Guidelines for Safe Collaborative Robot Design and Implementation

Introduction

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Contents

Overview of the Guidelines

The *Guidelines for Safe Collaborative Robot Design and Implementation* are divided into six individual documents. The following list describes the intention and purpose of each of the documents:

The first two documents listed below (i.e. “Introduction” and “Cobot Safety Flyers”) are designed to be informative introductory documents that assist in understanding how to use the guidelines. They also educate readers about the meaning and general safety aspects of human-cobot collaboration.

The two documents that follow (i.e. “Guidance on Safe Human-Cobot Interaction” and “Designing a Safe Cobot Workplace”) assist in the creative planning of an upcoming or amended workplace.

Finally, the last two documents (i.e. “Cobot Workplace Safety Checklists” and “Cobot Work Health and Safety Risk Assessment”) are analytical in nature to assess an existing (or a planned) workplace’s safety features.

Introduction (this document)

This document provides an overview of the comprehensive guidelines. It describes relevant definitions of working with collaborative robots, summarises important cobot-specific hazards and safety measures, and outlines the five design principles to create a cobot-safe workplace.

Cobot Safety Flyers

These flyers are designed to be easy-to-read one-pagers that summarise key information for non-technical experts/stakeholders. In addition, two example workplace flyers. The flyers are intended to educate and remind operators about basic safety aspects related to their own workplace. Organisations can use these flyers as a basis to create their own workplace-specific cobot safety flyers.

The purpose of these flyers is to be printed and shared separately from the rest of the guideline, e.g. as hand-outs, workplace posters, or part of your workplace-specific work health and safety trainings and inductions.

Guidance on Safe Human-Cobot Interaction

This part of the guidelines provides a comprehensive explanation of what human-cobot interaction means and how to safely program and test a cobot for interactive tasks.

Designing a Safe Cobot Workplace

This part of the guidelines outlines the individual roles and responsibilities of people involved in the planning and management of a safe cobot workplace over its whole life cycle.

Cobot Workplace Safety Checklists

This document includes intuitive, step-by-step checklists that highlight important safety aspects of human-cobot collaboration in a shared workplace. They should be completed as a preliminary measure to the “Cobot Work Health and Safety Risk Assessment” during the planning and management of a cobot workplace.

Cobot Work Health and Safety Risk Assessment

This assessment is closely aligned with the “Cobot Workplace Safety Checklists”. It is designed to identify and control potential risks in a human-cobot collaborative shared workplace across its lifecycle.

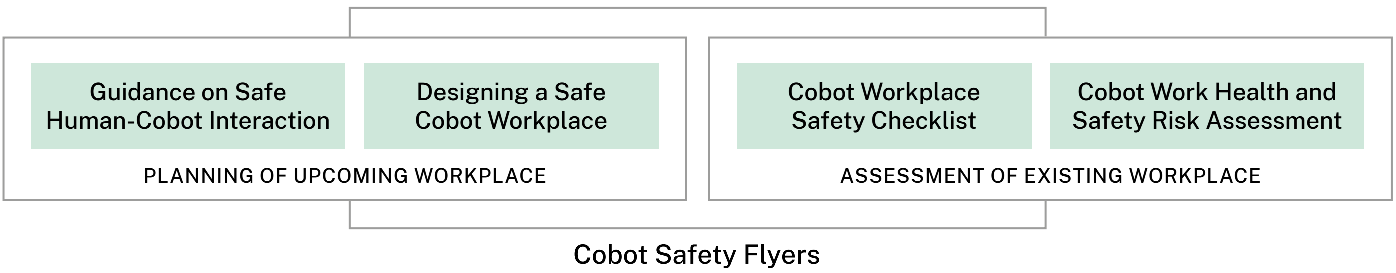
Table 1 below provides an overview of all six guideline documents and how they assist stakeholders over the lifecycle of a human-cobot workplace, ranging from the development of a cobot to its use and maintenance.

Table 1: Intended use of Guideline parts throughout the lifecycle of a human-cobot workplace

	Product Development & Manufacturing	Cobot Workplace Planning	Installation & Commissioning	Use Phase & Operation	Maintenance & Adjustments
Introduction	An informative document providing background information and terminology about relevant aspects for the understanding and use of the guidelines				
Cobot Safety Flyers	n/a	Educate relevant stakeholders (especially non-technical staff) about important considerations prior to working with a cobot	Encourage the development of easy-to-understand safety flyers for operators based on proposed templates	Educate relevant stakeholders (especially non-technical staff) about important aspects when working with a cobot	n/a
Guidance on Safe Human-Cobot Interaction	n/a	Guide and educate on design principles for cobot workplaces	Support training and on-boarding of staff	Support training and on-boarding of staff	Ensure any changes do not jeopardise cobot workplace safety
Designing a Safe Cobot Workplace	Design principles for facilitating the safe design of cobots and equipment	Guide the design of cobot workplaces	Guide for safe installation, including work processes, equipment, and training	Principles for safe use of cobot systems	Ensure changes do not jeopardise cobot workplace safety
Cobot Workplace Safety Checklists	Assess if manufactured cobot and equipment is safe	Assess all relevant aspects for safe human-cobot collaboration in order to inform the cobot risk assessment	Assess if planned hardware and processes are safe	Guide the regular cobot risk assessment	Assess if the workplace remains safe after maintenance and adjustments, informing the cobot risk assessment
Cobot Work Health and Safety Risk Assessment	n/a	Detailed assessment of designed cobot workplace and collaboration	Detailed assessment of installed/ commissioned workplace	Conduct smaller regular assessments	Assess the safety of maintained or changed cobot workplace

To support the navigation of the guidelines, each document starts with a summary page of its key aspects including the following overview graphic of where each part sits.

Guidelines for Safe Collaborative Robot Design and Implementation



Introduction

Collaborative robots (cobots) are specifically designed to operate alongside humans in shared and unfenced workspaces. For many small and medium enterprises in Australia, cobots offer a cost-effective strategy to automate work processes. However, there are cobot-specific physical, psychological, and ethical hazards that must be addressed by workplaces to protect workers and limit economic costs.

The *Guidelines for Safe Collaborative Robot Design and Implementation* offer practical advice to manage risks related to cobots on both a strategic-level for businesses and an operational level for workers. The guidelines aim to provide simple safety practices that can be applied to most workplaces and industries in Australia that are already using cobots or plan to work with them in the future.

People conducting a business or undertaking (PCBUs) will discover easy-to-adopt strategies that provide guidance on how best to plan and design cobot-safe workplaces, mitigate hazards, and minimise harm. The guidelines also include additional documents with detailed information on the matter.

Note: Due to the wide variety of cobot uses, these guidelines are not intended to address all possible cobot-related hazards or to replace the reader's responsibility in assessing workplace or industry-specific risks and hazards that may occur when working with cobots.

The guidelines focus on:

- Outlining cobot-specific physical, psychological, and ethical hazards such as hazardous collisions, mental strain, and lack of workers agency
- Clarifying how to practice safe human-cobot interaction
- Providing guidance on how organisations can design and plan for safe cobot workplaces
- Defining the roles and responsibilities of all stakeholders across the cobot's lifecycle
- Establishing workplace systems that address the complete cobot system
- Providing risk assessment and safety checklist resources

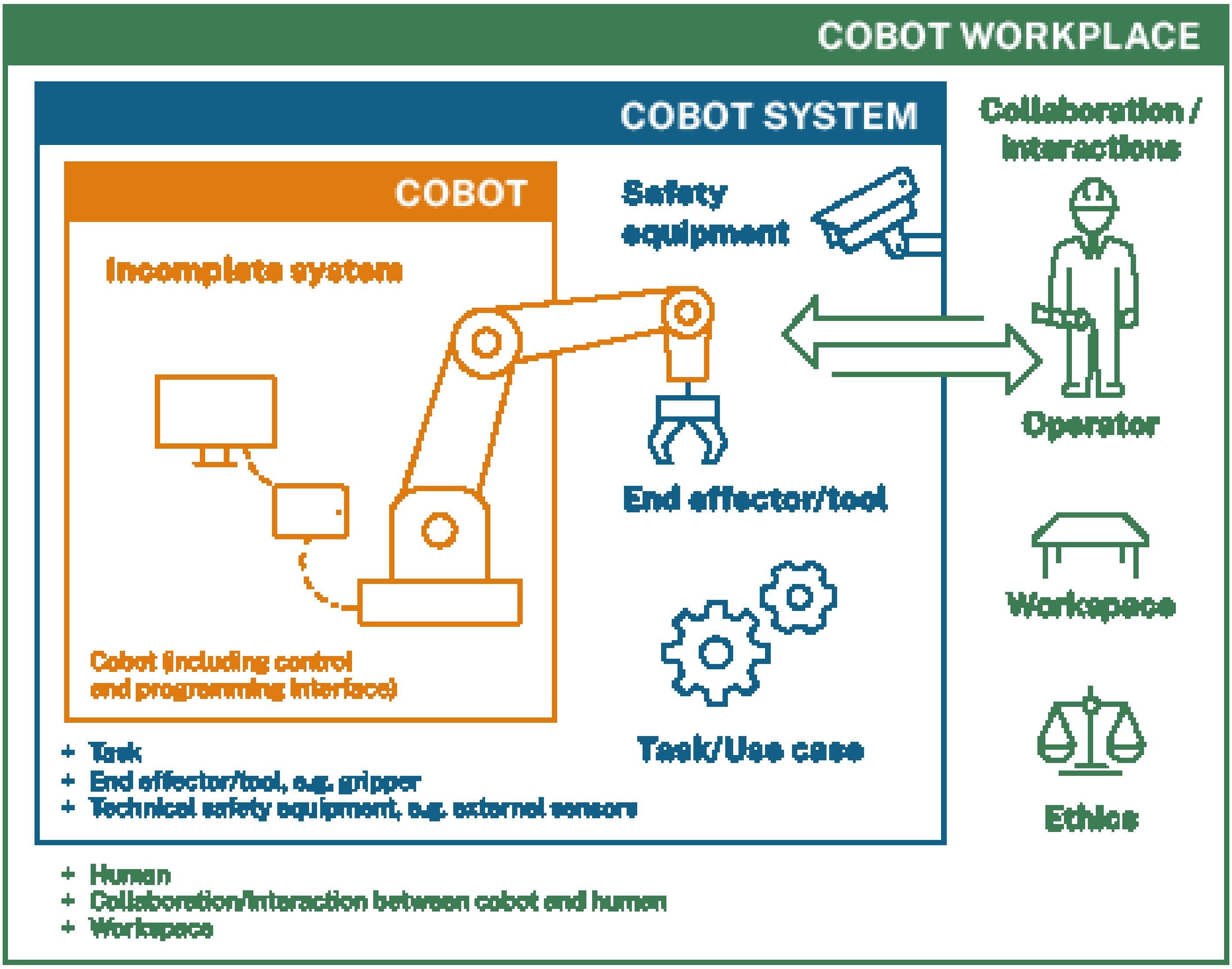
Cobot, cobot system, and cobot workplace

Compared to conventional industrial robots, cobots are robots designed to work in collaboration with humans. Cobots can operate in various interactive modes, each with varying minimum safety requirements. A cobot is a so-called "multi-purpose machine", i.e. it does not have to be used for only one specific task, but a variety of different tasks. This is enabled through the task application and/or the end effectors / tools installed onto the machine.

Robots marketed as cobots are manufactured according to international safety standards[1] for collaborative robots. It is possible to use those industrial robots collaboratively, but it requires a significant adjustment in safety measures to comply with safety requirements and protect the health and safety of human workers.

In Australia, most cobots (especially cobot arms) are sold as **incomplete systems** (See Figure 1). As incomplete systems, the machines are not able to complete their intended tasks yet. At this stage, cobot manufacturers can guarantee the safety of certain components, typically, the cobot arm, control and programming interface, or computer. This can vary depending on the manufacturer and the model.

Figure 1: The difference between cobots, cobot systems, and cobot workplaces



1 ISO/TS 15066:2016 "Robots and robotic devices - Collaborative robots" ; ISO 10218-1/2:2011 "Robots and robotic devices - Safety requirements for industrial robots"

To perform a specific task, the cobot requires an end effector / tool, such as grippers, welding torches, or even lasers. Together, they form the **cobot system**. However, normally the cobot system does not exist in isolation but is part of a cobot workplace. Aside from a physical space, this also includes a work process that the cobot supports, human co-workers, and interaction and collaboration with other cobots and humans. Table 2 summarises some key terms around robots and cobots.

> ⚠ **Note:** Although the most common type of cobots are cobot arms, other types of robots can also work in close collaboration with humans and must therefore be safe, such as waiter robots in restaurants or logistic robots in shared warehouses. The guidelines will often describe arm-based cobots, but can also be applied to other non-arm-based cobots, such as the aforementioned ones.

Table 2: Cobot related terminology

Industrial Robot	According to the international standard ISO 8373, an industrial robot is defined as an, "automatically controlled, reprogrammable, multi-purpose manipulator, programmable in three or more axes, which can be either fixed in place or mobile for use in industrial automation applications."
Cobot	A collaborative robot (also called a cobot) is defined as a "robot designed for direct interaction with a human within a defined collaborative workspace" [2]. While some robots explicitly designed for this purpose are available for purchase (see the examples in Figure 2, they not limited to such. Industrial robots can similarly act as cobots once sufficient safety measures are implemented through the cobot system. A cobot is therefore considered a practice rather than a physical entity. Refer to the Glossary of Terms at the end of this document for more detailed definitions.
Cobot System	The integrated combination of cobot, end effector, workplace, and any machinery, equipment, devices, external auxiliary axes, or sensors supporting the cobot performing tasks safely.
Cobot Workplace	A human-robot collaboration / interaction generally occurs in a so-called "cobot workspace". While the cobot itself makes up a key element in such a scenario, it is considered to be an incomplete system with multiple applicable purposes. A task-specific cobot system is created by defining a specific task and equipping the robot with appropriate tools, external infrastructure, and safety equipment. A cobot workplace is considered a space where the collaboration / interaction between the cobot system and human operator takes place, including their physical interaction and aligned work processes.

2 ISO 10218-2:2011 "Robots and robotic devices - Safety requirements for industrial robots, Part 2: Robot systems and integration"

As cobots are typically sold as 'incomplete machines' (or part-machines) in Australia, it means the system is not complete when purchased. When sold as an incomplete machine, four components of a cobot are assured as safe:

- Arm (the manipulator)
- Controller / Cabinet (computers and drivers)
- Connecting cable between manipulator and cabinet
- Teach pendant (human interface)

Installing an end effector/tool and assigning a task to a cobot will complete the cobot system. Only once this is done, is it considered and known as a 'complete machine'. The end effector and task application can greatly impact the safety of the cobot system.

Note: As a cobot is normally sold as an "incomplete machine", its in-built safety features can be easily jeopardised by attaching unsafe end effectors, such

as sharp tools or using it in an unsafe workplace setup. That said, missing in-built safety features can be implemented into the cobot system or workplace to strengthen work health and safety.

Consulting with integrators outside of your organisation can help establish a safe cobot workplace to Australian Standards [3]. Such integrators can also assist with selecting and installing the most appropriate equipment for your task.

Action: Refer to the "Designing a Safe Cobot Workplace" document to understand more about the roles and responsibilities of different stakeholders in following safe cobot work practices across the cobot lifecycle.

3 AS 4024.3303:2017 "Robots and robotic devices - Collaborative robots" *(This Standard is identical with, and has been reproduced from ISO/TS 15066:2016, "Robots and robotic devices - Collaborative robots")*

Figure 2: Examples of available commercial cobots[4]

Manufacturers, robot models and specifications

ABB (Switzerland)
YuMi - IRB 14000
DOFs: 7+7
Payload (in kg): 0.5
Reach (in mm): 55
Repeatability: ±0.02 mm
Weight (in kg): 38
Velocity: 1500 mm/s

ABB (Switzerland)
Roberta 1/ Roberta 2/ Roberta 3
DOFs: 6
Payload (in kg): 4 / 8 / 12
Reach (in mm): 600 / 800 / 1200
Repeatability: ±0.1 mm
Weight (in kg): 14.5 / 19.5 / 30.5
Velocity Joints: 110°/s

FANUC (Japan)
CR-35iA
DOFs: 6
Payload (in kg): 35
Reach (in mm): 1813
Repeatability: ±0.04 mm
Weight (in kg): 990
Velocity: 750 mm/s

FANUC (Japan)
CR-4iA / CR-7iA / CR-7iA/L
DOFs: 6
Payload (in kg): 4 / 7 / 7 kg
Reach (in mm): 550 / 717 / 911
Repeatability: ±0.02 mm / ±0.02 mm / ±0.02 mm
Weight (in kg): 48 / 53 / 55
Velocity: 1000 mm/s

Rethink Robotics (USA)
Baxter / Sawyer
DOFs: Baxter 7+7 / Sawyer 7
Payload (in kg): 2.2 p. arm / 4
Reach (in mm): 1210 p. arm / 1260
Repeatability: ±0.1 mm
Weight (in kg): 75 / 19
Velocity: 1500 mm/s

Universal Robot (Denmark)
UR 3 / 5 / 10
DOFs: 6
Payload (in kg): 3 / 5 / 10
Reach (in mm): 500 / 850 / 1300
Repeatability: ±0.1 mm
Weight (in kg): 11 / 18.4 / 28.9
Velocity: 1000 mm/s

MABI Robotics (Switzerland)
SPEEDY 6 / 10 / 12
DOFs: 6
Payload (in kg): 6 / 10 / 12
Reach (in mm): 800 / 1384.5 / 1250
Repeatability: ±0.1 mm
Weight (in kg): 28 / 28 /35
Velocity joints: 145 ■ 275°/s / 120 ■ 180°/s / 75 ■ 275°/s

KUKA (Germany)
LBR IIWA
DOFs: 7
Payload (in kg): 7 /14
Reach (in mm): 800 / 820
Repeatability: ±0.1 mm / ±0.15 mm
Weight (in kg): 22 / 30
Velocity joints: 90 ■ 180°/s

Techman Robot (Taiwan)
TM5-900/700
DOFs: 6
Payload (in kg): 4 / 6
Reach (in mm): 900 / 700
Repeatability: ±0.05 mm
Weight (in kg): 22.5 / 22
Velocity joints: 180 ■ 225°/s

Productive Robotics (USA)
OB7
DOFs: 7
Payload (in kg): 5
Reach (in mm): 1000
Repeatability: ±0.1 mm
Weight (in kg): 24
Velocity: 2000 mm/s

Yaskawa (Japan)
Motoman HC10
DOFs: 6
Payload (in kg): 10
Reach (in mm): 1200
Repeatability: ±0.1 mm
Weight (in kg): 45
Velocity joints: 130 ■ 250°/s

AUBO Robotics (China)
AUBO-i5
DOFs: 6
Payload (in kg): 5
Reach (in mm): 880
Repeatability: ±0.05 mm
Weight (in kg): 24
Velocity: 2800 mm/s

Franka Emika (Germany)
Franka Arm
DOFs: 7
Payload (in kg): 3
Reach (in mm): 855
Repeatability: ±0.1 mm
Weight (in kg): 18
Velocity: 20000 mm/s

Precise Automation (USA)
PP100 Cartesian
DOFs: 3
Payload (in kg): 1
Reach (in mm): X 635, Y 300, Z 225
Repeatability: ±0.1 mm
Weight (in kg): 20
Velocity: 1500 mm/s

Kawasaki Robotics (Japan)
duAro – Dual-arm SCARA Robot
DOFs: 4+4
Payload (in kg): 2
Reach (in mm): 760
Repeatability: ±0.05 mm
Weight (in kg): 200
Velocity: N/A

Bosch (Germany)
APAS
DOFs: 6
Payload (in kg): 2
Reach (in mm): 911
Repeatability: ±0.03 mm
Weight (in kg): 230
Velocity: 500 mm/s

4 Villani et al. "Survey on human–robot collaboration in industrial settings: Safety, intuitive interfaces and applications", Mechatronics

Cobot-specific harms and safety measures

Although cobots are specifically designed to work with humans, purchasing a cobot does not mean that the machine is safe with every end effector tool, task application, and/or workplace. The context (i.e. the cobot system and workplace), in which a cobot is used drastically impacts work health and safety (WHS).

Some common factors that can impact the safety of a cobot working with a human are:

- End effector (also known as end-of-arm tooling)
- Task application
- Workpiece
- Operating speed
- Operating payload
- Operating path
- Operator skill level / knowledge
- Incorrect integration of cobot / end effector
- Incorrect configuration of task application / workspace
- Work environment (e.g. working in a workspace with untrained staff or visitors, small workspace, or mobile cobot)

When these factors have not been appropriately addressed, there is an increased risk of severe harm.

Action: Refer to the “Safe Human-Cobot Interaction Guidance” document to explore practising safe human-cobot interaction.

Harms and hazards that can occur with cobots

Protecting worker health should always be the highest priority when it comes to human-cobot collaboration. Harms and hazards related to working with cobots can be classified into three main categories: physical, psychological, and ethical harms.

- **Physical harms** are mainly represented by collision events involving a human. They can occur due to a variety of reasons leading to unexpected behaviours in the cobot.
- **Psychological harms** focus on all aspects related to the psychological safety of an operator as an individual.
- **Ethical harms** address staff and an organisation as a whole, including anything that has potential to reduce psychological, societal, and environmental wellbeing.

For more information about these harms, refer to Table 3 on the next page.

Table 3: Summary of the different physical, pyschological, and ethical harms that can occur when humans work with cobots.

	PHYSICAL
Hazardous collisions	Non-functional or unwanted contacts between human and cobot system.
Loss of movement control	The loss of movement control of a cobot system potentially causes physical harm to humans.
Pinch points	During task operation humans and/or materials and objects may be caught between moving and/or stationary parts of a cobot.
Debris	The debris generated by some collaborative tasks may harm humans.
Cybersecurity	Cyber-attacks or local hacking may cause cobots to move unpredictably and harm the operator.
Lack of focus	A lack of concentration and focus may lead to not fulfilling tasks as intended, causing mishandling of the cobot.
	PSYCHOLOGICAL
Mental strain	The cobot system may cause stress and could negatively affect the psychological state and mental strain.
Complicated interaction mechanisms	Complicated information exchange between operator and cobot system can cause stress and insecurities.
Lack of trust	A lack of trust from the operator towards the cobot hinders safety and the development of a sense of comfort.
	ETHICAL
Social environment	The work with cobot systems can negatively affect or reduce the social environment.
Social impact	Introducing cobot systems may change the role of some operators and induce a fear of job loss.
Social acceptance	Predisposition for cobot systems influence the level of acceptance within the human work force.
Data collection	The cobot system could monitor individual performance and be able to collect, use, distribute or sell user data without user consent.

Safety measures to improve safety of working with cobots

The characteristics of collaborative robots bring together a unique combination of social and technical dimensions, calling for safety measures that go beyond mitigating physical risks.

Existing safety measures can be categorised into a **cobot-specific**, **working system** and **enterprise and context**. Table 4 summarises measures that have been identified to improve the operator's safety when working with a cobot in a collaborative workplace.

Table 4: Summary of safety measures when working with a cobot in a collaborative workplace

	Safety measure	Description
Cobot-specific	**Cobot type**	Lightweight cobots with inherent active/passive safety mechanisms often represent a safer option than covert industrial robots for collaborative tasks.
	Cobot appearance	Heavy, stiff, and rigid cobots can cause distress and discomfort to the humans that operate in their vicinity.
	Fail-safe system structure	Integrating general non-safety devices into collaborative systems may cause unwanted behaviours and loss of movement control.
	Tool/design operation	The way in which tools are selected and integrated into the cobot can impact operators' physical safety and psychological state.
	Collision avoidance	Monitoring the working area through software and sensors allows for avoiding and preventing collisions.
	Collision detection and mitigation	When collisions occur, they can be detected and mitigated through appropriate software and sensors.
	Situational awareness	Easily interpretable feedback from the cobot reduces both physical and psychological risks.
	Intuitive cobot programming	Intuitive programming allows operators to communicate commands more easily, reducing both physical and psychological risks.

	Safety measure	Description
Working system	**Work cell design**	Designing a cobot work cell to work harmoniously with the application, existing workspace, operators, and other staff.
	Human-friendly work distribution	Distributing tasks adequately reduces the risk of physical stress and musculoskeletal injuries.
	Human-friendly workplace arrangement	Arranging the workspace to allow enough distance/space between humans and cobot can reduce the risk of collisions and distress.
	Risk assessments	Systematic evaluation process that considers potential risks and harms that may occur when working with cobots.
	Simulation	Use of simulation programming to virtually visualise and assess the intended programmed operation for risks and other potential issues.
	Physical testing	Multi-step process of assessing various components of a cobot to ensure safe operation.
Enterprise and context	**Training to build knowledge and skills**	Ensuring that cobot user groups and other stakeholders possess the appropriate competencies, skills, and knowledge to ensure safe operation.
	Training to improve acceptance	Introducing predictability and familiarity to mitigate physical, psychological, and ethical risks.
	Assistive technology for training	Using virtual or augmented reality to prepare and train the operator before they come into contact with cobots.
	Supporting worker agency	Consulting and co-designing cobot solutions with operators and collaboration between operators and management teams.

Five guiding principles of creating a cobot-safe workplace

The Guidelines are underpinned by five guiding principles of creating a cobot-safe workplace. These principles ensure that the complete cobot system in the workplace holistically addresses the WHS impacts of working with cobots. They are phrased abstractly as they will provide overarching guidance for all socio-technical aspects and lifecycle phases of a cobot. They form the frame for detailed and specific safety assessments and measures. Table 5 provides a detailed overview of the five design principles.

Table 5: Design principles for safe human-cobot collaboration

Design principle	Description
UNDERSTAND COBOT & SAFETY FEATURES	▪ Understand what your cobot can and cannot do in terms of tasks, behaviour, and safety features. ▪ Understand how your cobot system ensures safety and how activities might impact safety features. ▪ Ensure everyone in your workplace has the same understanding.
MAINTAIN A HUMAN FOCUS	▪ Consider different cobot experience levels of operators and 'temporary workplace visitors'. ▪ Involve your staff in the cobot workplace design to maximise their benefits and provide upskilling and social contacts. ▪ Be realistic about the workforce implications of introducing cobots.
ALIGN COBOT, TOOL, WORKSPACE, AND WORKFLOW	▪ Build an understanding that the cobot is only one part of a socio-technical cobot system. ▪ Treat cobot, end effector tools, workplace, and workflow processes as interconnected systems, which must be aligned to ensure safety ("cobot readiness" of all parts).
ENSURE SECURITY AND PROTECTION	▪ Prevent and identify disallowed tempering with cobot hardware and software. ▪ Look out for potential issues and consequences of tampering with the cobot, human, end effector tools, workplace, and workflow processes. ▪ Ensure that the cobot does not cause any harm if the hardware or software fails.
SUPPORT EASE OF USE	▪ Ensure that the cobot and its safety features are user-friendly, and support, rather than impede, the user's work. ▪ Ensure that both the positive and negative impacts of engaging with the cobot are considered.

Glossary of terms

Term	Description
Cobot	A robot is considered collaborative (cobot) when: a) it shares the workspace with a human; b) tasks are performed at the same time and potentially require physical contact with a human; and c) its implementation includes dimensions specified by the respective standards (ISO 15066:2016, ISO 10218-2:2011).
Cobot Manufacturer	Are responsible for the research and development (R&D) and manufacturing of the physical cobot.
Cobot User	A general term referring to companies or individuals that have purchased and use cobots. Different user groups engage with cobots in a variety of ways, including: • **User System Integrators** The individual responsible for integrating the cobot into a workplace, conducting safety assessments, and consulting with other cobot users. • **Operators** Users that are aware that the cobot is operating and are directly responsible for operating and/or supervising the machine. • **Passive Users** Passive users are aware that the cobot is operating but cannot directly change its operation. *Examples include a patient using a cobot during physical rehabilitation.* • **Co-workers & Visitors** Other staff and/or visitors in the space who may be unaware of cobot operation and cannot change its operation. *For example, a nurse working on the same floor as a cobot.* • **Administrative staff** Managers and other administrative staff that do not actively interact with cobots but are responsible for establishing safe human-cobot collaborative workplaces.
Cobot Stakeholder	Organisations or individuals that are engaged in the cobot industry in various capacities.
Cobot System	The integrated combination of cobot, end effector, workplace, and any machinery, equipment, devices, external auxiliary axes, or sensors supporting the cobot performing tasks safely.

Term	Description
Cobot Workplace	A human-cobot collaboration / interaction generally occurs in a so-called "cobot workspace". While the cobot itself makes up a key element in such a scenario, it is considered an incomplete system with multiple applicable purposes. A task-specific cobot system is created by defining a specific task and equipping the cobot with appropriate tools, external infrastructure, and safety equipment. A cobot workplace is finally considered a space where the collaboration / interaction between the cobot system and human operator takes place, including their physical interaction and aligned work processes.
Cobot Workplace Planning	The consultation phase to assess whether human-cobot collaborative processes would be appropriate and how to integrate the cobot into the workplace.
Distributors	Companies that are certified by cobot manufacturers to stock specific cobot brands. Distributors can also provide implementation and post-implementation support.
End Effector	A tool or device attached to the end of a cobot arm so that the machine can perform its assigned task and purposefully interact with its environment.
Harm	To cause hurt, injury, or damage. • **Physical harm** Harm that impacts upon an individual's physical wellbeing. • **Psychological harm** Harm that impacts upon an individual's mental wellbeing. • **Ethical harm** Harms that impact upon organisational, societal, and/or environmental wellbeing.
Hazard	A potential source of harm.
Human Factors	Human-related workplace aspects defining how humans interact or are affected by a cobot system, including capabilities, ergonomics, physical, and psychological abilities.
Human-Robot Collaboration	The collaborative process of human and cobot agents working together to achieve shared goals.
Human-Robot Interaction	The human-robot interaction is considered an umbrella term for any kind of human-robot joined work, which include co-existent, cooperative, and collaborative arrangements.

Term	Description
Industrial Robot	According to the international standard ISO 8373, an industrial robot is defined as an, “automatically controlled, reprogrammable, multi-purpose manipulator, programmable in three or more axes, which can be either fixed in place or mobile for use in industrial automation applications.”
Industrial Setting	Describes how a cobot is used in industry, e.g. manufacturing, non-manufacturing, health, and food & hospitality.
Installation and Commissioning	The installation of cobots into a workplace, including the integration into other work processes and equipment. This phase also includes the training of operators.
Lifecycle Stages	Specific times in the lifecycle of a cobot.
Maintenance and Adjustments	The maintenance and changing use of cobots in a workplace.
Operation and Use	The interaction of operator and cobot in order to perform the assigned task application.
Risk	The possibility of the harm occurring when exposed to a hazard, often also including a probability/likeliness.
Risk Assessors	Companies or individuals independent of a cobot user company that conduct a cobot risk assessment analysis and action recommendations.
Risk Mitigation Strategy	The processes that ensure that safety measures are being practised.
R&D & Cobot Manufacturing	Concerned with the research and development (R&D) of cobots and associated equipment, such as end effectors and safety peripheral equipment.
Safety Features	Integrated safety aspects, including technology, processes, procedures, methods, and training.
Safety Measures	Methods and practices that reduce and/or limit risks from occurring.
Suppliers	Companies that sell cobots. Suppliers can also provide implementation and post-implementation support.

Term	Description
Storage & Decommissioning	The process that occurs when a cobot has reached its end of life or use and is removed from the workplace.
Task Application	The assigned activity that a robot/cobot system has been set up to perform.
Third Party Manufacturer	Are companies that are responsible for R&D and manufacturing of additional cobot components such as end effectors, accessories, and safety peripherals.
Third Party System Integrators	Companies that assist cobot users in integrating cobots into their existing workplaces and configuring software and hardware systems. They also provide post-implementation support and can conduct safety assessments.
Use Case	Outlining the system from the perspective of a user.
Work Health & Safety (WHS)	Considering the hazards and risks to the health and safety of everyone in a workplace.
Work 'Cell' / Workspace	The space in which a robot/cobot is configured to operate within.
Workpiece	The material or object that the cobot and/or human are working with.