Workplace Safety & Prevention Services

Ergonomics and Machine Safety/Robotics: Balancing Compliance with MSD Prevention

Don Patten
Specialized Practice Lead (Ergonomics)

Michael Wilson
Specialized Practice Lead (Machine & Robotics Safety)

Robert Vomiero
Specialized Practice Lead (Machine & Robotics Safety)

Workplace Safety and Prevention Services

Disclaimer

Workplace Safety & Prevention Services

What Is the MSD Prevention Guideline?

- The Guideline has been written to fit into common health and safety programs and provide step-by-step instructions on what needs to be done and how to do it.
- Resources have been created to help you problem solve and improve your workplace.
- Roadmap to success

STEP 1	Demonstrate Management Commitment and Leadership	Senior Management provide the leadership, vision, and resources needed to implement an effective **MSD prevention** program within the organization's overall Health and Safety program. Management is fully committed to continuously improving workplace health, safety and wellbeing.
STEP 2	Facilitate and Encourage Workers' Participation	An effective OH&S program includes the meaningful participation of workers. Workers know their jobs and are aware of potential hazards that are not known to others in the organization. Support for open communication about health and safety hazards, **including prevention of MSD**, is critical.
STEP 3	Plan Hazard Identification and Risk Assessment	A hazard identification and risk assessment process that **includes hazards related to MSD** is key for the prevention of injury and well-being. The management develops, implements, documents and maintains a risk assessment process that **includes MSD hazards.**
STEP 4	Conduct Hazard Identification and Risk Assessments	Perform hazard identification and risk assessment that **includes hazards related to MSD**, including anticipation of hazards being introduced by new equipment or processes. A process that includes the understanding of the root causes of injuries, **including MSD**, facilitates the selection and implementation of effective controls. *This element completes the first two parts of the Recognize, Assess, Control and Evaluate cycle.*
STEP 5	Develop a Set of Targets and Goals to Eliminate Hazards & Control Risks	Effective controls protect workers from workplace hazards. They prevent injuries, illnesses, and incidents, minimize or eliminate OH&S risks **including those related to MSD**, and help employers provide workers with safe and healthy working conditions.
STEP 6	Control Hazards and Implement Necessary Changes to Achieve Goals and Targets	All the hazard identification, risk assessment and planning are for nothing if the necessary changes are not made **including those related to MSD**. This step is therefore of the utmost importance: of course, good planning is needed but the whole OH&S program must support this step for an effective program to protect workers' health, safety and well-being and be more productive. *This element completes the third part of the Recognize, Assess, Control and Evaluate cycle.*
STEP 7	Provide Education and Training	Legally, workers must know about workplace hazards, **including those related to MSD**, and measures **that are in place to control them, so they can work safely.**
STEP 8	Evaluate Controls, the Program and Organization's Performance	Evaluate controls **including those related to MSD**. This should be done during implementation of the changes, shortly after their implementation and on an ongoing basis. To ensure that control measures remain effective, track progress in implementing controls, inspect controls once they are installed. *This element completes the fourth part of the Recognize, Assess, Control and Evaluate cycle for hazards, including those related to MSD.*
STEP 9	Document Lessons Learned and Stakeholders' Feedback	The OH&S program, **including MSD prevention**, is reviewed to identify gaps and barriers and areas for improvement. Report back to top management.
STEP 10	Review Processes, Achievements, and Identify Areas for Improvement	Management reviews the process and achievements and identifies areas for improvement. Management provides support for implementing measures to correct any deficiencies identified, **including those related to MSD prevention.**

https://www.msdprevention.com/Prevent-MSD.htm

Workplace Safety & Prevention Services

Problem Statement

- Human factors and ergonomics (HFE) often competes with other safety programs most of which are compliance and/or standards driven
- Questions to ask
  - Does the presence of a machine guard result in an increase in MSD hazards?
  - Are the requirements to protect humans from robotic equipment causing MSD hazards?

Workplace Safety & Prevention Services

Work Systems

- Think of work as a system of interconnected parts, all impacting one another trying to work in harmony towards a common goal
- That common goal may be hampered if there is some disruption in the system
- Central to that work system is the human and its relationship to machines and robots

Workplace Safety & Prevention Services

Machine Safety

- Legislation
  - Performance-based requirements
- Role of consensus standards
  - Technical and application requirements
  - Ergonomic considerations
- Complications

CSA Group ANSI American National Standards Institute ISO

Workplace Safety & Prevention Services

Machine Safety – Risk Assessment

- Hazard Focus
  - Acute versus chronic outcomes
- Risk assessment
  - May include several phases of machine's life cycle
- Trained eye to identify potential for MSDs
  - Consideration for CSA Z1004-12

CSA Group ANSI American National Standards Institute ISO

Workplace Safety & Prevention Services

Guard Openings and Minimum Safe Distance

- Presented in CSA Z432-16
  - Table 10.2 – legacy data
  - Table 10.3 – data from CAN/CSA ISO 13857

Workplace Safety & Prevention Services

Machine Design and Application Requirements

- Emergency stops
  - Accessible
  - Shrouding
- Two-hand controls
  - Height of controls
  - Spacing of buttons
- Enabling devices
  - Pressure required to activate
  - Duration of use

Source: WSPS

Workplace Safety & Prevention Services

Safe Distance Calculations

- Two hand controls: Potential to release buttons and access hazard
- Interlocking doors: Ability to reach hazard before safe state is achieved

Distance = Speed x Time

$$Ds = [K \times T] + Dpf$$

Where: Ds = Minimum safe distance
K = Speed of the hand (1.6 m/sec or 63 inches/second)
T = Overall stopping performance
Dpf = Depth Penetration Factor

Source: CSA Z432 (2016), Safeguarding of Machinery, clause 10.11

Workplace Safety & Prevention Services

Motivation to Defeating Safeguarding – Annex G, Z432

- Improperly applied safeguarding measures
- Poor visibility of the process
- Hard to address 'minor' process issues
- Maintenance and setup activities were not part of design considerations

Machine Design and Controls

- Control panels
  - Location and access to buttons
  - Colours of buttons
  - Glare, contrast
  - Location of labels
- Ability to detect warnings and alerts
  - Background noise

Human Performance

- Informative Annexes of CSA Z432, Z460, Z462
- Error precursors
  - Task Demands
  - Work Environment
  - Individual Capabilities
  - Human Nature

Robotics- Some background on robot standards

Robotics – Some background on robot standards

- ISO 10218:2011 International Robot Standard
  - Is the seed document for CSA/ANSI
- ANSI/RIA R15.06-2012 (US Robot Standard) – harmonized with and fully adopted ISO 10218:2011
  - ANSI publishes technical reports to assist with implementation, knowledge transfer, and clarity
- CSA Z434-14 (Canadian Robot Standard) contains 'deviations' – harmonized with ISO 10218:2011 with some 'Deviations'
  - Deviations highlight some differences between CSA and ISO/ANSI
  - Assist with implementation, knowledge transfer, and clarity
  - Deviations marked with a 'DV' in the standard
- Robot Standards (ISO/ANSI/CSA) – Structure
  - Part 1 – Robot manufacturer requirements
  - Part 2 – For Robot Integrators, Suppliers, and End-Users

Ergonomics and Robotic Systems Design

- **Manual Load/Unload Stations:**
  - A key aspect in the design of a robot cell, is the interface between the robotic equipment and the operator.
    - Robot Standard –CSA Z434-14 (ISO 10218:2011) - Manual L/UL Stations - Part 2, Clause 5.10.6
    - ISO Technical Report – ISO/TR 20218-2:2017 - Manual L/UL Stations
  - Robot cell Manual Load/Unload Station design involves both machine/robot hazard safeguarding as well as MSD hazard considerations.
  - Design challenge for both equipment engineers and ergonomists?
    - Compliance with both machine/robot standard safeguarding requirements (i.e. per CSA Z432, CSA Z434, etc.), and achieving ergonomically sound design.
    - Can manage this change using CSA Z1004 and the MSD Prevention Guidelines.

Purpose of Risk Assessments

- Evaluate potential for injury or damage to health under hazardous situations presented by machinery.
- To select appropriate risk reduction methods and monitor their effectiveness

Workplace Safety & Prevention Services

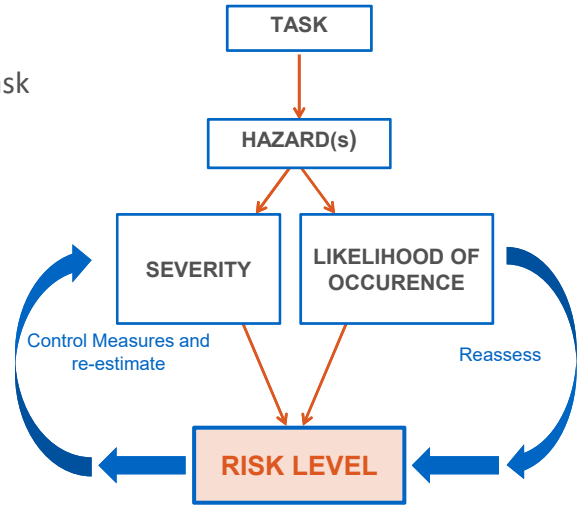
Risk Assessments

- CSA Z434 requires a risk assessment be carried out on all robot systems.
- CSA standard indicates Integrator responsible for risk assessment
  - Involvement/input from the user is required
  - Ultimately the employer is responsible for health and safety
- Conducted in the design lifecycle phase of the robot cell, or prior to making modifications.
- MSD hazards should be considered during risk assessment (i.e. part load task/process hazards; line-of-site of controls, warning lights, signage, etc.).
  - Ensures sound ergonomic design principles will be incorporated in the overall risk reduction strategy.

Workplace Safety & Prevention Services

Risk Assessments Fundamentals

- Task based – Hazards are assessed for each task
- Involves all stakeholders (e.g., Integrators, Operators, Maintenance, Ergonomist, Engineering, Health and Safety…), in order to develop a comprehensive 'Task/Hazard List'
- Hazards are initially assessed assuming no safeguards are in place



Manual Load/Unload Stations - Overview

- CSA Z434-14 – Part 2 (ISO 10218-2:2011), Cl 5.10.6 and ISO/TR 20218-2 – Overview
  - ISO 10218-2, Cl 5.10.6 – Normative requirements for the design of Manual L/UL Stations
  - ISO/TR 20218-2 – Supplemental design guidance/information to ISO 10218-2.
  - The Robot Standard and supplemental Technical Report focus on three main areas of safety of Manual L/UL Station:
    - Preventing access to Manual L/UL hazards (i.e. fixture clamps, resistance welding guns, fixture turntables, shuttle-tables, pneumatic/hydraulic actuators, etc.).
    - Preventing access past the Manual L/UL Station into robot cell safeguarded space.
    - Preventing the robots and human from being in the Manual L/UL area at the same time.

Manual Load/Unload Stations – Overview cont…

- CSA Z434-14 – Part 2 (ISO 10218-2:2011), Cl 5.10.6 and ISO/TR 20218-2 – Some General Requirements:
  - — Since Manual L/UL stations act as a barrier to prevent human access into the robot cell the design requirements in the following standards are referenced:
    - ISO 14120 – Design of Fixed and Moveable Guards, and
    - ISO 13857 – Upper and Lower Limb Reach Safety
      - Contains tables that provide barrier guarding height, and opening size dimensional requirements.
      - Prevent upper and lower limb reach **A**round, **U**nder, **T**hrough, or **O**ver of barrier guards (i.e. sometimes referred to as **AUTO** rule)

Workplace Safety & Prevention Services

Manual Load/Unload Stations – Some design considerations

- Minimum height requirement for Manual L/UL Stations is 1400mm
- For manual stations between 1000mm up to 1400mm in height additional protective measures should be taken to:
  - Prevent operator exposure to application hazards (e.g. weld sparks, ejected parts)
  - Prevent operator access to hazards inside robot cell safeguarded space or bring hazards to a safe state before access is possible.
  - Ensure that a robot system and operator cannot access the same (shared) workspace at the same time (e.g. the Manual L/UL Station workspace)
- Barriers heights lower than 1000mm in height do not provide sufficient level of impedance.

Workplace Safety & Prevention Services

Manual Load/Unload Stations…Importance of Ergonomics

- If sound ergonomic principles are not considered in the design phase – Manual L/UL station may be designed to solely meet robot safety standard (and Technical Report) dimensional requirements.
- Resulting design of loading station may result in unnecessary MSDs
- Sound ergonomic design for equipment early in the design phase may alter the safeguarding strategy, and safeguarding devices incorporated.
  - This is true with respect to both the dimensional design of the Manual L/UL itself, and the overall process layout (i.e. process time-motion study results).
- Making changes to the equipment after MSD injuries occur is very costly.
  - Can take some time before manifesting themselves.

Workplace Safety & Prevention Services

Outcomes

- Implementing machine safety/ robotics standards could have a positive impact on your MSD prevention program
  - For this to work you must look at ergonomics in the design phase
- Capturing these successes will help build your MSD prevention program even if that wasn't your original intent

Workplace Safety & Prevention Services

Revisiting Work Systems

- There is a strong relationship between various work system elements (machine/robots) and ergonomics
- Success of any program is how well it can be understood and performed by the human
- The guideline offers a framework to manage change and ensure long term success

Workplace Safety & Prevention Services

Reference for Small Business

- https://www.msdprevention.com/Quick-Start-Guide.htm
- https://www.msdprevention.com/risk-assessment/
- https://www.msdprevention.com/hazards-and-controls/

Workplace Safety & Prevention Services

For all your health and safety solutions, contact:

Workplace Safety & Prevention Services

1 877 494 WSPS (9777)

WSPS.CA

Workplace Safety & Prevention Services