Australian Government

Department of Education, Employment and Workplace Relations

MEM234014A Design a robotic system

Release: 1

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Modification History

New unit

Unit Descriptor

This unit of competency covers the design of an engineering application employing a robot and integrating it with other equipment and systems. It includes the use and integration of actuators, sensors, end effectors, including tactile effectors, dynamic analysis of strength and stability, programming and protocols for communications and networking, as appropriate.

Application of the Unit

This unit applies to the design of a robotic system across all forms of manufacturing and engineering. Design activities may also include reverse engineering, design rectification, integration of off the shelf components, or modifications of an existing design. It is suitable for robotic system designers or maintenance technologists, and those pursuing qualifications and careers in engineering design involving robotics and automation.

Prior experience in the application of computing technology, mathematics, scientific principles and techniques, including kinematics and kinetics, electrical and fluid power principles and techniques, programming of computers and controllers, robotic systems evaluation and mechanical construction techniques is required.

Licensing/Regulatory Information

Not applicable.

Pre-Requisites

Not applicable.

Employability Skills Information

This unit contains employability skills.

Elements and Performance Criteria Pre-Content

Elements describe the essential outcomes of a unit of competency.	Performance criteria describe the performance needed to demonstrate achievement of the element. Where bold italicised text is used, further information is detailed in the required skills and knowledge section and the range statement. Assessment of performance is to be consistent with the evidence guide.

Elements and Performance Criteria

1	Clarify client brief or contract requirements	1.1	Establish, in consultation with the client, the required features and functions of the the application and establish control requirements
		1.2	Determine technical, commercial and environmental parameters to the brief or contract
		1.3	Determine stakeholders to be consulted in the design and application process
		1.4	Provide initial advice to client on the feasibiliy of the project
2	Prepare concept proposal	2.1	Investigate and take initial measurements to define robotic system performance parameters
		2.2	Carry out required modelling, simulations and calculations using appropriate techniques, software and validation techniques
		2.3	Generate a range of robotic system solutions that may include consideration of motions, loads, accuracy, precision and repeatability, kinematics, kinetics and dynamic stability, sensing, control, end effectors, data requirements, hardware requirements, system integration, network topology and communication protocols
		2.4	Check feasibility and evaluate solutions against design criteria ensuring conformity to occupational health and safety (OHS), regulatory, sustainability and environmental requirements
		2.5	Review concept proposals with clients and select preferred solution

3	Design robotic device or system	3.1	Finalise design of robotic system
		3.2	Provide documentation, drawings, specifications and instructions
		3.3	Consult and negotiate with clients and stakeholders to obtain sign-off on design
		3.4	Monitor installation and commissioning with stakeholders, when required, and make any necessary modifications

Required Skills and Knowledge

This section describes the skills and knowledge required for this unit.

Required skills

Required skills include:

- determining the features and functions of the application, including OHS, regulatory and risk management requirements
- interpreting parameters to the brief or contract
- researching latest trends and techniques in application of robots, robot functions, programming options and reverse engineering
- investigating and measuring, modelling and calculating for options
- investigating faults in existing designs and proposing solutions
- simulating and systematically programming and testing
- generating and evaluating a range of solutions for feasibility against design criteria
- evaluating solutions for feasibility against design criteria, including relevant engineering and financial calculations and analysis
- evaluating suitability of off the shelf components
- communicating, negotiating and reviewing with stakeholders and client throughout process to obtain agreement on proposal and sign-off on design
- documenting design with drawings, specifications and instructions

Required knowledge

Required knowledge includes:

- contemporary engineering for robot and robotic application design methods
- robotic fundamentals, including mechanical, electrical, fluid, electronic and information technologies, sensor/transducers, controllers, interfacing and signal conditioning, networking, software, data sharing and control functions
- techniques for:
  - continuous improvement
  - problem solving and decision making
  - root cause analysis (RCA) or failure mode and effects analysis (FMEA) or design review based on failure mode (DRBFM), and Pareto analysis
- OHS and regulatory requirements, codes of practice, standards, risk management and registration requirements
- processes for investigation, developing options, modelling and calculating, generating a range of solutions, completing feasibility and evaluation studies, and preparing proposals and designing
- software modelling techniques to analyse robot capability including motions, loads, accuracy, precision and repeatability, kinematics, kinetics and dynamic stability
- validation techniques, including use of simple case traditional methods and calculations:

  - robot drive systems
  - manipulators and end effector options
- fundamentals of locomotion for mobile robots, such as wheels, legs, combined leg and wheels and tracks:
  - object detection and sensor options
- program techniques for a range of robot functions, such as:
  - pick and place
  - proximity detection (presence and distance)
  - motion control algorithms
- system control and data acquisition (SCADA) or distributed control systems (DCS), communications methods and protocols, and networking requirements
- programs and programming techniques for robot functions, communications and networking, as required by design
- documentation, drawings, specifications, programs and instructions

Evidence Guide

The evidence guide provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge, range statement and the Assessment Guidelines for the Training Package.

Critical aspects for assessment and evidence required to demonstrate competency in this unit	Assessors must be satisfied that the candidate can competently and consistently: • consult and negotiate throughout the design process • interpret features of the robotic system • confirm parameters to the brief or contract and provide initial advice based on discipline knowledge, standards, OHS, regulatory and risk assessment requirements • research sustainability and current and emerging trends • investigate and review robotic concept proposals and performance parameters and options • measure, model and calculate using appropriate techniques, software and validation techniques • apply innovation and creativity to generate a range of solutions • evaluate solutions against design criteria ensuring conformity to OHS requirements • prepare robotic system proposal • design a robotic system • provide documentation, drawings, specifications and instructions • obtain sign-off on design.
Context of and specific resources for assessment	• This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job, that is, the candidate is not in productive work, then a simulated working environment must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. • Where applicable, reasonable adjustment must be made to work environments and training situations to accommodate ethnicity, age, gender, demographics and disability. • Access must be provided to appropriate learning and/or assessment support when required. Where applicable, physical resources should include equipment modified for people with disabilities.
Method of assessment	• Assessment must satisfy the endorsed Assessment Guidelines of the MEM05 Metal and Engineering Training Package. • Assessment methods must confirm consistency and accuracy of performance (over time and in a range of workplace relevant contexts) together with application of underpinning knowledge. • Assessment methods must be by direct observation of tasks and include questioning on underpinning knowledge to ensure its

	correct interpretation and application. • Assessment may be applied under project-related conditions (real or simulated) and require evidence of process. • Assessment must confirm a reasonable inference that competency is able not only to be satisfied under the particular circumstance, but is able to be transferred to other circumstances. • Assessment may be in conjunction with assessment of other units of competency where required.
Guidance information for assessment	Assessment processes and techniques must be culturally appropriate and appropriate to the language and literacy capacity of the candidate and the work being performed.

Range Statement

The range statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold italicised wording, if used in the performance criteria, is detailed below. Essential operating conditions that may be present with training and assessment (depending on the work situation, needs of the candidate, accessibility of the item, and local industry and regional contexts) may also be included.

Client	Client may be: • internal or external to the designer's organisation
Parameters to the design brief	The design brief may include the design of new equipment or fault analysis, rectification or modification to an existing design. Parameters to the design brief may include: • determination of the degree of innovation and creativity expected by the client • design process limits and budgets • product cost limits and budgets • performance specifications • equipment availability, capacities and restrictions • specified administrative, communication and approval procedures • use and integration of off the shelf components • other special features and limits in the design brief
Robotic system	A robotic system is a system that includes a self-controlling machine (robot) that can perform functions automatically without human initiation and assistance after initial programming and other components to allow integration with other equipment and systems within the workplace. The robot may have sensory elements, electrical, hydraulic or pneumatic actuators for linear or rotary motion and components to perform functions (e.g. grasping hands, lifting magnets and heating pads). The robot may be networked so as to serve an automated environment. Robots are usually programmed to perform repetitive tasks or tasks unsuitable for humans.
OHS, regulatory, sustainability and environmental issues	OHS, regulatory, sustainability and environmental issues may include: • OHS Acts and regulations • relevant standards • industry codes of practice • risk assessments • registration requirements • safe work practices • minimising ecological and environmental footprint of process, plant and product • maximising economic benefit of process plant and product to the

	organisation and the community • minimising the negative OHS impact on employees, community and customer • state and territory regulatory requirements
Standards and codes	Standards and codes refer to all relevant Australian and international standards and codes applicable to a particular design task

Unit Sector(s)

Engineering practice

Custom Content Section

Not applicable.