuries. This situation might be characterized as inherently unsafe design, yet the machine was CE-marked. This means that the machine user either must develop procedures for protecting employees from harm or develop an alternative design for the system so that the tasks can be performed safely. This should be completed by the machine supplier. But the machine was CE-marked as safe.

Lesson: CE-marked or purportedly certified machines may not be all that the supplier represents them to be in terms of safety. Do the homework, know what the standards and international laws require. If a safety professional lacks familiarity with the requirement, s/he should reach out to others in the industry who can offer guidance on making machines safer and conforming to standards and laws.

When No Standard Exists

It is usually a straightforward process to meet the detailed requirements of a machine-specific (type-C) standard such as ANSI/ASSP A1264.1-2017, Safety Requirements for Workplace Walking/Working Surfaces and Their Access; Workplace, Floor, Wall And Roof Openings; Stairs and Guardrail/Handrail Systems; ANSI B11.10, Safety Requirements for Metal Sawing Machines; or ANSI/RIA R15.06-2012, Safety Requirements for Industrial Robots and Robot Systems. Read the requirements, implement the solution. But what if no specific requirements exist or no standard is applicable?

One great use of risk assessment comes into play when no standard exists for a specific application, or when the machine, process or equipment is unique and, thus, the requirements do not fit well. How does one know if the design is acceptable if no requirement exists with which to demonstrate compliance? This becomes a subjective decision that many people fear making, especially engineers.

The beauty of the risk assessment process for a standard such as ANSI B11.0 is that it applies broadly. Although the hazards and subsequent risk reduction measures vary greatly from one application to another, the overall process of identifying hazards, assessing risks, reducing risks to an acceptable level, documenting the results and following up remain consistent across all applications that the author has encountered. This is not to say that risk assessment is a single solution to all safety problems; it is not.

TABLE 1

B11.0 REQUIREMENTS FOR NEW & EXISTING MACHINERY

Scenario and description	Requirement
1) New machinery/system (created utilizing new or used components)	Perform a risk assessment to confirm the risks are at an acceptable level. Comply with current applicable standard(s).
2) Repair/rebuild/refurbish machinery (utilizing comparable components)	No risk assessment required. Comply with applicable standard(s) existing at time of manufacture or initial installation.
3) Rebuild/refurbish machinery (utilizing noncomparable components, changing the use of the machinery)	Perform a risk assessment to confirm the risks are at an acceptable level. Comply with current applicable standard(s) on any new hazards.
4) Reconfigure/relocate machinery (existing machinery is relocated or layout is reconfigured)	Perform a risk assessment on any hazards created by the new layout or change in spatial configuration, and to confirm the risks associated with the reconfigured machinery are at an acceptable level.
	Comply with current applicable standard(s) on any new hazards associated with relocation. All other (pre-existing) hazards comply with applicable standard(s) existing at time of manufacture or initial installation.
5) Modify, reconfigure or remanufacture machinery (machinery or components are added to or removed from an existing machinery system, or are modified to introduce new features)	Perform a risk assessment to confirm the risks are at an acceptable level. Comply with current applicable standard(s).

Note. Adapted from Table 1 in "ANSI B11.0, Safety of Machinery," by ANSI/B11 Standards Inc., 2020.

INDUSTRY STANDARDS REQUIRING RISK ASSESSMENTS

- **aviation;**
- **chemical and oil;**
- **construction;**
- **consumer products;**
- **electrical systems;**
- **elevators/lifts;**
- **fire prevention;**
- **food;**
- **machinery;**
- **medical devices;**
- **military;**
- **occupational health and safety management systems;**
- **packaging machinery;**
- **risk management;**
- **robots;**
- **semiconductor equipment.**

Many different tools for risk reduction exist for good reasons. But the author has not encountered a situation in which the risk assessment process cannot be applied. The author has applied the process in applications including:
- automated baggage handling;
- automotive;
- cable making;
- consumer products;
- food;
- industrial cooling equipment;
- industrial truck equipment;
- laboratory and testing;
- longshoring operations;
- machine tools;
- pharmaceuticals;
- power generation;
- stationary and mobile robots;
- steel making;
- theater safety;
- wind turbines;
- waste treatment systems.

EXAMPLE OF AN UNNECESSARILY COMPLEX RISK SCORING SYSTEM

Consider the following example of an overly complicated risk scoring system (not a recommended method). This system assesses risk (R) along four factors: severity of the possible harm (S); frequency and duration of the exposure to the hazard (F); possibility of the occurrence of the dangerous event (O); possibility of avoidance or reduction of harm (A), thus, R = f (S, F, O, A).

Setting aside the details of how each factor is assessed, the four factors are combined in a colorful matrix (Figure A) to arrive at a risk level:

		Risk matrix (R)														
		F1			F2			F3			F4			F5		
		A1	A2	A3	A1	A2	A3	A1	A2	A3	A1	A2	A3	A1	A2	A3
S1	O1	R1	R1	R1	R1	R1	R1	R1	R1	R2	R2	R2	R2	R2	R2	R3
	O2	R1	R1	R1	R1	R1	R1	R1	R2	R2	R2	R2	R2	R2	R3	R3
	O3	R1	R1	R1	R1	R1	R1	R2	R2	R2	R2	R2	R2	R3	R3	R3
	O4	R1	R1	R1	R1	R1	R2	R2	R2	R2	R2	R2	R3	R3	R3	R3
	O5	R1	R1	R1	R1	R2	R2	R2	R2	R2	R2	R3	R3	R3	R3	R3
S2	O1	R1	R1	R1	R2	R2	R2	R2	R2	R2	R3	R3	R3	R3	R3	R3
	O2	R1	R1	R2	R2	R2	R2	R2	R2	R3	R3	R3	R3	R3	R3	R4
	O3	R1	R2	R2	R2	R2	R2	R2	R3	R3	R3	R3	R3	R3	R4	R4
	O4	R2	R2	R2	R2	R2	R2	R3	R3	R3	R3	R3	R3	R4	R4	R4
	O5	R2	R2	R2	R2	R2	R3	R3	R3	R3	R3	R3	R4	R4	R4	R4
S3	O1	R2	R2	R2	R2	R3	R3	R3	R3	R3	R3	R4	R4	R4	R4	R4
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	O4	R2	R3	R3	R3	R3	R3	R3	R4	R4	R4	R4	R4	R4	R5	R5
	O5	R3	R3	R3	R3	R3	R3	R4	R4	R4	R4	R4	R4	R5	R5	R5
S4	O1	R3	R3	R3	R3	R3	R4	R4	R4	R4	R4	R4	R5	R5	R5	R5
	O2	R3	R3	R3	R3	R4	R4	R4	R4	R4	R4	R5	R5	R5	R5	R5
	O3	R3	R3	R3	R4	R4	R4	R4	R4	R4	R5	R5	R5	R5	R5	R5
	O4	R3	R3	R4	R4	R4	R4	R4	R4	R5	R5	R5	R5	R5	R5	R5
	O5	R3	R4	R4	R4	R4	R4	R4	R5	R5	R5	R5	R5	R5	R5	R5

Let's delve down into the O factor of occurrence probability. To arrive at a value, this method uses the following table (Figure B):

No.	Item	Score
1	History of incidents due to specific kinds of machines or parts of machines	
	• No information	15
	• More than one incident per year	12
	• Between one incident per year and one incident per 10 years	8
	• Between 1 incident per 10 years and one incident per 30 years	4
	• Incident never happened	1
2	Parts in the dangerous zone that can create a hazard	
	• More than 5	15
	• 5 or 6	12
	• 3 or 4	8
	• 2 or 3	4
	• 1	1
3	Complexity of the operations	
	• High complexity	25
	• Medium complexity	10
	• Low complexity	4
	• Very low complexity	1
4	Technology for safety application	
	• Totally new technology (less than 3 years)	20
	• Partially new technology	15
	• Consolidated technology (between 3 years and 10 years)	4
	• Very consolidated technology (more than 10 years)	1
5	Concentration required for the operations	
	• Very high or very low	25
	• Medium	12
	• Normal	3
	Total score	**Maximum 100**

The outcome of this analysis is the following decision (Figure C):

Overall score	Parameter O
≤ 50	O1
> 50	O2

The occurrence probability is either likely or unlikely. Is all this analysis necessary for such a basic decision?

Since the mid-1990s, risk assessment has become a requirement in a wide array of industry standards and applications. Many industries now have standards that require a risk assessment be performed (see "Industry Standards Requiring Risk Assessments" sidebar on p. 39).

If risk assessment was just about safety, its application would not likely range as far and wide as it currently does. The requirements for risk assessments have proliferated because better machinery, equipment and processes result: more productive, faster, more reliable, easier to use and safer. Some examples include:

- clearing jams quickly and efficiently;
- cleaning faster and more effectively (to a microbiological level);
- controlling energy versus locking out;
- use of more reliable engineering controls versus depending on workers following procedures.

Lesson: The risk assessment process applies broadly. Becoming skilled in the process can take a safety professional in interesting directions.

Fears

Many people are afraid of the risk assessment process; therein lies opportunity.

Many engineers abhor the idea of having to make subjective decisions about risk. Engineers seem to want a formula, a table, a requirement from an authoritative body (e.g., a standard) to tell them what they need to do (specifically) to achieve acceptable risk. Engineers will go to great lengths to craft detailed tables and assign values to various elements and sub-elements of risk, then calculate a value against which they will know what to do.

Yet in crafting these marvelous systems, sometimes the subjectivity of the design becomes buried and obscured in the method, and a fundamentally subjective decision appears to be objective when in fact it is not objective at all.

Although the risk assessment process is subjective, the process allows teams to identify hazards, assess risks and reduce them to an acceptable level. The method points the way for better designs. Moreover, the process allows for capturing variables (e.g., personnel, products, methods of work) that may contribute to injury or illness in the future.

Several examples of useful risk scoring systems and approaches to the risk assessment process have been previously presented (Designsafe, 2011; Main, 2004).

To illustrate the point about fear of risk assessment, consider an example of an overly complicated risk scoring system presented in the "Example of an Unnecessarily Complex Risk Scoring System" sidebar.

The table (Figure B) appears to be an objective analysis to arrive at a quantitative value from which a specific O parameter is derived. Hiding in plain sight are the point values, how they were assigned and their impacts. Who determined the values and on what basis? Similarly, in the matrix (Figure A), what is the basis for the risk bands and how were they derived?

If these tools are contained in a standard or technical report, they appear credible. So, the single subjective decision of determining the O parameter becomes five different smaller subjective decisions with point values based on math that makes the decision appear objective. Often subjectivity in the risk assessment process is masked and elusive.

Whereas engineers delight in creating tables and charts to "quantify" risk, safety practitioners are often intimidated or afraid to make risk reduction decisions. Most safety practitioners are not engineers and fear being embarrassed by not having answers on what should be done for risk reduction. The path to avoid embarrassment is often disengagement or finding other things to do that provide plausible deniability. This is unfortunate as the key contribution safety practitioners can bring is an understanding of the risk assessment process. There is plenty of help available in selecting appropriate risk reduction measures. Driving the risk assessment process should be well within the purview of safety practitioners.

Lesson: Do not let fear dissuade or derail risk assessment efforts. Learn the process and lead it. Do not allow engineers' fear of subjectivity to drive the risk assessment process into gymnastics to try to appear scientific. Risk assessment is subjective. Do the homework and be able to support the decisions. Teamwork and collaboration coupled with input from the factory floor can help to overcome obstacles.

Training

The author has trained more than 3,000 people on the risk assessment process. The training is hands-on whereby participants learn by performing risk assessments on actual machinery, equipment or projects in their facilities or product lines. Participants typically include engineers, senior production personnel, maintenance leads and safety practitioners. In most cases, all participants are engaged in the training during the entire session. Yet, on many occasions, those in safety leadership roles disengage. It is not unusual that safety personnel have other things to do during the training, but it is still a bit disappointing. Sometimes they stay for the overview session before departing, but they often miss the revealing questions and discussions with their coworkers that highlight the challenges the team faces.

The risk assessment process is critical for identifying hazards and preventing harm to workers or customers. One would think that safety personnel would want to lead such a critical process. The risk assessment process drives risk reduction efforts, decisions about acceptable risk, training that will be required, safe work procedures that must be developed or refined, and many other factors that impact safety of products and facilities.

Fortunately, several opportunities exist to learn about risk assessment and PTD in the form of books, industry standards, online training courses and conference presentations from professional organizations and other providers.

Lesson: Some safety professionals shy away from the risk assessment process when they should be a champion for it. One does not need to be expert in risk reduction to be a risk assessment leader. Again, teamwork and collaboration coupled with input from the factory floor can help to overcome obstacles. Be comfortable with the uncomfortable. It is an opportunity for growth and understanding to become a better safety professional.

How to Perform a Risk Assessment

There are several different ways to perform a risk assessment including methods presented in:

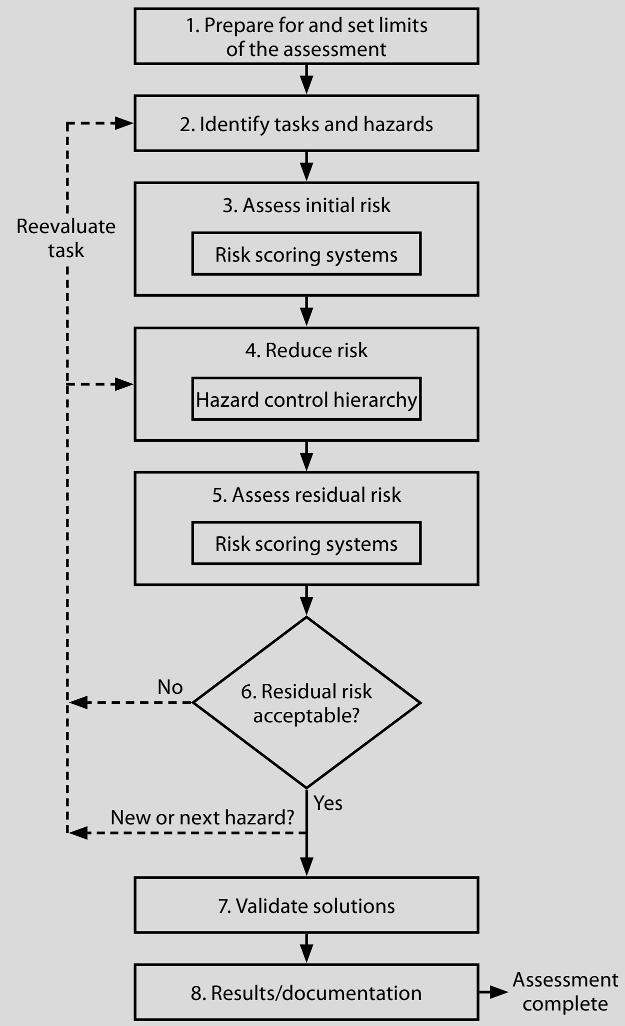
•ANSI B11.0, Safety of Machinery;

•ANSI/PMMI B155.1, Safety Requirements for Packaging Machinery and Packaging-Related Converting Machinery;

•ISO 12100, Safety of Machinery—General Principles for Design—Risk Assessment and Risk Reduction;

FIGURE 1

B11.0 RISK ASSESSMENT METHOD



Note. Adapted from "Safety requirements for metal sawing machines [(ANSI B11.10-2003 (R2015)]," by ANSI/B11 Standards Inc., 2015.

•ANSI/ASSP 590.3, Prevention Through Design Guidelines for Addressing Occupational Hazards and Risks in Design and Redesign Processes;

•ANSI/ASSP Z10.0, Occupational Health and Safety Management Systems;

•SEMI S10-1119, Safety Guideline for Risk Assessment and Risk Evaluation Process.

Each of these methods has more commonalities than differences, which is to say the differences are relatively small. The method the author uses most frequently for its effectiveness is the ANSI B11.0 and ANSI/PMMI B155.1 approach shown in Figure 1.

Although ANSI B11.0 applies to machinery, it has been used in a wide variety of applications in addition to machinery, including equipment, products and operations. The most critical steps in any risk assessment are identifying hazards and reducing risk. Hazards that are not identified cannot be addressed, which is often the source of harmful incidents.

Assessing risk is often where the risk assessment process becomes derailed. Assessing risk helps in prioritizing risk reduction efforts, but there is little intrinsic value in the actual estimation itself. Unfortunately, safety teams spend too much time and effort haggling over risk scores. Techniques can be used to help teams stay out of the weeds in assessing risk (Main, 2012).

Risk reduction is where design improvements occur. Using the hazard control hierarchy, the focus of discussions should be on feasible risk reduction measures that can be applied to improve safety. Feasibility is key; risk reduction measures must be evaluated against several factors including those described in ANSI B11.0:

- regulatory obligations;
- effectiveness;
- usability;
- durability, maintainability and ability to clean;
- ergonomic impact;
- economic feasibility;
- introduction of new hazards;
- productivity;
- machine performance;
- technological feasibility.

Lesson: There are many approaches to the risk assessment process. The most important parts are identifying hazards and reducing risks. Feasible risk reduction is the key to achieving acceptable risk. The good news is that this is often the fun part for engineers and floor personnel. These folks like to fix things and the entire spectrum of the hazard control hierarchy offers a great tool kit.

What Do Design Engineers Know About Safety?

In the early 1990s, a study examined the question, What do engineers know and do about safety? (Main & Ward, 1992). Key results from the research include:

> The major problem concerning design safety is providing the engineer with methods to address safety issues. Moreover, design engineers . . . receive little or no formal safety training.
>
> Most engineers (especially faculty) receive little or no formal safety training. This is a predictable consequence of what design engineers are not taught about safety.
>
> The results . . . indicate that motivating the design engineer is not a problem; engineers do not try to create unsafe designs. Therefore, if the hazard identification task is explicit or formalized within the design process, the subsequent hazard evaluation and control would likely follow.

The current status is only marginally better. Some university engineering programs teach engineers risk assessment and other safety methods, but most engineers receive no such formal training in their university studies. This is not a critique, but rather a factual observation that has implications to safety practitioners.

Lesson: Design engineers have historically received little training or tools on how to include safety in their designs. Safety practitioners can and should use the risk assessment process to help move safety into design, which is the essence of PTD. Safety practitioners could have an important role to play in PTD.

Conclusion

Risk assessment is not rocket science, but neither is it child's play or a fool's folly. There are pitfalls to be avoided and opportunities to exploit. Safety practitioners must learn the process and become capable in applying it to workplaces, machinery, equipment and processes. Read, study, get training and do risk assessments. Safety professionals able to identify hazards and develop feasible risk reduction measures will be valuable to any organization. **PSJ**

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Bruce W. Main, P.E., CSP, is president of Design Safety Engineering Inc. He is a member or chair of several national and international industry standards committees on risk assessment and safety of machinery, including ANSI B11.0 and ISO 12100. He is also the primary representative to the B11 Committee on behalf of ASSP. Main holds mechanical engineering degrees from MIT and University of Michigan, and an M.B.A. from University of Michigan. He has authored numerous articles, papers and books, and is a member of several professional engineering and safety organizations, including ASSP, where he is a professional member of the Greater Detroit Chapter.