Guidelines for Safe Collaborative Robot Design and Implementation

Cobot Work Health and Safety Risk Assessment

This best practice guide has been produced through partnership with:

Centre for Work Health and Safety

UTS

Centre for Inclusive Design

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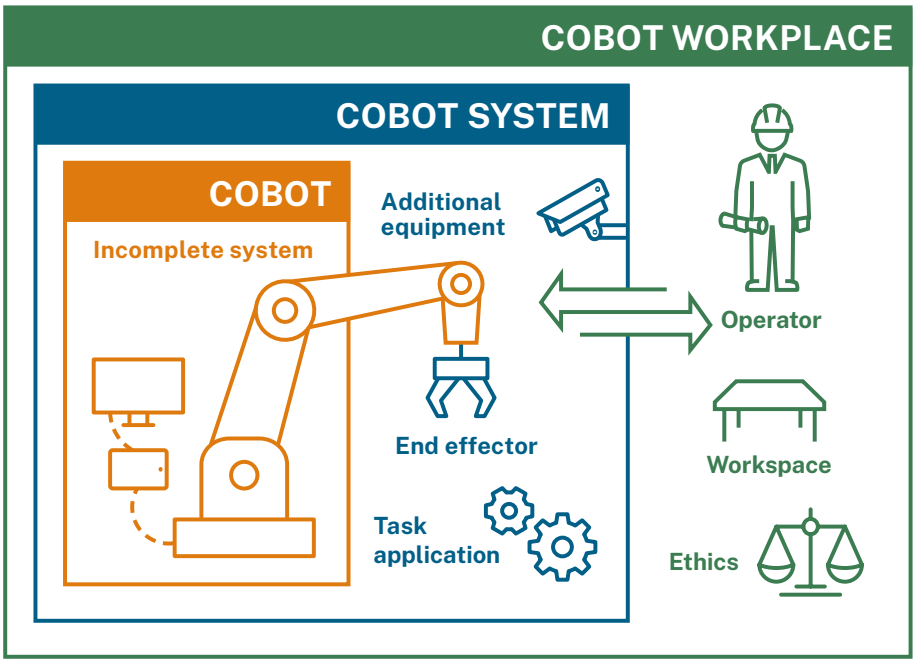
Cobot Risk Assessment

Document purpose

This document offers guidance on how to conduct a risk assessment if you do not have existing resources in place to do so. If you already have such resources readily available, we recommend that you continue to use them and consider how you can embed the Cobot Workplace Safety Checklist within them.

The templates presented in this document provide an overview of what a risk assessment is and how to effectively conduct one. To increase usability, we recommend using an electronic risk register.



Relevant cobot lifecycle phases

Product Development & Manufacturing	Cobot Workplace Planning	Installation & Commissioning	Use Phase & Operation	Maintenance & Adjustments
		Assessment if cobot equipment can be integrated safely into work environment		To re-assess if cobot equipment is integrated into the work

Who should use this document?

- Cobot manufacturers
- Distributors and suppliers
- ✓ Operators
- ✓ Co-workers and visitors
- Manufacturers of third-party equipment
- ✓ Integrators
- ✓ Beneficiary users
- ✓ Managers and administrative staff

Where does this document fit into the overall Guidelines?

Guidelines for Safe Collaborative Robot Design and Implementation

PLANNING OF UPCOMING WORKPLACE
- Guidance on Safe Human-Cobot Interaction
- Designing a Safe Cobot Workplace

ASSESSMENT OF EXISTING WORKPLACE
- Cobot Workplace Safety Checklist
- ✓ Cobot Work Health and Safety Risk Assessment

Cobot Safety Flyers

Contents

How to use this document

This document offers guidance on how to conduct a risk assessment if you do not have existing resources in place to do so. If you already have such resources readily available, we recommend that you continue to use them and consider how you can embed the Cobot Workplace Safety Checklist within them.

The templates presented in this document provide an overview of what a risk assessment is and how to effectively conduct one. To increase usability, we recommend using an electronic risk register.

This risk assessment document:

- Is a process-driven analysis tool to identify, estimate, and evaluate safety risks and their potential causes;
- Aims to minimise safety risks and hazards before, during, and after working with the cobot;
- Provides continuous safety improvements in work with the cobot;
- Offers starting points to derive mitigation strategies from the identified risks and hazards; and
- Approaches safety holistically so that risk assessors can ensure that cobot, tools, workplaces, and processes are assessed appropriately.

When should you conduct a risk assessment?

- After completing the “Safety Checklist”
- Prior to introducing the cobot into a workspace for the first time
- When the cobot is integrated into a new workspace environment
- When the cobot environment and workspace is altered
- When processes are being modified or applied in a new way
- After a near-miss or incident

It should be noted that a periodical review of this risk assessment is mandatory

Action: Refer to the “Cobot Workplace Safety Checklists” document.

The risk assessment procedure

- The risk assessment serves as a general guideline to assess risks, while specific content- or workspace-related details may vary depending on the specific organisation or industry.
- All legally binding standards, guidelines, and regulations must be met.
- Must be approved and maintained with project documentation.
- All questions answered “unsure”/ “no” in the “Safety Checklist” must be included in this risk assessment for their individual analysis.

Project details

Full title of project / cobot workplace	
Location(s) of cobot workplace	
Cobot implementation date	
Estimated cobot decommissioning date	
Brief description of cobot operation process (e.g. what will the cobot's task be and how does interaction with human look like)	

Signatures

I, as Project Supervisor, confirm that:

- All Work Health, Safety and Environmental hazards arising from this cobot are identified and their risks assessed;
- Control measures will be implemented at the proposed date to reduce risks to an acceptable level;
- Safe Work information and training will be provided to operators and all other stakeholders; as new hazards arise during the life of the cobot, risks will be re-assessed, and new appropriate control measures implemented; and
- The completed Cobot Risk Assessment will be made available for management review and audit.

Position	Full name	Date	Signature
Project Supervisor			

Persons Consulted

The following list should document each person consulted in regards to potential hazards and implemented actions.

N.B. *Work health and safety (WHS) legislation requires that any workers involved in the cobot project must be consulted about WHS matters that may affect them. This may include operators, co-workers and visitors, integrators, passive users, managers, and administrative or technical staff.*

Full name	Date	Signature	Remarks

Full name	Date	Signature	Remarks

Have all relevant persons been consulted? ☐ Yes ☐ No

General information

General information risk assessment			
Date of assessment		**Document version no.**	
Next review date (planned)		**Activity start** (planned)	
Responsibilities			
Risk assessor's name		**Assessor's project role**	
Cobot workplace manager's name		**Participants actively involved in risk assessment**	
Legislations/ standards/ codes of practice/ manufacturer's guidance that need to be involved			

Action: Use the "Cobot Workplace Safety Checklists" document to complete this risk assessment.

How to perform the risk analysis

Complete the "Cobot Workplace Safety Checklist"

Identify potentially hazardous tasks

Ideally, this risk assessment should be executed by a cross-functional team with diverse knowledge about the cobot, its process, environment, and user needs. Individuals participating in the risk assessment could come from manufacturing, quality, testing, maintenance and assembly, design, purchasing, etc.

Briefly describe hazardous tasks involved in this work activity.

All foreseeable hazards need to be identified during the risk assessment. The identified hazards need to be evaluated and controlled appropriately.

This risk assessment should give particular consideration to:

- the intended and unintended operations of the cobot, including operation, maintenance, setting, and cleaning;
- unexpected starting or speeding;
- access by personnel from all directions;
- foreseeable misuse of the cobot;
- failure in the control system; and
- specific hazards associated with this specific cobot application.

The following examples of potential hazards may be used for the identification of hazards:

Manual Handling	Special attention should be given to moving objects, repetitive movements, lifting awkwardly, lifting of heavy objects, and potential of falling.
Work Environment	Slippery surfaces/trip hazards, extreme temperatures, work at heights, explosive atmosphere, workload, work alone, work after hours, confined spaces, and bad lightning.
People	Potentially scared or volatile operators/visitors and poor risk awareness.
Environmental	Discharge to soil and water bodies (including stormwater run-off), nuisance noise, odour, and poor ventilation/air quality.
Plant & Equipment	Noise, vibration, dust, moving parts (crushing, friction, stab, cut, shear), pressure vessels, lifts/hoists/cranes, sharps, maintenance, design/ assembly, AEV/Drone, and speed.
Electrical	Plug-in equipment used in 'hostile' work environments, exposed conductors, and high voltage equipment.
Chemical	Hazardous substances, dangerous goods, fumes, dust, compressed gas, and hazardous waste.
Biological	Exposure to bodily fluids/infectious materials, pathogenic microorganisms (e.g. bacteria, viruses, parasites, fungi), security-sensitive biological agents, sharps/needles, animal bites and scratches, and allergies to animal bedding.

GMOs	Cobot/humans in immediate environment dealings with genetically modified organisms.
Cytotoxins	Cobot/humans in immediate environment carcinogens, mutagens, or teratogens.
Radiation (ionizing)	Ionizing radiation source such as radioactive substance or radionuclide, or irradiating apparatus.
Radiation (non-ionizing)	Handling with lasers, microwaves, or UV light.

Describe existing control measures

This describes existing measures in place to reduce hazards, harms, and risks.

Evaluate the Risk Priority Number (RPN)

The risk priority number (RPN) provides an initial indication about the severity of the risk. However, calculating the RPN requires a closer look at the underlying severity of impact, likeliness of occurrence, and chance of detection.

Severity of impact – The description of the outcome of a hazardous event (e.g. the number of people that could be harmed or the severity of injury). *Evaluate between 1 (very low) and 3 (very high).*

Likeliness of occurrence – The probability of a harm occurring is affected by the duration of the activity and its frequency, the number of people conducting the activity, and the level of exposure to the hazard. *Evaluate between 1 (very unlikely to occur) and 3 (very likely to occur).*

Chance of detection – The probability of detecting the failure or its cause before the actual event happens. *Evaluate between 1 (very likely to be detected) and 3 (very unlikely to be detected).*

Action: Specific attention is needed to RPN above a certain level any risk that has a rating of 3 for any of the three assessment criteria.

Recommended action requirement:

1-2: low action requirement

3-8: medium action requirement

9-18: high action requirement

27: immediate action requirement

Define recommended actions to avoid or reduce the identified hazards

Recommended actions should be proposed to reduce the risk to a level acceptable by management. The higher the Risk Priority Number, the higher should be the attention towards recommended actions and prioritizing such in the implementation.

When defining "Recommended Actions", remember that risks should first be eliminated or reduced by design or by substitution, then by safeguarding and other complementary measures. Any residual risks should then be reduced by other measures (e.g. training, warnings, and audiovisual signs). Refer also the "Hierarchy of Controls" listed below when deciding on recommended actions to apply. Note that control types closer to the top of the list are preferable.

Hierarchy of risk controls

- **Eliminate the hazard**
  For example, avoid noisy work in the immediate vicinity to the cobot to avoid not hearing warning signals or sensory overload.
- **Substitute the hazard**
  For example, let the cobot end effector use a less dangerous piece of equipment.
- **Isolate the hazard from people**
  For example, move a sharp end effector/tool into a secluded area that is not accessible to unauthorised personnel when it is not in operation.
- **Use engineering controls**
  For example, use a fume cupboard for chemicals and use a guard for rotating parts.
- **Use administrative controls**
  For example, when the cobot end effector uses a dangerous piece of equipment, reduce the cobot's speed and include power and force limits.
- **Use personal protective equipment (PPE)**
  For example, use a respirator, hearing protection, and gloves. Training and information is always required for the use of PPE.

Inform about harmful effects of each remaining hazard

Provide details of the harm to people or the environment caused by potentially hazardous events. For example, inhalation of fumes, self-moving objects, and noise. Consider what could happen if control measures fail or are not in place.

Hazard identification and risk assessment

Cobot Safety Checklist ID	TASK List and describe potentially hazardous task / activity / process step / equipment	POTENTIAL HAZARD In what ways can the task go wrong?	HARMFUL EFFECT What is the potentially harmful impact on the cobot user / workplace?	SEVERITY OF IMPACT How severe is the effect of the hazard on the cobot user / workplace? (1 - very low >3 - very high)	POTENTIAL CAUSES What are the potential causes of the task going wrong?	LIKELINESS OF OCCURRENCE How likely will the cause occur? (1 - very unlikely >3 - very likely)	CHANCE OF DETECTION How likely is the hazard or its cause likely to occur? (1 - very unlikely >3 - very likely)	EXISTING CONTROL MEASURES What are the existing control measures to minimise occurrence, reduce impact, or maximise detection of a hazard?	RISK PRIORITY NUMBER (RPN) (Severity x Occurrence x Detection)	RECOMMENDED ACTION What action/s are recommended to reduce the occurrence of the cause and/or improve its detection?	TARGET DATE The date by which implementation of the proposed action/s is expected	NEW RISK PRIORITY NUMBER Reassess severity, occurrence, detection, and RPN with recommended actions in place
	Human working in proximity to cobot	Collision between cobot and person	Physical injury / harm (injury but no severe ones)	2	No system in place for cobot system to detect human presence before collision	3	Floor markings that indicate no humans near cobot	3	18 (=2*3*3)	Adding laser scanner to enable speed and separation monitoring. (reduces likeliness to 1) Better training of personnel (reduces likeliness)		6
	Human working in proximity to cobot	End-effector harms person	Physical injury / harm (severe injuries expected)	3	Custom tooling on end-effector has sharp edges / pinch points	2	None	3	18 (=3*2*3)	Redesign of end-effector tooling to remove sharp edges and pinch points. (reduces severity) Add padding to tooling. (reduces severity to 1)		6
	Cobot lifts and moves heavy components that are assembled by human	Human feels anxious about cobot safety, which impacts their performance	Anxiety impacting human stress level and reduced productivity	3	Cobot moves component above human operator due to insufficient path planning	3	None	1	9 (=3*3*1)	New cobot path planning including the definition of no-go zones around the human (reduces likeliness to 1) Use of augmented reality simulation to show human worker how cobot will operate including the possibility for improvement suggestions (reduces severity to 2)		2

Risk assessment register

This register includes all versions of the risk assessment (to be completed regularly):

Name of main risk assessor	**Date**	**Notes** (pecularities, references, further documents)	**Risk assessment version**	**Filing location**