This course has been accredited under Part 4.4 of the Education and Training Reform Act 2006.

Accreditation period: 1st July 2017 to 30th June 2022





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²²³³²VIC Graduate Certificate in Tool Design for Plastics

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Section A: Copyright and course classification information

1.	Copyright owner of the course	Copyright of this course is held by the Department of Education and Training, Victoria	
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2.	Address	Executive Director Industry Engagement And VET Systems Higher Education and Skills Group Department of Education and Training PO Box 4367 Melbourne, Victoria, 3001	
		Organisational Contact:	
		Manager: Training Products Unit Higher Education and Skills Group Telephone: (03) 9637 3092 Email: <u>course.enquiry@edumail.vic.gov.au</u>	
		Day to day contact:	
		Curriculum Maintenance Manager Service - General Manufacturing Chisholm Institute 2 New Holland Drive Cranbourne VIC 3977	
		PO Box 684 Dandenong VIC 3175 T +61 3 9238 8448 Email: <u>paul.saunders@chisholm.edu.au</u>	
3.	Type of submission	This course is submitted for reaccreditation.	
4.	Copyright acknowledgement	Copyright of this material is reserved to the Crown in the right of the State of Victoria.	
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		Copyright of the following unit of competency from nationally endorsed training packages is administered by the Commonwealth of Australia and can be accessed from Training.gov at <u>www.training.gov.au</u>	
		Imported unit: PMBTECH505 Choose polymer materials for an application from PMB Plastics, Rubber and Cablemaking Training Package.	



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		Request for other use should be add	ressed to:	
		Executive Director Industry Engagement and VET Systems Higher Education and Skills Group Department of Education and Training (DET) Email: <u>course.enquiry@edumail.vic.gov.au</u>		
		Copies of this publication may be downloaded, free of charge, from the DET website:		
		http://www.education.vic.gov.au/training/providers/rto/Pages/courses.aspx#link100		
6.	Course accrediting body	Victorian Registration and Qualifications Authority: <u>http://www.vrqa.vic.gov.au</u>		
7.	AVETMISS information	ANZSCO (Australian and New Zealand	233500 Industrial Mechanical and Production Engineers	
		Standard Classification of Occupations)	The course also covers the following occupational areas:	
			233511 Industrial Engineers233512 Mechanical Engineers233914 Engineering Technologists	
		ASCED code – 4 digit (Field of Education)	0307 Mechanical and Industrial Engineering and Technology	
		National course code	22332VIC	
8.	Period of accreditation	1st July 2017 to 30 th June 2022		



Section B: Course information

1. Nomenclature	Standard 1 AQTF Standards for Accredited Courses	
1.1 Name of the qualification	22332VIC Graduate Certificate in Tool Design for Plastics	
1.2 Nominal duration of the course	380 – 500 hours.	
2. Vocational or educational of	utcomes Standard 1 AQTF Standards for Accredited Courses	
2.1 Purpose of the course	 Graduates of the qualification will be able to meet the current and future industry requirements to work effectively across the plastics product and tool design industry with the skills and knowledge to: manage appropriate application of tool design methodologies and principles to meet product specifications incorporate emerging additive manufacturing technologies to facilitate rapid prototyping and rapid tool fabrication for plastics processing manage optimisation of production methodologies and principles develop frameworks for achieving project outcomes manage tool design within: injection moulding specialisation manage tool design within extrusion specialisation evaluate systems and outcomes Maintain knowledge of local and international industry and position of Australian tool design. 	
3. Development of the course	Standards 1 and 2 AQTF Standards for Accredited Courses	
3.1 Industry / enterprise/ community needs	This qualification provides the specialist skills in tool design for plastics that are vital for many enterprises to gain, and maintain niche markets in manufacturing within Australia and overseas. Emerging technologies are providing opportunities for Australian manufacturers to onshore production to supply local and international demand. Local tool design and tool fabrication is essential for the plastics industry to enhance flexibility, enable innovation and provide for rapid response to market demand.	



	Australian manufacturers will be successful if their products are world leading, innovative and produced using the latest tooling design and tooling technology.
	Personnel require the highly specialised skills of this qualification. Consultation with industry has confirmed that the balance of sophisticated skills in CAD, the latest in engineering software, melt flow analysis software, and other technologies, such as rapid prototyping technologies, coupled with a strong emphasis on the decision-making, consultation and evaluation functions of tool design are required now and into the future.
	Tool design for plastics remains very much a niche area but it requires support in skills development if Australia is to combat the trend to send manufacturing off-shore. Indeed, this qualification addresses the observed need for specialist training in order to keep abreast of contemporary industry practices and remain relevant.
	The main target groups comprise:
	 materials and/or mechanical engineers looking for specialisation in tool design for plastics
	• experienced tool makers / moulding technicians who wish to upgrade their qualification to tool design
	• experienced plastics product designers / industrial designers who wish to add tool design to their portfolio
	This qualification supports the Victorian Government's manufacturing strategy, the accreditation of which was initiated by the Victorian Department of Education and Training The strategy - "A More Competitive Manufacturing Industry: New Directions for Industry Policy and Manufacturing" (Department of Economic Development, Jobs, Transport and Resources) states:
	"Niche and specialist skills"
	Manufacturers will be supported with a systematic and structured approach to identifying and addressing priority specialist skill needs for key trades and other occupations critical for the future manufacturing workforce."
	The skills and knowledge content of this course meets this call for skills development for manufacturing.
	Anticipated employment opportunities are within industry fields such as packaging, building and construction and the more advanced manufacturing and precision engineering sectors e.g. medical and composites applications.
	Employment roles include:
	• industrial engineer
	mechanical engineer
	plastics product or part engineer



 tool designer for plastics product within any one or combination of: injection moulding tool design blow moulding tool design extrusion tool design
Industry consultation in consideration of the accreditation of this qualification commenced with site visits to and / or telephone conversations or meetings with a number of manufacturing enterprises/specialists across the Melbourne metro area: Plastool International, Diecraft Australia, Dolphin Products, Forme Technologies, Modfix, Caps and Closures, E3 & Associates. Society of Plastics Engineers, Australia
Representatives of these organisations were then invited to form the accreditation Steering Committee. Prior to the initial Steering Committee meeting invitees were asked to provide a skills and knowledge profile for manufacturing industry tool designers.
Members of the steering committee were:
 Gary Down, Managing Director, <i>Plastool</i> Danny Tasmakis, Senior Designer, <i>Diecraft</i> Australia Wilhelm Morgan, <i>Wilhelm Morgan Institute</i> (Private RTO) Stefano Stefani, Engineering Design Manager, <i>Dolphin</i> Eric Weiqin Poh, <i>Caps and Closures</i>
At the initial Steering Committee meeting the skills and knowledge provided by 22181VIC Graduate Certificate in Tool Design for Plastics were reviewed. The Steering Committee determined that 22181VIC required updating and the additional skills and knowledge were now required in the workplace.
Minor amendments to the current units were called for and the addition of coverage of :
 Selection of polymer materials 3D printing for prototyping 3D printing for fabrication of production tools / part tools
In addition the Steering Committee required that consideration be given to ensuring that graduates had experience of actual practical production of plastic products.
Skills and knowledge profiles were developed for these three aspects of tool design for plastics.
The skills and knowledge required relating to the selection of polymer materials has been provided for by the importation of the unit of competency:
PMBTECH505 Choose polymer materials for an application



	Two new units have been written to provide the skills and knowledge required in the plastics processing industry to utilise emerging additive manufacturing technologies (3D printing): VU21986 Utilise 3D printing for plastic product manufacturing	
	VU21987 Utilise 3D printing for plastic product prototyping	
	The new course structure provides for all identified skills and knowledge outcomes.	
	The skills and knowledge provided through this course are not covered by a qualification and / or units of competency within a Training Package.	
3.2 Review for re- accreditation	This course replaces 22181VIC Graduate Certificate in Tool Design for Plastics which expired 31/12/2016. (<i>Refer to Appendix 1: Transition table, page 19</i>).	
4. Course outcomes	Standards 1, 2, 3 and 4 AQTF Standards for Accredited Courses	
4.1 Qualification level	This qualification is consistent with the criteria and specifications of the AQF Graduate Certificate as outlined in the Australian Qualification Framework Second Edition 2013, as follows:	
	• Purpose and Summary: Graduates at this level will apply a body of knowledge in a range of contexts to undertake professional and highly skilled work and as a pathway for further learning in an emerging professional area through:	
	 recalling and application of a complex and specialised range of design, engineering and scientific principles and knowledge to a wide range of plastics product and tool design applications 	
	 development of optimal design solutions for complex and varied tool design problems, through the creative application of specialised technical and scientific knowledge and skills 	
	 application of evaluation, selection and management methodologies and systems to meet optimum outcomes required of design briefs 	
	• Knowledge: Graduates at this level will have specialised knowledge within a systematic and coherent body of knowledge that may include the acquisition and application of knowledge and skills in a new or existing discipline or professional area, namely:	
	 tool design, such as: complex and specialised range of design, engineering and scientific principles and knowledge applicable to a wide range of tool design projects 	
	 planning, such as: project management planning; risk and contingency planning; evaluation planning; resource planning 	

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		 management and communication, such as: oversight of implementation and evaluation of projects; liaison with range of stakeholders and interdependent roles to achieve optimal design solutions 	
		 research, such as: relevant methodologies, principles and systems and their application to a wide range of design 	
		• Application of knowledge and skills: Graduates at this level will apply knowledge and skills to demonstrate the following as a practitioner:	
		 autonomy, through leadership in design and oversight of implementation, promulgation, monitoring and review of plastics product and tool design projects 	
		 well-developed judgement required to analyse tool design briefs: plan and manage the projects; initiate, execute and evaluate design decisions; to evaluate materials, technologies and systems and review capabilities and applications of same 	
		• adaptability through development of quality and sustainability	
		 procedures to minimise waste and optimise outcomes: manage complex projects in time and within budget; development and execution of risk and contingency management procedures 	
		 responsibility through managing non-routine situations in procedure development, risk and contingency management and oversight of own and others' contributions in plastics product and tool design contexts 	
		• Volume of learning: meets the specification of being typically 0.5 to 1 year	
		 Additional unsupervised self-directed learning, including research, work experience and/or industry-based learning to support successful course completion is required. 	
4.2	Employability skills	This qualification has been mapped to national employability skills.	
		Refer to Appendix 2: Employability skills summary.	
4.3	Recognition given to	Standard 5 AQTF Standards for Accredited Courses	
	the course (if applicable)	Not applicable	
4.4	Licensing/ regulatory	Standard 5 AQTF Standards for Accredited Courses	
	requirements (if applicable)	At the time of accreditation no licensing or regulatory requirements apply.	



5.	Course rules	Standards 2, 6,7 and 9 AQTF Standards for Accredited Courses
5.1	Course structure	To be eligible for the award of 22332VIC Graduate Certificate in Tool Design for Plastics, learners must successfully complete a total of seven (7) units comprising • three (3) core units
		 four (4) electives, with at least three (3) units being selected from one of the following three streams:
		Injection MouldingBlow MouldingExtrusion
		Note: In Addition one elective unit may be selected from an endorsed Training Package qualification or accredited course, at AQF Level 8 as part of the four elective unit streams. The unit selected should relate to the vocational outcomes of the 22332VIC Graduate Certificate in Tool Design for Plastics.
		A Statement of Attainment will be issued for any unit of competency completed if the full qualification is not completed.

Unit of competency/ module code	Field of Education code (six-digit)	Unit of competency/module title	Pre- requisite	Nominal hours
Core units				
VU21972	030705	Design plastics product or part	Nil	80
VU21973	030705	Manage plastics tool design	Nil	80
PMBTECH505	030705	Choose polymer materials for an application	Nil	50
Elective units				
Complete four elective three.	e units with at l	east three selected from one of streams one	, stream two o	or stream
Stream One – Injectio	n Moulding			
VU21974	030705	Implement plastics injection moulding tool design	Nil	40
VU21975	030705	Manage plastics injection moulding tool design application	Nil	70
VU21976	030705	Implement injection moulding tool design for plastics product details	Nil	70
VU21977	030705	Implement plastics injection moulding temperature control	Nil	70
Stream Two – Blow M	oulding	· · · ·		
VU21978	030705	Implement plastics blow moulding tool design	Nil	40
VU21979	030705	Manage plastics blow moulding tool design application	Nil	70
VU21980	030705	Implement blow moulding tool design for plastics product design details	Nil	70
VU21981	030705	Implement advanced blow moulding tool design	Nil	70
Stream Three – Extrus	sion			
VU21982	030705	Implement plastics extrusion tool design	Nil	40
VU21983	030705	Manage extrusion sheet and film tool design	Nil	70
VU21984	030705	Manage extrusion pipe, tube and cable tool design	Nil	70
VU21985	030705	Manage extrusion profile tool design	Nil	70
Stream Four – Additive Manufacturing				
VU21986	030705	Utilise 3D Printing for plastic product manufacturing	Nil	80
VU21987	030705	Utilise 3D printing for plastic product prototyping	Nil	50
		Total nominal hours		380-500

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5.2 Entry requirements	Standard 9 AQTF Standards for Accredited Courses
	Applicants for the 22332VIC Graduate Certificate in Tool Design for Plastics are expected to have:
	 a demonstrated capacity in learning, reading, writing, oracy and numeracy competencies to Level 4 of the Australian Core Skills Framework (ACSF). See <u>https://www.education.gov.au/</u>
	and have:
	• obtained a Diploma/ Advanced Diploma qualification in related fields of study (e.g. engineering) and 2 years' equivalent full-time relevant vocational practice
	or
	• obtained a Bachelor degree or Advanced Diploma in related fields of study (e.g. mechanical/materials engineering; industrial design) and I year equivalent full-time relevant vocational practice
	or
	Three year's equivalent full-time relevant vocational practice.

6. Assessment	Standards 10 and 12 AQTF Standards for Accredited Courses
6.1 Assessment strategy	All assessment will be consistent with the Australian Quality Training Framework Essential Conditions and Standards for Initial/Continuing Registration Standard 1.2 (Initial) and Standard 1.5 (Continuing). See:
	AQTF User guides to the Essential Conditions and Standards for Initial/Continuing Registration:
	or Standard 1: Clauses 1.1 and 1.8 of the <u>Standards for Registered</u> <u>Training Organisations (SRTOs) 2015</u>
	or
	relevant Standards for Registered Training Organisations in effect at the time of assessment.
	Assessment methods and collection of evidence will involve application of knowledge and skills to plastics product and tool design workplaces or simulated environments.
	All assessment activities will be related to a plastics product and tool design context.
	A range of assessment methods will be used, such as:
	 action learning projects in real, or simulated plastics product and tool design settings research projects in plastics product and tool design portfolio practical exercises observation direct questioning presentation third party reports
	Assessment strategies must therefore ensure that:
	• all assessments are valid, reliable, flexible and fair
	• learners are informed of the context and purpose of the assessment and the assessment process
	• feedback is provided to learners about the outcomes of the assessment process and guidance given for future options
	• time allowance to complete a task is reasonable and specified to reflect the industry context in which the task takes place.
	A holistic approach to assessment may be used, by combining the assessment of more than one unit, where it better replicates working practice and reduces the potential for over assessment.
	RTOs must ensure that Recognition of Prior Learning (RPL) is offered to all applicants in determining competency for Credit.
	There is no mandatory workplace assessment.



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6.2 Assessor competencies	Standard 12 AQTF Standards for Accredited Courses The Australian Quality Training Framework Essential Conditions and Standards for Initial/Continuing Registration, Standard 1.4 states the requirements for the competence of persons assessing the course See <u>AQTF User guides to the Essential Conditions and Standards for</u> <u>Initial/Continuing Registration:</u> or Standard 1: Clauses 1.1 3,1.14, 1.15, 1.16,and 1.17 of the <u>Standards for</u> <u>Registered Training Organisations (SRTOs) 2015</u>
	or relevant Standards for Registered Training Organisations in effect at the time of assessment. Assessment of the imported unit PMBTECH505 Choose polymer materials for an application, must reflect the requirements of the Assessment Requirements for the relevant Training Package. (From PMB Plastics, Rubber and Cablemaking Training Package)

7. Delivery	Standards 11 and 12 AQTF Standards for Accredited Courses
7.1 Delivery modes	Standard 11 AQTF Standards for Accredited Courses Delivery of units of competency will take into consideration the individual needs of students and will involve
	 workshops individual assignments team-based assignments applied learning in the workplace or simulated plastics product and tool design environment
	Learners may be supported through: on-line (internet, social media, email and telephony); face-to-face conferencing, mentoring and interviews; ad hoc arrangements, and regular progress monitoring, particularly for practical work.
	The course may be delivered part-time or full-time.
	There is no mandatory workplace delivery.
7.2 Resources	Standard 12 AQTF Standards for Accredited Courses
	Resources must include:
	 Equipment and materials relevant to the units of competency Relevant range of texts, references and/or audio/visual material Workplace documentation
	- Relevant organisational OHS/WHS policies and procedures
	 teachers/trainers who meet the Australian Quality Training Framework Essential Conditions and Standards for Initial/Continuing Registration Standard 1.4. See <u>AQTF User</u> guides to the Essential Conditions and Standards for Initial/Continuing Registration:
	or
	• Standard 1: Clauses 1.1 3,1.14, 1.15, 1.16,and 1.17 of the Standards for Registered Training Organisations (SRTOs) 2015
	or
	relevant Standards for Registered Training Organisations in effect at the time of assessment and,
	access to computers and internet
	• access to workplace or simulated plastics product and tool design environment
	Refer to Appendix 3: Recommended references.
	Generally, arrangements for articulation into higher education qualifications will need to be undertaken individually and on a case by case basis. When RTOs are arranging articulation they should refer to the AQF Second Edition 2013 Pathways Policy.

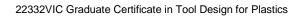


8. Pathways and articulation	Standard 8 AQTF Standards for Accredited Courses
	There are no formal articulation arrangements at present. Individuals will receive credit for any units completed as part of this course if they enrol in further training where the units are part of the qualification.
9. Ongoing monitoring and evaluation	Standard 13 AQTF Standards for Accredited Courses
	The Curriculum Maintenance Manager (CMM), General Manufacturing is responsible for monitoring and evaluation of the 22332VIC Graduate Certificate in Tool Design for Plastics The 22332VIC Graduate Certificate in Tool Design for Plastics will be reviewed at mid-point in the accreditation period. Evaluations will involve consultation with:`
	 course participants plastics product and tool design industry representatives teaching staff assessors Any significant changes to the course resulting from course monitoring and evaluation procedures will be reported to the VRQA through a formal amendment process.



Appendix 1: Transition table

New Qualification title:	22332VIC	C Graduate Certificate in Tool Design fo	r Plastics
Previous Qualification title:	22181VIC Graduate Certificate in Tool Design for Plastics		
General Comment	All existing units in 22181VIC have been transferred to 22332VIC. 22181VIC Graduate Certificate in Tool Design for Plastics has been reviewed and revised to provide for current industry skills and knowledge requirements. In particular the course has been enhanced to include the application of additive manufacturing technologies to the plastics processing industry.		
Unit code and title in this qualification		Relationship to unit in 22181VIC	Comments
VU21972: Design plastics product or part		VU20732: Design plastics product or part	Equivalent
VU21973: Manage plastics to	ool design	VU20733: Manage plastics tool design	Equivalent
VU21974: Implement plastics injection moulding tool design		VU20734: Implement plastics injection moulding tool design	Equivalent
VU21975: Manage plastics injection moulding tool design application		VU20735: Manage plastics injection moulding tool design application	Equivalent
VU21976: Implement injection moulding tool design for plastics product details		VU20736: Implement injection moulding tool design for plastics product details	Equivalent
VU21977: Implement plastics injection moulding temperature control		VU20737: Implement plastics injection moulding temperature control	Equivalent
VU21978: Implement plastics blow moulding tool design		VU20738: Implement plastics blow moulding tool design	Equivalent
VU21979: Manage plastics blow moulding tool design application		VU20739: Manage plastics blow moulding tool design application	Equivalent
VU21980 Implement blow moulding tool design for plastics product design details		VU20740 Implement blow moulding tool design for plastics product design details	Equivalent
VU21981: Implement advanced blow moulding tool design		VU20741: Implement advanced blow moulding tool design	Equivalent
VU21982 Implement plastics extrusion tool design		VU20742 Implement plastics extrusion tool design	Equivalent





Unit code and title in this qualification	Relationship to unit in 22181VIC	Comments
VU21983: Manage extrusion sheet and film tool design	VU20743: Manage extrusion sheet and film tool design	Equivalent
VU21984: Manage extrusion pipe, tube and cable tool design	VU20744: Manage extrusion pipe, tube and cable tool design	Equivalent
VU21985: Manage extrusion profile tool design	VU20745: Manage extrusion profile tool design	Equivalent
PMBTECH505: Choose polymer materials for an application	New imported unit – N/A	From PMB Plastics, Rubber and Cablemaking Training Package
VU21986 Utilise 3D Printing for plastic product manufacturing	New Unit – N/A	New
VU21987 Utilise 3D printing for plastics product prototyping	New Unit – N/A	New

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Appendix 2: Employability Skills Summary

Victorian Registration & Qualifications Authority	Employability Skills Summary	
Qualification Code:	22332VIC	
Qualification Title:	Graduate Certificate in Plastics Product and Tool Design	
conjunction with the detailed requ	mary of the employability skills required for this qualification. This table should be interpreted in irements of each unit of competency packaged in this qualification. The Employability Skills dustry requirements that may vary depending on the packaging options.	
Employability Skill	Industry/enterprise requirements for this qualification include the following facets:	
Communication that contributes to productive	• utilising excellent interpersonal skills to consult, question, clarify and evaluate information	
and harmonious relations across employees and customers	• liaising, listening and consulting with colleagues, management and stakeholders to encourage participation, and clarify and evaluate issues	
	• consulting with stakeholders and others on managing a range of project plans	
	• developing and managing formal and informal communication networks	
	negotiating solutions to new and emerging issues	
	• producing a wide range of reports, visual presentations and charts to document project progress, targets, milestones and outcomes	
Teamwork that contributes to productive	• demonstrating high-level leadership and consultation processes with team and stakeholders to foster informed work practices	
working relationships and outcomes	• designing evaluation and feedback from stakeholder consultation	
	• working with, and motivating others, to gather information, prepare plans, and implement projects	
	• seeking expertise from other/s as required	
Problem solving that	analysing and selecting information for relevance and accuracy	
contributes to productive outcomes	• high-level research to provide innovative approaches to design solutions	
	• analysing, co-ordinating and refining budgets	
	• sourcing relevant people to provide consultative assistance and specialised information where required	
	• developing strategies and implementation plans	



Initiative and enterprise that contribute to innovative outcomes	• applying learning to flexibility in design and production
	• applying learning to anticipating opportunities for improved processes
	• identifying trends in plastics product and tool design sector
	identifying improvements to work design and organisation
	reviewing processes to inform future activity
	participating in industry networks
Planning and organising that	• consulting with stakeholders and others on developing and managing a range of plans and projects
contribute to long and short-term strategic planning	• contributing to managing project completion through time management, setting priorities, timelines, targets and milestones for self and with others
P.C.I.I.I.Ig	 monitoring and adjusting operations to optimise outcomes and for contingency planning
	 maintaining information systems, records, inspection and reporting procedures
	contributing to continuous improvement and planning processes
Self-management that	planning own work
contributes to employee satisfaction and growth	• selecting and prioritising projects within scope of own role
Salislacion and growin	• evaluating and monitoring own performance
	• identifying and acting on professional development opportunities
	• working within organisational and developing policies, procedures, and legislative requirements
Learning that contributes to ongoing improvement	• developing and maintaining personal competence in related industry skills and knowledge
and expansion in employee and company operations	• relevant legislation, regulations, standards and codes of practice
and outcomes	• establishing, implementing and/or managing systems and opportunities for ongoing professional development and training
	 passing on to broader practice community, lessons learned from implementation of projects
Technology that	• using a range of software to develop diagrams, sketches and plans
contributes to the effective carrying out of tasks	• using project management specific programs and databases to analyse information
	 applying OHS technology and learning about ergonomics to using technology safely
	• using technology to achieve improvements in sustainable energy and resource efficiency technologies outcomes



Appendix 3: Recommended references

- Australian Engineering Drawing Standards AS1100.
- Baird, D & Collias, D. *Polymer Processing: Principles and Design*, Wiley, New York, 1998.
- Beck, R. *Plastics Product Design,* Van Nostrand Reinhold, 1980
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 - Quality System Requirements QS9000
 - Production Parts Approval Process
 - Advanced Product Quality Planning
 - Quality System Assessment
 - Potential Failure Mode and Effects Analysis
 - Published by American Society for Quality Control and Automotive Industry Action Group.



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Section C: Units of Competency

Core units

VU21972: Design plastics product or part

VU21973: Manage plastics tool design

PMBTECH505: Choose polymer materials for an application

Stream One: Injection Moulding

VU21974: Implement plastics injection moulding tool design

VU21975: Manage plastics injection moulding tool design application

VU21976: Implement injection moulding tool design for plastics product details

VU21977: Implement plastics injection moulding temperature control

Stream Two: Blow Moulding

VU21978: Implement plastics blow moulding tool design

VU21979: Manage plastics blow moulding tool design application

VU21980: Implement blow moulding tool design for plastics product design details

VU21981: Implement advanced blow moulding tool design

Stream Three: Extrusion

VU21982: Implement plastics extrusion tool design

VU21983: Manage extrusion sheet and film tool design

VU21984: Manage extrusion pipe, tube and cable tool design

VU21985: Manage extrusion profile tool design

Stream Four: Additive manufacturing

VU21986: Utilise 3D printing for plastic product manufacturing

VU21987: Utilise 3D printing for plastics product prototyping



VU21972 Design plastics product or part

VOZISTZ Design plastics product of part			
Unit Descriptor	This unit describes the skills and knowledge required to develop and implement plastics product and/or part design to enable the achievement of tooling and production requirements and to meet specified outcomes.		
	No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.		
Employability Skills	This unit contains Employability Skills.		
	The required outcomes described in this unit of competency contain applicable facets of Employability Skills. The Employability Skills Summary of the qualification in which this unit is included will assist in identifying employability skill requirements.		
Application of the Unit	This unit supports the work of designers, managers, leaders and project personnel who are responsible for development of plastics products and tool design across a broad range of processing applications, such as: injection moulding; blow moulding, and/or extrusion, within the plastics industry. Practitioners are typically engaged in implementing tool design strategies that are responsive to: product intent; stakeholder-specified; regulatory, and sustainability requirements.		
ELEMENT			
ELEMENT Elements describe the essential outcomes of a unit of competency.	sustainability requirements.		
Elements describe the essential outcomes of a unit of	sustainability requirements. PERFORMANCE CRITERIA Performance criteria describe the required performance needed to demonstrate achievement of the element. Where bold italicised text is used, further information is detailed in the required skills and knowledge and/or the range statement. Assessment		
 Elements describe the essential outcomes of a unit of competency. 1 Determine principles and procedures for plastics 	 sustainability requirements. PERFORMANCE CRITERIA Performance criteria describe the required performance needed to demonstrate achievement of the element. Where bold italicised text is used, further information is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide. 1.1 Current theories, models and methodologies of <i>product design</i> are researched, analysed and debated for current and future application to <i>product design projects</i> within <i>organisational</i> and <i>regulatory</i> 		
 Elements describe the essential outcomes of a unit of competency. 1 Determine principles and procedures for plastics 	 sustainability requirements. PERFORMANCE CRITERIA Performance criteria describe the required performance needed to demonstrate achievement of the element. Where bold italicised text is used, further information is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide. 1.1 Current theories, models and methodologies of product design are researched, analysed and debated for current and future application to product design projects within organisational and regulatory requirements 1.2 Manufacture and assembly implications of product design project 		

- 2 Determine processes for achieving optimal relationship between plastics product design, processing method, material and tool design
- 2.1 Impact of *end-use requirements* and the *distinctive features* of plastics products on selection of *processing method* and material is analysed



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- 2.2 Effect of *properties* of a range of polymer materials on the performance of plastics products are analysed
- 2.3 Impact of *product design* and *production considerations* on *tool design* is investigated
- 2.4 **Design fault prevention strategies**, across a range of plastics products and parts, are determined and incorporated into project
- e 3.1 Product requirements are analysed and appropriate polymer and process/es to meet specified outcomes are determined
 - 3.2 Product features are designed to optimise function and performance of the product/part
 - 3.3 Design drawings, incorporating specified distinctive features and design details, are prepared, and *critically evaluated* against specified project outcomes, organisational and regulatory requirements in consultation with *relevant people*
 - 3.4 Recommendations for improvement are made and agreed upon in consultation with relevant people

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3 Implement and evaluate design project

REQUIRED SKILLS AND KNOWLEDGE

This describes the essential skills and knowledge and their level, required for this unit.

Required Skills:

- interpersonal skills to work with clients, colleagues, management and stakeholders either under direction, independently, or within a team
- leadership and interpersonal skills to communicate design concepts, implications, requirements and parameters to stakeholders
- leadership and organisational skills to manage implementation and evaluation of design project
- research and analytical skills to identify methodologies to achieve optimal relationship between product or part design and production
- strategic thinking skills to evaluate design methodologies for application to specific project outcomes
- manual and computer-aided design and drafting skills to develop, test and simulate designs
- calculation skills to determine design requirements
- problem-solving skills to identify potential barriers to projected outcomes, analyse risks and establish prevention strategies
- analytical and evaluation skills to assess product and tool design for plastics project and use results to inform future practice

Required Knowledge:

- behaviour and applications of polymer materials
- operating principles of plastics processing methods
- principles and processes of plastics product and tool design
- product design detailing
- implications of product design for tool design
- factors that affect decisions in the design process
- principles of design for manufacture and assembly
- risk management strategies
- quality procedures
- relevant Federal, State or Territory legislation and local government legislation, regulations and standards
- sustainability implications for tool design for plastics
- safe work practices



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 in the Performance Criteria is detailed below. Add any 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.

Product design may refer to: •

- <u>range of factors</u> to be considered at each main stage of a product design process, such as:
 - product specifications and end-use
 - product fitness for purpose
 - product aesthetics
 - o fit with other components
 - o production quantity, cost and time requirements
 - quality guidelines in design, such as:
 - simplify
 - optimise
 - innovate
 - reduce waste
 - o suitability of material specification
 - o quality standards, such as:
 - testing
 - validation
 - o available production machinery
 - relevant legislation, regulations and standards
 - post-operation processes, such as:
 - re-grinding
 - finishes
 - labelling
 - o environmental issues / product stewardship
- <u>key stages</u> of the product design process, such as:
 - o design brief
 - o regulatory requirements
 - o industry code requirements
 - o intellectual property requirements
 - product design proposal
 - o design review and verification by relevant people
 - selection of appropriate:
 - materials

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- processes
- equipment

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- o analysis of implications of design features
- o design validation
- o evaluation of impact on other systems
- o design changes as required
- o product trialling, evaluation and adjustment
- o quality assurance
- Failure Mode and Effects Analysis (FMEA)
- record keeping
- evaluation of product design project process for continuous improvement
- <u>range of processes</u> to develop product design, such as:
 - from engineering drawings and specifications
 - o from a product model
 - sketching
 - o Computer-Aided Drafting (CAD) techniques
 - o rapid prototyping
 - o sculpture
 - carving
 - epoxy resin moulding
- description / definition / rationale
- outcomes and goal setting
- strategic planning
- resource requirements and allocation
- budget
- targets and milestones
- completion phases and timelines
- quality management policies and procedures
- personnel
- responsibilities
- accountabilities
- agreed reporting procedures
- communication strategies
- stakeholder engagement strategies, including critical consultation points
- monitoring and evaluation



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Product design projects

may refer to:

Organisational requirements may refer to:	• vision
	• mission
	• purpose and values
	business strategy and performance plans
	• Return On Investment (ROI)
	operational planning, policies and procedures
	• processes
	resource requirements and financial considerations
	risk management policies and procedures
	reporting procedures
	legal and ethical requirements and codes of practice
	• quality standards and continuous improvement processes
	• economic, social and environmental sustainability goals, initiatives, reporting and protocols
	knowledge and Intellectual Property (IP) policies
	OHS policies, procedures and programs
	customer / client satisfaction
Regulatory requirements may refer to:	• Federal, State or Territory legislation and local government regulations and legislation
	Australian Standards, such as:
	• technical drawing
	 quality management processes
	• compliance with relevant International Standards, such as:
	• technical drawing
	• covenants, such as:
	 Plastics and Chemicals Industries Associations (PACIA) - Packaging covenant
	environmental regulations
	product stewardship legislation
	Occupational Health and Safety (OHS)
	• food grade requirements
	• poisons
	dangerous goods
	• structural codes
Manufacture and assembly	• product simplification, such as:
implications may include:	• design for minimum number of parts

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Implications and requirements

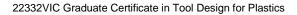
for incorporating product

design details refers to:

- early and accurate costing of method of assembly, material, process and tooling to enable optimal design decisions
- updating of costs as tolerances, surface finishes and other part details are determined
- consultation on design, cycle times and costs with suppliers, customer and other stakeholders
- holes or slots, such as:
 - moulded holes
 - o wall sections in blind holes
 - o drilled holes
 - tapped holes
- implications and requirements, such as:
 - o spacing and positioning
 - o tool design for holes or slots
 - o cavity inserts
 - o pins and posts
- undercuts:
 - purpose of undercuts
 - o alternatives to undercuts
 - o collapsible cores
 - tooling requirements
 - o precautions for successful results
 - product actuation
- threads, such as:
 - o moulded threads
 - o internal and external threads
 - tapped threads
- implications and requirements, such as:
 - o mould design for threads
 - removal of thread parts from moulds
 - o advantages and disadvantages of different types of threads
- inserts, such as:
 - plastic inserts
 - o metal inserts
- implications and requirements, such as:
 - positioning of inserts
 - o material thickness around inserts
 - o mould temperature
 - o sealants

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- o insert wall thickness
 - press inserts





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- rotating moving halves
- multiple material moulding
- robot-assisted de-moulding/de-sprueing
- methods of fastening and joining plastics:
 - o mechanical fasteners, such as:
 - thread forming and cutting screws
 - blind rivets
 - speed nuts and clips
 - drive studs
 - welding, such as:
 - hot gas/air welding
 - heat bonding (flange welding)
 - ultrasonic welding
 - high frequency welding
 - induction welding
 - friction welding
 - adhesive and cohesive chemical bonding, such as:
 - solvent cement
 - bodied cement
 - monomeric cement
 - thermosetting cement
 - o chemical bonding joint configuration
- hinge types
- methods of decorating plastics, such as:
 - o spray painting
 - o metallising
 - metal plating
 - screen printing
 - o multi colour moulding
 - o in mould decorating / labelling
 - hot stamping
 - o labels and decals
- implications and requirements, such as:
 - o materials suitability
 - o surface preparation
 - product and part configuration
- tooling configuration
- advanced product quality planning
- Production Part Approval Process (PPAP)
- Quality System Assessment (QSA)



Quality policies and

procedures may include:



- potential Failure Mode and Effects Analysis (FMEA)
- control plans
- Operator Training Requirements
- End-use requirements may •

refer to:

- top load strength
- flexibility
- flexural strength
- impact performance
- gas permeation (PET)
- Environmental Stress Crack Resistance (ESCR)
- UV resistance
- chemical resistance
- burst strength
- visual appearance
- printability
- environmental costs, such as:
 - recycling
 - waste disposal
 - toxicity
- cost
- hollow product
- thin walls
- totally moulded surfaces
- continuous product
- irregular shape
- rigid product
- low cost tooling
- length of run
- injection moulding
- blow moulding
- extrusion
- assembly methods
- finishing methods

Properties may refer to:

Processing method may

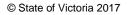
refer to:

Distinctive features of

product design may refer to:

- physical and mechanical properties, such as:
 - o thermal behaviour
 - o chemical resistance
 - appearance, such as:
 - flash
 - sink marks
 - grain wash out

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ection C. Onits of Competency	VOZ1972 Design plastics prod
	 gloss levels
	 drag marks
	– distortion
	 harmony with adjacent parts
	 grain/gloss/colour matching
	• glass transition temperature
	o shrinkage
	material flow or viscosity
Production considerations	production capacity
may refer to:	 length of run / number of products
	• size and complexity of product
	process equipment available
	dimensional precision of product
Tool design may refer to:	• gating methods, such as:
	• standard gate
	• valve gate
	• edge gate
	• fan gate
	• submarine gate
	• taper / draft angles
	• ejection / release methods
	• tolerance / shrinkage
	moveable cores
	• insert moulding
	• over moulding
Design fault may refer to:	• premature failure
	 radii and chamfers
	• wall thickness
	• burn marks
	• sink marks
	• weld lines
	• warpage
	• shrinkage
	ejection problems
(Design fault) Prevention	• careful initial evaluation of product requirements / specifications
strategies may refer to:	 thorough analysis of the design constraints of different processes, materials and tools

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- thorough and ongoing consultation with client / suppliers / other team members and stakeholders
 - effective project management
 - quality assurance procedures, including:
 - o design checklist
 - production checklist
 - o failure minimisation
 - o zero defects methodology
 - process control
 - functionality and fitness for end-use
 - manufacturability
 - cost of production
 - environmental costs and impact of production
 - minimising product design complexity
 - utilisation of strategies to eliminate or minimise faults
- *Relevant people* may refer to:

Critically evaluated may

include consideration of:

- management
- colleagues
- clients
- customers
- suppliers
- stakeholders
- technical experts
- industry professionals
- planners
- advisors
- consultants
- regulators



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EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment Guidelines for this Training Package.

Critical aspects for assessment and evidence required to demonstrate competency in this unit	A person who demonstrates competency in this unit must provide evidence of:
	• directing, implementing and evaluating plastics product design project/s across a range of distinctive features and details
	• determining prevention strategies for design faults in a range of plastics and parts
	• knowledge of principles and process of plastics product design including design details and subsequent implications for manufacture, assembly, processing, materials and tool design
Context of and specific	Assessment must ensure:
resources for assessment	• activities are related to a tool design for plastics context
	Resources for assessment include:
	• access to suitable simulated or real workplace opportunities
	 access to a range of plastics products/parts and associated tooling
	 access to Computer Aided Design and Tooling Design software
Method of assessment	A range of assessment methods should be used to assess practical skills and knowledge. The following assessment methods are appropriate for this unit:
	• evaluation of plastics product design project that meets specific outcomes and that include a range of distinctive features and design details
	• evaluation of research project into theories, models and methodologies in plastics product design including fault prevention strategic planning
	• evaluation of research project into relevant Australian and international legislation, regulations and industry standards
	• practical exercises, such as: manual sketching and Computer- Aided Design (CAD)
	• observation
	direct questioning
	• presentations

• third party reports

Guidance information for assessment (Optional) Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. Suggested units may include but are not limited to:

Unit VU21973: Manage plastics tool design



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VU21973 Manage plastics tool design

Uni	t Descriptor	design	This unit describes the skills and knowledge required to manage plastics tool lesign projects, both individually and within a team setting, across a range of ocal and international industry contexts.	
			<i>No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.</i>	
Emj	ployability Skills	This u	nit contains Employability Skills.	
		facets qualif	equired outcomes described in this unit of competency contain applicable of Employability Skills. The Employability Skills Summary of the ication in which this unit is included will assist in identifying yability skill requirements.	
Арг	Dication of the Unit	This unit supports the work of designers, managers, leaders and project personnel who are responsible for the development of tool designs for the manufacture of plastics products across a broad range of processing applications, such as: injection moulding; blow moulding, and/or extrusion within the plastics industry. Practitioners are typically engaged in implementing tool design strategies that are responsive to: product intent; stakeholder-specified; regulatory, and sustainability requirements.		
ELI	EMENT	PER	FORMANCE CRITERIA	
out	ments describe the essential comes of a unit of npetency.	achie detai	ormance criteria describe the required performance needed to demonstrate evement of the element. Where bold italicised text is used, further information is iled in the required skills and knowledge and/or the range statement. Assessment rformance is to be consistent with the evidence guide.	
1	Determine principles and procedures for plastics tool design	1.1	Current theories, models and methodologies of <i>tool design</i> are researched, analysed and debated for current application to <i>tool design projects</i> within <i>organisational</i> and <i>regulatory requirements</i>	
		1.2	Implications of <i>value analysis and value engineering</i> on the tool design process is analysed and findings documented	
		1.3	Quality policies and procedures , including environmental impact of tool design, are delineated and incorporated into project	
2	Develop and oversee tool design project	2.1	Own role and responsibilities of tool designer , both as a skilled individual and in relation to others associated with tool design project are delineated and practised	
		2.2	Project management tools and methodologies relevant to supporting efficient, timely and successful completion of tool design projects are evaluated, selected and implemented, in consultation with relevant people	

2.3 Communication strategies, including identification of *critical consultation points*, that support project objectives processes and procedures are developed and practised

- 3 Evaluate impact of emerging local and international trends on plastics tool design management
- 2.4 *Risk* and contingency management is built into tool design project strategy
- 2.5 *Performance monitoring and review policies and procedures* are established, communicated to relevant people and undertaken
- 3.1 Relevant and up-to-date information on current and emerging trends in plastics tool design is researched through *key industry organisations* and professional networks and then evaluated.
- 3.2 *Local trends* are analysed and assessed for their interrelationship and interaction with *global factors* and impact on client expectations of tool design.
- 3.3 Impact of local and **global trends** on the local industry is analysed, findings documented and agreed innovations are incorporated into tool design management strategy in consultation with relevant people.



REQUIRED SKILLS AND KNOWLEDGE

This describes the essential skills and knowledge and their level, required for this unit.

Required Skills:

- interpersonal skills to work with clients, colleagues, management and stakeholders either under direction, independently, or within a team
- leadership and interpersonal skills to communicate design concepts, implications, requirements and parameters to stakeholders
- leadership and organisational skills to manage implementation and evaluation of tool design project
- research and strategic thinking skills to evaluate design methodologies for application to specific project outcomes
- manual and computer-aided design and drafting skills to develop, test and simulate designs
- calculation skills to determine design requirements
- problem-solving skills to identify potential barriers to projected outcomes, analyse risks and establish prevention strategies
- analytical and evaluation skills to assess tool design for plastics project and use results to inform future practice,
- research and analytical skills to identify and evaluate emerging local and international trends in tool design for plastics and to develop response and innovation

Required Knowledge

- principles and processes of plastics product and tool design
- factors that affect decisions in the design process
- concepts of value analysis and value engineering
- behaviour and applications of polymer materials
- operating principles of plastics processing methods
- implications of product design for tool design
- factors that affect decisions in the design process
- project management tools and methodologies
- risk management strategies
- quality procedures
- relevant Federal, State or Territory legislation and local government legislation, regulations and standards
- sustainability implications for tool design for plastics
- current and emerging local and global trends in plastics tool design
- current and emerging local and global economic, legislative and political influences on plastics industry
- relevant industry organisations and networks
- safe work practices



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 in the Performance Criteria is detailed below. Add any 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.

Tool design may refer to:

- Range of factors to be considered at each main stage of a tool design process, such as:
 - o product specifications and end-use
 - o product fitness for purpose
 - o product quantity, cost and time requirements
 - environmental issues, such as:
 - recycling
 - waste minimization
 - carbon abatement
 - o suitability of material specification
 - o available production machinery
 - o tool to machine compatibility
 - o quality standards, such as those pertaining to:
 - testing and validation
 - dangerous goods
 - food contact
 - poisons
 - post-operation processes, such as:
 - re-grinding
 - finishes
 - labelling
- key stages of the tool design process, such as:
 - o design brief

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- action plan and timeline
- tool design proposal
- quality assurance and Failure Mode and Effects Analysis (FMEA) procedures
- design review and verification by all stakeholders
- o confirmation of appropriate materials, process and equipment
- design validation
- o design changes as required
- evaluation of impact on other systems
- prototype tool trialling
- maintain accurate records
- evaluation of tool design project process for continuous improvement



• range of processes to develop tool design, such as:

- from engineering drawings and specifications
- from a product model
- sketching
- Computer Aided Drafting (CAD) techniques
- rapid prototyping
- o sculpture
- carving
- epoxy resin moulding
- o application of flow analysis software
- description / definition / rationale
- outcomes and goal setting
- strategic planning
- resource requirements and allocation
- budget
- targets and milestones
- completion phases and timelines
- quality management policies and procedures
- personnel
- responsibilities
- accountabilities
- agreed reporting procedures
- communication strategies
- stakeholder engagement strategies, including critical consultation points
- monitoring and evaluation
- vision
- mission
- purpose and values
- business strategy and performance plans
- Return On Investment (ROI)
- operational planning, policies and procedures
- processes
- resource requirements and financial considerations
- risk management policies and procedures
- reporting procedures
- legal and ethical requirements and codes of practice
- quality standards and continuous improvement processes
- economic, social and environmental sustainability goals, initiatives, reporting and protocols
- knowledge and Intellectual Property (IP) policies
- OHS policies, procedures and programs
- customer / client satisfaction



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Organisational

requirements may include:

Tool design projects may refer to:

ection C: Units of Competency	VUZ1973 Manage plastics tool desig
Regulatory requirements may include:	• Federal, State or Territory legislation and local government regulations and legislation
	• Australian and International Standards, such as:
	• technical and architectural drawing
	 quality management processes
	• heat treatment
	o electrical
	• covenants, such as:
	 Plastics and Chemicals Industries Associations (PACIA) - Packaging covenant
	environmental regulations
	product stewardship legislation
	Occupational Health and Safety (OHS)
	food grade requirements
	• poisons
	dangerous goods
	• structural codes
Value analysis and value engineering may refer to:	• use of Value Analysis and Value Engineering (VA-VE) job plan
engineering may refer to.	regular benchmark costings
	 quality control and management methods
	 defect prevention through good initial design
	• 'get it right the first time'
	• focus on improved product quality, performance and cost
Quality policies and	advanced product quality planning
procedures may include:	Production Part Approval Process (PPAP)
	Quality System Assessment (QSA)
	• potential Failure Mode and Effects Analysis (FMEA)
Own role and	• technical competence:
responsibilities of the tool	 tool design proposals: outline and full concept
<i>designer</i> may refer to:	 professional competence, such as:
	 researched knowledge of current and emerging trends in plastics industry, such as:
	 new commercial polymers
	 waste minimisation
	 recycling technologies
	 CAD and other software
	 professional networks

 researched knowledge of current and emerging local and global economic, legislative and political influences on plastics industry

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• management competence, such as:

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- strategic planning and implementation, such as:
 - projects align with overall organisational strategic planning
 - project management
 - OHS policies and procedures
- quality management for minimum tool trialling, such as:
 - zero defects
 - quality built into initial design
 - quality built into design processes and stages
 - risk and contingency planning
 - continuous improvement
- o communication and management skills, such as:
 - delegation
 - effective communication of policies and procedures
 - effective problem-solving
 - team-based work methods
 - consultative management approaches
 - participative management approaches
- systems thinking, such as:
 - project evaluation
 - costings and quotations
 - design evaluation and assessment, such as:
 - viability
 - organisational capacity
 - fit for purpose
 - constraints cost
 - operations management, such as:
 - supply
 - resourcing
 - work flow to downstream work areas, such as:
 - toolmakers
 - mould shop technicians
 - rapid prototypers
 - production engineers
 - sustainability management, such as:
 - design decision based on environmental impact
 - costs
 - policies and procedures for sustainable energy and resource efficient technologies



- client and stakeholder management, such as:
 - o feedback on project brief
 - consultation and briefing on progress
 - o consultation and briefing on necessary alterations to project
 - review of project outcomes
 - management of conflicting needs and/or constraints of stakeholders, such as those related to:
 - rapid prototypers
 - raw material suppliers
 - sales engineers
 - production engineers

Others (associated with tool design project) may include:

project team

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- product/industrial designers
- production engineers
- inter-department personnel
- OHS personnel
- quality personnel
- operational management personnel
- raw material suppliers
- toolmakers
- sales engineers
- mould shop technicians
- polymer technicians
- rapid prototypers
- client/s
- external stakeholders
- other suppliers
- Project management tools may include:

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- design checklists
- Key Performance Indicators (KPIs)
- project management software
- timelines
- target review tables
- risk management pro formas
- budgets
- costing spreadsheets
- tool quotation forms
- performance monitoring and review policies and procedures
- Failure Mode and Effects Analysis (FMEA) procedures
- Quality Assurance procedures and processes



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<i>Relevant people</i> may include:	 management colleagues clients customers suppliers stakeholders technical experts industry professionals planners advisors consultants regulators
<i>Critical consultation points</i> may refer to:	 feedback to client on initial design brief as early as possible consultation with all stakeholders to verify design consultation with all stakeholders when establishing project timeline consultation with client to confirm decisions regarding: design materials process equipment briefing of all stakeholders of necessary changes to design in time to minimise cost and loss of time
<i>Risk</i> may refer to:	 constraints and obstacles, such as: flawed product design poor quality procedures failure to evaluate the product design initially failure to communicate effectively with others related to the project timeline blowouts excessive numbers of tool trials containment of costs, including environmental costs cost overruns inadequate budget
Performance monitoring and review policies and procedures may include:	 conformance, measuring and assessment methodologies reporting structures and procedures regular and timely reporting record keeping completion documentation

• compliance manuals



	quality assurance manuals policies and procedurescontinuous improvement policy and procedures
<i>Key industry organisations</i> may include:	 Australian Manufacturing Technology Institute Limited (AMTIL) Plastics and Chemicals Industry Association (PACIA) Society of Automotive Engineering (SAE America and Australia)
<i>Local trends</i> may include:	 increase in rapid prototyping shorter timelines fewer skilled technicians tool design moving offshore manufacturing sector contracting and becoming more competitive high labour costs sub-assembly manufacturers: value added design for export: not just local collaboration with outside organisations on technology impact of National and State economies
<i>Global factors</i> may refer to:	 impact of relevant legislative and regulatory reform collaboration with international suppliers intellectual property issues timelines and delivery implications cultural issues and protocols quality assurance issues implications of differences in legislation and standards
Global trends may refer to:	 increased competition from overseas increased offshore production increased automation new technologies increasing sophistication of process control 'end to local loyalty' integrated technologies integrated companies time-to-market pressure innovation: demonstrating differentiation of product sustainability issues, such as: energy costs

- recyclability
- \circ waste minimisation



- carbon abatement
- new, or retro-fitted, sustainable energy and resource efficient technologies
- culture-neutral designs
- moving trade agreements
- individual tools with quick change components
- international alliances
- international trading arrangements and protocols
- impact of global organisations, such as:
 - o United Nations
 - International Monetary Fund (IMF)
 - World Trade Organisation (WTO)



EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment Guidelines for this Training Package.

Critical aspects for assessment and evidence required to demonstrate competency in this unit

A person who demonstrates competency in this unit must provide evidence of:

- directing, implementing and evaluating plastics tool design project/s across a range of applications
- developing and implementing monitoring and evaluation procedures for plastic tool design project/s including risk and contingency management
- knowledge of principles and process of plastics tool design
- knowledge of relevant legislative and regulatory requirements
- knowledge of current and emerging local and global trends in plastics tool design and their projected consequences for industry

Assessment must ensure:

- activities are related to a tool design for plastics context Resources implications for assessment include:
- access to suitable simulated or real workplace opportunities
- access to a range of plastics products/parts and associated tooling
- access to material specification charts/data sheets
- access to Computer Aided Design and Tooling Design software

A range of assessment methods should be used to assess practical skills and knowledge. The following assessment methods are appropriate for this unit:

- evaluation of plastics tool design project that meets specific outcomes
- evaluation of a research project into the range of different processes for developing tool designs
- evaluation of research project into theories, models and methodologies in plastics tool design including risk management
- practical exercises in leadership; use of project management tools and tool design processes
- observation
- direct questioning
- presentations
- third party reports



Method of assessment

Context of and specific

resources for assessment

Guidance information for assessment (Optional) Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. Suggested units may include but are not limited to:

VU21972: Design plastics product or part



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VU21974 Implement plastics injection moulding tool design

		-	
Unit	Descriptor		unit describes the skills and knowledge required to make optimal tools regarding design requirements for plastics injection moulding tools.
			No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.
Empl	oyability Skills	This	unit contains Employability Skills.
		appli of the	required outcomes described in this unit of competency contain cable facets of Employability Skills. The Employability Skills Summary e qualification in which this unit is included will assist in identifying oyability skill requirements.
Appli	cation of the Unit	perso desig indus strate	unit supports the work of designers, managers, leaders and project onnel who are responsible for development of injection moulding tool in across a broad range of product design applications within the plastics stry. Practitioners are typically engaged in implementing tool design egies that are responsive to: product intent; stakeholder-specified; atory, and sustainability requirements.
ELEI	MENT	PER	FORMANCE CRITERIA
outco	ents describe the essential mes of a unit of etency.	achi deta	Formance criteria describe the required performance needed to demonstrate evement of the element. Where bold italicised text is used, further information is iled in the required skills and knowledge and/or the range statement. Assessment erformance is to be consistent with the evidence guide.
	Research injection noulding tools	1.1	Principles of operation of a range of commonly used <i>injection moulding tools</i> are researched and delineated
		1.2	Different applications and requirements of a range of <i>injection</i> <i>moulding tool components</i> are researched and clarified
i i r f	Analyse the nterrelationship between njection moulding nachines operating unctionality and tool lesign	2.1	<i>Design characteristics and functions of injection moulding machines</i> are analysed for effect on tool design
		2.2	Importance of <i>matching mould design to machine operating</i> <i>functionality</i> is researched and evaluated
		2.3	Operating cycle of moulds are analysed for effect on injection moulding tool design
		2.4	<i>Machine factors</i> are analysed for effect or limitation on injection moulding tool design



_

3	Select materials and tool construction methods to achieve production requirements and processing	3.1	Effect of mould design and production requirements is appraised in determining selection of the <i>metal materials</i> and <i>finishing treatments</i> , according to their particular <i>properties</i> , used in mould construction
		3.2	Effect of mould design and production requirements is appraised in determining selection of <i>mould component construction methods</i>
		3.3	Effect of mould design, production requirements and <i>environmental costs</i> is appraised in determining selection of raw materials
4	Analyse and evaluate product design to determine tool design requirements	4.1	Product design specifications are evaluated to determine injection moulding tool design requirements
		4.2	Optimal materials for mould construction to meet design and <i>production requirements</i> is selected
		4.3	Tool design concept proposals are developed and <i>critically evaluated</i> to achieve specified product outcomes
5.	Implement and evaluate injection mould tool design project	5.1	<i>Project management methodologies</i> and <i>communication</i> <i>strategies</i> are applied to implementation
		5.2	<i>Tool design faults</i> and their causes are analysed and <i>prevention strategies</i> established and implemented
		5.3	Project is reviewed against specified outcomes and findings used to inform improved processes, procedures and planning in consultation with <i>relevant people</i>



REQUIRED SKILLS AND KNOWLEDGE

This describes the essential skills and knowledge and their level, required for this unit.

Required Skills

- interpersonal skills to work with clients, colleagues, management and stakeholders either under direction, independently, or within a team
- leadership and interpersonal skills to communicate design concepts, implications, requirements and parameters to stakeholders
- leadership and organisational skills to manage implementation and evaluation of design project
- research and strategic thinking skills to evaluate design methodologies for application to specific project outcomes
- manual and computer-aided design and drafting skills to develop, test and simulate designs
- calculation skills to determine tool design requirements
- problem-solving skills to identify potential barriers to projected outcomes, analyse risks and establish prevention strategies
- analytical and evaluation skills to assess tool design for plastics project and use results to inform future practice

Required Knowledge

- principles and processes of plastics product and tool design
- principles and processes of plastics injection moulding tool design
- design features and functions of plastics injection moulding machine operating systems
- implications of product design for tool design
- behaviour and applications of polymer materials
- operating principles of plastics processing methods
- factors that affect decisions in the design process
- causes and elimination strategies of common product faults
- project management tools and methodologies
- risk management strategies
- quality procedures
- relevant Federal, State or Territory legislation and local government legislation, regulations and standards
- sustainability implications for tool design for plastics
- safe work practices



RANGE STATEMENT

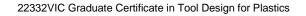
The range statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold italicised wording in the Performance Criteria is detailed below. Add any essential operating conditions that may be present with training and assessment depending on the work situation, needs of the candidate, accessibility of the item, and local industry and regional contexts.

Injection moulding tools may include:

- cold runner, two plate
- cold runner, three plate
- hot runner .
- insulated hot runner
- hot manifold
- multi-cavity hot runner •
- sequential gating •
- family .
- sizing inserts •
- stacked •
- gas injection
- prototypes ٠
- flash moulds (thermoset)

Injection moulding tool components may include:

- cavity design •
- runner system
- ejection system, such as: •
 - 0 return springs
 - gas springs 0
- temperature control system
- standard part components
- actuating mechanisms .
- inserts and cores
- sliding cores and cavities
- clamping systems •
- gas injection needles
- injector nozzles •
- mould clamping units •
- platens, stationary and moveable
- magnetic platens •
- tail plates
- magnetic backing plates







Design characteristics

machines may include:

and functions of

injection moulding

• methods of fixing moulds to platens, such as:

- bolting
- o clamps
- o slides
- dogs
- toggle systems:
 - o single
 - o double
 - o rotary
- direct hydraulic locking:
 - o single
 - multi cylinder
- methods of locking and blocking systems
- selecting type of attachment to platens
- calculating clamp tonnage in relation to mould size for safe machine operation for given materials types
- calculating pillar support requirements to accommodate clamp tonnage for mould bases incorporating 'U' shaped injection housing
- die change procedures
- disassembly and assembly procedures
- safe die transport, handling and storage procedures
- die trialling procedures
- resetting machine for new process
- commissioning new tooling into production
- handling the mould during maintenance and servicing operations
- identification and labelling of dies

Machine factors may include:

Matching mould design

functionality may include:

to machine operating

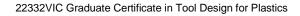
Operating cycle of

moulds may include:

- opening
- sequence and machine platen
- daylight
- ejector hole positions
- hydraulic coupled ejector systems
- platen size
- bolt pattern
- available stroke
- clamp capacity and mould/part size

Metal materials may include:

- mild steel
- surface hardening steel
- stainless steel
- tool steel





include:

- aluminium
- kirksite
- beryllium copper
- interpretation of mould steel data sheets and property tables

Finishing treatments may •

• texturing

polishing

- heat treatment processes, such as:
 - normalising
 - annealing
 - o quench hardening
 - carburising
 - nitriding
 - tempering
 - o stress relieving
- plating and coating techniques
- etching
- graining

Properties may include:

- tensile strength
- thermal conductivity
- cost
- hardness
- surface finish

Mould component construction methods may include:

- Numerical Control (NC) machining
- Computer Numerical Control (CNC) machining
- Electronic Discharge Machining (EDM) commonly called spark erosion
- wire cutting
- grinding
- laser cutting
- water jet cutting
- 3D printing

Environmental costs may include:

- recyclability
- waste management
- waste minimisation
- waste disposal
- resource management
- energy consumption used in processing, such as:



Product design specifications may

include:

services required for production, such as: 0

- cooling supply
- power supply
- heating supply
- carbon abatement
- samples
- drawings .
- specifications
- customer requirements •
- moulding shop specifications •
- environmental issues •
- runner and gate systems for cavity design •
- types of gates
- runner, sprue and gate layout for single or multiple cavity moulds •
- runner cooling ٠
- runner pressure, runner drop-off
- material viscosity •
- thermal conductivity of runner system
- thermal conductivity of part or sections of part
- venting
- temperature control
- ejection methods for products including those with undercuts
- part lines, undercuts, draft angles, shut off witness lines •
- allowance for side pressures and deflection of mould components
- clamp pressures •
- calculation of part line relief
- calculation of pressure required to keep mould closed •
- calculation of mould deformation under pressure and safe work limits
- finishing for application •
- shrinkage
- stakeholder requirements ٠
- sustainability issues
- raw materials and their possible limitations
- Failure Mode and Effects Analysis (FMEA)

Production requirements may include:

- production capacity ٠
- production run specifications •
 - production method •
- end-use applications

Critically evaluated may refer to considerations of:

- functionality and fitness for end-use •
- manufacturability





- include:
- Injection moulding tool design requirements may

Project management methodologies may refer

to:

- cost of production •
- environmental costs and impact of production
- minimising product design complexity •
- utilisation of strategies to eliminate or minimise faults .
- description / definition / rationale •
- outcomes and goal setting •
- strategic planning •
- resource requirements and allocation •
- budget •
- targets and milestones •
- completion phases and timelines •
- quality management policies and procedures
- personnel •
- responsibilities
- accountabilities
- agreed reporting procedures
- communication strategies
- stakeholder engagement strategies, including critical consultation points •
- monitoring and evaluation

team leadership •

- consultative management •
- participative management
- project evaluation •
- stakeholders engagement
- critical consultation points, such as: •
 - feedback to client on initial design brief as early as possible 0
 - consultation with all stakeholders to verify design 0
 - consultation with all stakeholders when establishing project 0 timeline
 - consultation with client to confirm decisions regarding: 0
 - design
 - materials
 - process _
 - equipment
 - briefing of all stakeholders of necessary changes to design in time 0 to minimise cost and loss of time

poor tool design

include:

Tool design faults may

- selection of inappropriate materials
- poor material preparation
- technical faults within production and processes, such as:
 - runner system 0
 - part lines, undercuts, draft angles, shut off witness lines



Communication

strategies may refer to:

- gating 0
- weld lines 0
- flow lines 0
- part position on opening 0
- burn marks 0
- sink marks 0
- depressions 0
- voids 0
- high and low temperature cooling 0
- venting 0
- jetting 0
- sticking sprue 0
- ejection 0
- radius 0
- sticking parts 0
- 0 product retained on fixed or moving side
- moisture 0
- wall thickness variation 0
- · careful initial evaluation of product requirements / specifications
 - thorough analysis of the design constraints of different processes, materials and tools
 - thorough and ongoing consultation with client / suppliers / other team members and stakeholders
 - · effective project management
 - quality assurance procedures, including: •
 - 0 design checklist
 - 0 production checklist
 - 0 failure minimisation
 - zero defects methodology 0
 - process control 0

Relevant people may include:

- management
- colleagues ٠
- clients
- customers
- suppliers
- stakeholders
- · technical experts
- industry professionals
- planners
- advisors
- consultants
- regulators



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(Fault) Prevention

strategies may include:

thick section / thin section 0

EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment Guidelines for this Training Package.

Critical aspects for assessment and evidence required to demonstrate competency in this unit

A person who demonstrates competency in this unit must provide evidence of:

- implementing injection moulding tool design project for a plastics product design concept
- determining prevention strategies for tool design faults
- evaluating project outcomes to inform future practice
- knowledge of principles and processes of injection moulding tool design including: capabilities of injection moulding machine operating systems and requisite materials and tool construction methods

Context of and specific resources for assessment

Method of assessment

Assessment must ensure:

• activities are related to a tool design for plastics context

Resources implications for assessment include:

- access to suitable simulated or real workplace opportunities
- access to a range of plastics products/parts and associated injection moulding tooling
- access to material specification charts/data sheets
- access to Computer Aided Design and Tooling Design software

A range of assessment methods should be used to assess practical skills and knowledge. The following assessment methods are appropriate for this unit:

- evaluation of project in injection moulding tool design that meets specified outcomes of a product design concept.
- evaluation of research project into fundamentals of injection moulding tool design across a range of contexts
- practical exercises
- observation
- direct questioning
- presentations
- third party reports



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Guidance information for assessment

Holistic assessment with other units relevant to the qualification stream, industry sector, workplace and job role is recommended. Suggested units may include but are not limited to:

- VU21975: Manage plastics injection moulding tool design application
- VU21976: Implement injection moulding tool design for plastics product details
- VU21977: Implement plastics injection moulding temperature control



VU21975 Manage plastics injection moulding tool design application

Uni	t Descriptor	impler specif	init describes the skills and knowledge required to develop and ment injection mould tool designs to achieve plastics product ications across a range of contexts. <i>No licensing, legislative, regulatory or certification requirements</i> <i>apply to this unit at the time of publication.</i>	
Em	ployability Skills	This u	nit contains Employability Skills.	
		facets qualif	equired outcomes described in this unit of competency contain applicable of Employability Skills. The Employability Skills Summary of the ication in which this unit is included will assist in identifying syability skill requirements.	
Application of the Unit		This unit supports the work of designers, managers, leaders and project personnel who are responsible for development of injection moulding tool design across a broad range of product design applications within the plastics industry. Practitioners are typically engaged in implementing tool design strategies that are responsive to: product intent; stakeholder-specified; regulatory, and sustainability requirements.		
ELE	EMENT	PER	FORMANCE CRITERIA	
oute	ments describe the essential comes of a unit of npetency.	achie detai	ormance criteria describe the required performance needed to demonstrate evement of the element. Where bold italicised text is used, further information is iled in the required skills and knowledge and/or the range statement. Assessment rformance is to be consistent with the evidence guide.	
1	Apply the principles of cavity mould design to plastics tool design	1.1	<i>Methods of translating product dimensions and specifications</i> into cavity mould designs are researched and delineated	
		1.2	<i>Principles and main elements of cavity mould design</i> are analysed for their different applications	
		1.3	Moulding and cooling conditions for cavity moulds are analysed using <i>simulation software</i>	
2	Research optimum runner feed system for multi- cavity mould/s	2.1	<i>Principles and process of cavity mould balancing</i> are researched and delineated	
		2.2	Range of data required to accurately design an optimum runner system/s is calculated and documented	
3	Apply the principles of product ejection to plastics tool design	3.1	Actuating mechanisms for product ejection from moulds are researched and analysed for their different applications	
		3.2	Possible tool design problems and contexts are assessed and corresponding product ejection designs are developed	

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5

- 4 Determine requirements for multiple-plate cavity mould tool design project
 4.1 Product end-use requirements are analysed and appropriate material and machine process determined
 4.2 Methods to best meet *production and design requirements* are canvassed and selected
 4.3 Product specifications are analysed for possible faults, their causes analysed and *prevention strategies* established
 - 4.4 *Project management methodologies* and *communication strategies* are determined
 - 4.5 Tool design/s are *critically evaluated* against *tool design requirements*
 - Evaluate design project 5.1 Project is implemented and reviewed against specified outcomes
 - 5.2 Findings are used to inform improved processes, procedures and planning in consultation with *relevant people*



REQUIRED SKILLS AND KNOWLEDGE

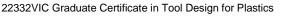
This describes the essential skills and knowledge and their level, required for this unit.

Required Skills

- interpersonal skills to work with clients, colleagues, management and stakeholders either under direction, independently, or within a team
- leadership and interpersonal skills to communicate design concepts, implications, requirements and parameters to stakeholders
- leadership and organisational skills to manage implementation and evaluation of design project
- research and strategic thinking skills to evaluate design methodologies for application to specific project outcomes
- manual and computer-aided design and drafting skills to develop, test and simulate designs
- calculation skills to determine tool design requirements
- problem-solving skills to identify potential barriers to projected outcomes, analyse risks and establish prevention strategies
- analytical and evaluation skills to assess tool design for plastics project and use results to inform future practice

Required Knowledge

- principles and processes of plastics product and tool design
- principles and processes of plastics injection moulding tool design
- design features and functions of plastics injection moulding machine operating systems
- principles and processes of cavity mould tool design
- methods for translating product dimensions and specifications into cavity mould designs
- principles and process of cavity mould balancing and runner system design
- different actuating mechanisms for product ejection from moulds
- behaviour and applications of polymer materials
- operating principles of plastics processing methods
- implications of product design for tool design
- factors that affect decisions in the design process
- causes and elimination strategies of common product faults
- project management tools and methodologies
- risk management strategies
- quality procedures
- relevant Federal, State or Territory legislation and local government legislation, regulations and standards
- sustainability implications for tool design for plastics
- simulated
- safe work practices





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 in the Performance Criteria is detailed below. Add any 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.

Methods of translating product dimensions and

specifications may refer to:

product drawings

•

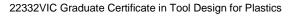
- material and machine specifications
- product models for which drawings can be produced
- product models for which drawings are too difficult to produce, such as:
 - carving
 - o sculpture
- CAD data
- CAD model
- prototype with some working measurements

Principles and main elements of cavity mould design may refer to:

- core and cavity design
- shrinkage and tolerancing
- draft angles
- cores
- splits
- parting surfaces
- part lines
- ejection
- holes and slots
- inserts
- venting
- use of standard parts in moulds
- calculation of cavity and shot size for moulding
- calculation of optimum number of cavities in a mould
- calculation of flow path to cavity thickness ratio
- calculation of size and placement of vents
- CAD system software applications to optimise moulding and cooling conditions for cavity moulds

Simulation software to optimise moulding and cooling conditions, may include:

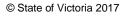
- Moldflow
- Moldtemp
- Cadmold
- Moldcool
- Fillcalc
- Simcon





Principles and process of cavity mould balancing may refer to:	 using pressure drop in the runner system sprue and runner layout for single and multi-cavity die systems principles of design, such as: length cross sectional area shape balanced and unbalanced systems purpose and types of gates
<i>Range of data</i> may include:	 suitable gate dimensions for a range of common materials and gate types rheological data to calculate optimum and minimum runner sizes pressure drop in sections of runner systems efficiency of a range of cross section shapes of runners data relating to volumetric flow shear rate viscosity
Actuating mechanisms may refer to:	 manual ejection ejector actuation mechanisms ejector pins or blades ejection sleeves stripper rings stripper plates compressed air hydraulic ejection other devices, such as: spring loaded ejector pins gas springs taking account of undercuts and sprue removal in design
<i>Production and design requirements</i> , may refer to:	 large volume moulding mechanical and thermal properties of the material part to production requirements machine types

• machine types



(Fault) <i>Prevention</i>	• careful initial evaluation of product design and requirements
strategies may include:	• thorough and ongoing consultation with client / suppliers / other team members and stakeholders
	adequate mould-proofing
	effective project management
	• quality assurance procedures, including:
	• failure minimisation
	 zero defects methodology
Project management	description / definition / rationale
methodologies may refer	 outcomes and goal setting
to:	 outcomes and goal setting strategic planning
	strategic planningresource requirements and allocation
	budget
	 targets and milestones
	 completion phases and timelines
	 quality management policies and procedures
	 quanty management poncies and procedures personnel
	responsibilities
	accountabilities
	 agreed reporting procedures
	 communication strategies
	 stakeholder engagement strategies, including critical
	consultation points
	• monitoring and evaluation
Communication strategies	• team leadership
may refer to:	consultative management
	participative management
	project evaluation
	stakeholders engagement
	• critical consultation points, such as:
	• feedback to client on initial design brief as early as possible
	 consultation with all stakeholders to verify design
	 consultation with all stakeholders when establishing project timeline
	 consultation with client to confirm decisions regarding:



- design
- materials
- process
- equipment
- briefing of all stakeholders of necessary changes to design in time to minimise cost and loss of time
- functionality and fitness for end-use
- manufacturability
- cost of production
- environmental costs and impact of production
- minimising product design complexity
- utilisation of strategies to eliminate or minimise faults
- customer requirements
- environmental costs
- raw materials and their possible limitations
- Failure Mode and Effects Analysis (FMEA)
- management
- colleagues
- clients
- customers
- suppliers
- stakeholders
- technical experts
- industry professionals
- planners
- advisors
- consultants
- regulators



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Critically evaluated may

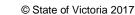
Tool design requirements

refer to considerations of:

Relevant people may

include:

may include:



A person who demonstrates competency in this unit must provide

EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment Guidelines for this Training Package.

and evidence required to	evidence of:
demonstrate competency in this unit	• managing injection moulding tool design project for a multiple-plate cavity mould tool that addresses principles of cavity mould design, runner systems and product ejection systems
	• determining prevention strategies for tool design faults
	• evaluating project outcomes to inform future practice
	• knowledge of principles and processes of injection moulding tool design to meet plastics product design requirements
Context of and specific	Assessment must ensure:
resources for assessment	• activities are related to a tool design for plastics context
	Resources implications for assessment include:
	 access to suitable simulated or real workplace opportunities
	• access to a range of plastics products/parts and associated injection moulding tooling
	access to material specification charts/data sheets
	 access to Computer Aided Design and Tooling Design software
Method of assessment	• A range of assessment methods should be used to assess practical skills and knowledge. The following assessment methods are appropriate for this unit:
	• evaluation of project in injection moulding tool design

- evaluation of project in injection moulding tool design • application that includes cavity mould design; optimises runner system, and ejection systems for a range of contexts and applications
- evaluation of project in comprehensive investigation of • injection mould tools and moulding machinery
- evaluation of investigative project in correlation between product drawings, specifications and mould tool designs and product requirements
- review of portfolio of research into principles and processes of injection moulding tool design



Cont reso

Critical aspects for assessment

- practical exercises
- observation
- direct questioning
- presentations
- third party reports

Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. Suggested units may include but are not limited to:

- VU21976: Implement injection moulding tool design for plastics product details
- VU21977: Implement plastics injection moulding temperature control
- VU21978: Implement plastics blow moulding tool design

Guidance information for assessment

(Optional)



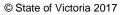
VU21976 Implement injection moulding tool design for plastics product details

Uni	t Descriptor	injec speci	unit describes the skills and knowledge required to realise the design of tion mould tools that achieve product specifications for products with ial design features, such as: split cavities; side cavities and cores; ections; internal or external undercuts, and internal or external screw ids. <i>No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.</i>
Em	ployability Skills	This	unit contains Employability Skills.
		appli of th	required outcomes described in this unit of competency contain cable facets of Employability Skills. The Employability Skills Summary e qualification in which this unit is included will assist in identifying oyability skill requirements.
Арр	olication of the Unit	perso desig indus strate	unit supports the work of designers, managers, leaders and project onnel who are responsible for development of injection moulding tool gn across a broad range of product design applications within the plastics stry Practitioners are typically engaged in implementing tool design egies that are responsive to: product intent; stakeholder-specified; latory, and sustainability requirements.
EL	EMENT	PER	FORMANCE CRITERIA
out	ments describe the essential comes of a unit of npetency.	ach is de	formance criteria describe the required performance needed to demonstrate ievement of the element. Where bold italicised text is used, further information etailed in the required skills and knowledge and/or the range statement. essment of performance is to be consistent with the evidence guide.
1	Apply the principles for incorporating screw threads to mould tool design	1.1	<i>Applications and methods for incorporating screw threads</i> into mould tool design are researched and delineated
		1.2	Range of <i>gating and actuating methods</i> for removal of products with screw threads are compared and analysed for their different

applications

- 1.3 Mould tool design sketches that incorporate screw threads are developed in consultation with *relevant people*
- 2 Apply the principles for 2 incorporating undercuts to mould tool design
- 2.1 **Applications and methods for incorporating undercuts** into mould tool design are researched and delineated

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3 Apply the principles for incorporating standard mould components and inserts to mould tool design

Implement and evaluate

injection moulding tool design project for plastic products with design

features

4

2.3 Mould tool design sketches which incorporate undercuts are developed in consultation with relevant people

2.2

3.1 Applications and methods for incorporating standard mould components and inserts into mould tool design are researched and delineated

compared and analysed for their different applications

Range of methods for parts removal of products with undercuts are

- 3.2 Sources for, and availability of, standard mould components and inserts are researched and finding documented
- 3.3 Mould tool design sketches that incorporate standard mould components and inserts are developed in consultation with relevant people
- 4.1 *Product design details* are determined and *tool design requirements* formulated
- 4.2 **Project management methodologies** and **communication strategies** are applied to implementation
- 4.3 Mould tool design concepts and sketches are developed and *critically evaluated* to achieve specified product outcomes
- 4.4 Project is reviewed against specified outcomes and findings used to inform improved processes, procedures and planning in consultation with relevant people

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REQUIRED SKILLS AND KNOWLEDGE

This describes the essential skills and knowledge and their level, required for this unit.

Required Skills

- interpersonal skills to work with clients, colleagues, management and stakeholders either under direction, independently, or within a team
- leadership and interpersonal skills to communicate design concepts, implications, requirements and parameters to stakeholders
- leadership and organisational skills to manage implementation and evaluation of design project
- research and strategic thinking skills to evaluate design methodologies for application to specific project outcomes
- manual and computer-aided design and drafting skills to develop, test and simulate designs
- calculation skills to determine tool design requirements
- problem-solving skills to identify potential barriers to projected outcomes, analyse risks and establish prevention strategies
- analytical and evaluation skills to assess tool design for plastics project and use results to inform future practice

Required Knowledge

- principles and processes of plastics product and tool design
- principles and processes of plastics injection moulding tool design
- design features and functions of plastics injection moulding machine operating systems
- principles and processes for incorporating screw threads, undercuts, standard components and inserts into mould tool design
- behaviour and applications of polymer materials
- operating principles of plastics processing methods
- implications of product design for tool design
- factors that affect decisions in the design process
- project management tools and methodologies
- risk management strategies
- quality procedures
- criteria for critically evaluating mould tool design solutions
- relevant Federal, State or Territory legislation and local government legislation, regulations and standards
- sustainability implications for tool design for plastics
- safe work practices



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 in the Performance Criteria is detailed below. Add any 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.

Applications and methods for incorporating screw threads may include:

- production of threaded caps:
- o internal
- o external
- rotational and reciprocating methods of unscrewing
- position of threaded cavity in die design
- gating considerations
- methods of rotating threaded core or cavity:
 - o rack design

electric motor

o sun, wheel and planet design

Gating and actuating

methods may include:

Relevant people may

include:

- air
- hydraulic
- rack and pinion
- advantages and disadvantages of various mechanisms
- hot runner
- management
- colleagues
- clients
- customers
- suppliers
- stakeholders
- technical experts
- industry professionals
- planners
- advisors
- consultants
- regulators

• advantages and disadvantages of undercuts in products

- internal and external undercuts
- safety requirements associated with undercut design

Applications and methods for incorporating undercuts may include:



methods for parts removal	•	use	of:
may include:		0	sliders
		0	Splits
		0	jump ups

- loose inserts
- collapsible cores
- angle pins
- hydraulic cylinders
- springs
- use of:
 - riser plates
 - backing plates
 - cavity plates
 - ejector pins
 - ejector sleeves
 - ejector plates
 - ejector springs
 - o guide plates
 - guide bushes
 - sprue bushes
- different applications, such as:
 - innovations
 - o different actuators that control part ejection
- advantages and disadvantages of using standard components and inserts

Product design details may

Applications and methods for incorporating standard

mould components and

inserts may include:

- refer to:
- --
- split cavities, side cavities and cores
- . ..
- projections,
- internal or external
- undercuts,
- internal or external screw threads.

SPLIT CAVITIES:

- guiding and retention
- actuation, such as:
 - finger cams
 - dog-leg cams
 - side cams
 - spring
 - o hydraulic
- locking, such as:
 - o open channel chase bolster
 - enclosed chase bolster
- safety in operation, such as:
 - spring detent

0

spring loading



- stripper plate design
- angle lift splits

SIDE CAVITIES AND CORES:

- activation
- locking
- safety in operation
- curved side cores

PROJECTIONS:

- external and internal bosses
- staking
- threads
- embossed details
- texture

INTERNAL OR EXTERNAL UNDERCUTS:

- form pin
 - straight action
 - angled action
- split cores
 - o straight action
 - o angled action
 - stripping internal undercuts

INTERNAL OR EXTERNAL SCREW THREADS:

- fixed core
- stripping internal and external threads
- interchange cores
- unscrewing moulds
 - rotating cores
 - o rotating cavities
 - power systems

Tool design requirements may include:

- suitable runner, vent and ejection systems
- preliminary mould designs optimised by using melt flow and cooling analysis techniques
- detailed drawings of tool assembly
- necessary dimensions and labels
- necessary component drawings
- necessary calculations
- tool specifications to achieve the product requirements, such as:





- material 0 0
 - equipment
- finish 0
- construction 0
- details, such as: \cap
 - undercuts _
 - projections _
 - threads _
- description of tool operation
- mould quotation form and design process cost estimate
- finishing for application
- shrinkage
- stakeholder requirements
- sustainability issues
- risk management, including:
 - limitations of raw materials 0
 - Failure Mode and Effects Analysis (FMEA) 0
- project timeline
- completed mould design checklist
- description / definition / rationale
- outcomes and goal setting .
- strategic planning •
- resource requirements and allocation
- budget
- targets and milestones
- completion phases and timelines
- quality management policies and procedures
- personnel
- responsibilities
- accountabilities
- agreed reporting procedures
- communication strategies
- stakeholder engagement strategies, including critical consultation points
- monitoring and evaluation .

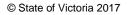
Communication strategies

Project management

methodologies may refer to:

may refer to:

- team leadership ٠
- consultative management •
- participative management •
- project evaluation
- stakeholders engagement
- critical consultation points, such as:





- feedback to client on initial design brief as early as possible
- consultation with all stakeholders to verify design 0
- consultation with all stakeholders when establishing project 0 timeline
- consultation with client to confirm decisions regarding: 0
 - _ design

0

- materials _
- process _
- _ equipment
- briefing of all stakeholders of necessary changes to design in 0 time to minimise cost and loss of time
- functionality and fitness for end-use •
- manufacturability •
- cost of production, including environmental costs .
- minimising mould design complexity ٠
- utilisation of strategies to eliminate or minimise faults



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Critically evaluated may

include consideration of:

EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment Guidelines for this Training Package.

Critical aspects for assessment and evidence required to demonstrate competency in this unit

A person who demonstrates competency in this unit must provide evidence of:

- implementing injection moulding tool design project that addresses plastics product requirements across a range of particular design details including: undercuts, projections and threads
- evaluating project outcomes to inform future practice
- knowledge of principles and processes of injection moulding tool design that meet plastics product design requirements
- Assessment must ensure:
- activities are related to a tool design for plastics context
- Resources implications for assessment include:
- access to suitable simulated or real workplace opportunities
- access to a range of plastics products/parts and associated injection moulding tooling
- access to material specification charts/data sheets
- access to Computer Aided Design and Tooling Design software

A range of assessment methods should be used to assess practical skills and knowledge. The following assessment methods are appropriate for this unit:

- evaluation of project in applying principles for addressing projections and incorporating screw threads, undercuts, and standard mould components and inserts into mould tool design
- evaluation of calculations made in meeting tool design requirements
- evaluation of research project into current principles and processes of injection moulding tool for plastic product with specific design details
- review of presentation of design project outcomes
- practical exercises
- observation
- direct questioning
- presentations
- third party reports

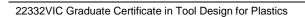


Context of and specific resources for assessment

Method of assessment

Guidance information for assessment	Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. Suggested units may include but are not limited to:
	o VU21974: Implement plastics injection moulding tool design
	 VU21975: Manage plastics injection moulding tool design application

• VU21977: Implement plastics injection moulding temperature control





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VU21977 Implement plastics injection moulding temperature control

	• •	-	
Uni	t Descriptor	and co	unit describes the skills and knowledge required to determine the heating ooling requirements of plastics injection moulding tools, including the nd application of hot runners.
			No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.
Emj	ployability Skills	This ι	unit contains Employability Skills.
		facets qualif	equired outcomes described in this unit of competency contain applicable of Employability Skills. The Employability Skills Summary of the fication in which this unit is included will assist in identifying byability skill requirements.
Арг	blication of the Unit	person design indust strate	unit supports the work of designers, managers, leaders and project nnel who are responsible for development of injection moulding tool n across a broad range of product design applications within the plastics try. Practitioners are typically engaged in implementing tool design gies that are responsive to: product intent; stakeholder-specified; atory, and sustainability requirements.
ELI	EMENT	PER	FORMANCE CRITERIA
out	ments describe the essential comes of a unit of npetency.	achi deta	formance criteria describe the required performance needed to demonstrate evement of the element. Where bold italicised text is used, further information is iled in the required skills and knowledge and/or the range statement. Assessment erformance is to be consistent with the evidence guide.
1	Determine heating and cooling requirements for a plastics injection mould tool design	1.1	<i>Principles for achieving temperature control</i> during moulding operations are researched and delineated
		1.2	Different applications and requirements for a range of <i>mechanisms for heating and cooling mould tools</i> are researched and clarified
		1.3	<i>Dimensions of heating and cooling circuits</i> to achieve specified heat loss requirements for given mould designs are calculated
		1.4	Designs for heating and cooling circuits that achieve temperature control requirements for mould designs are developed in consultation with relevant people
2	Apply the principles of melt flow and mould cooling analysis to tool design practice	2.1	<i>Techniques to optimise flow and cooling behaviour of polymer materials</i> during processing are researched and delineated
		2.2	Applications of melt flow and mould cooling analysis in injection mould tool design are evaluated

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- 2.3
- 3 Implement and evaluate temperature control system design project for injection moulding tool/s
- and used to improve mould tool design and optimise tool performance
- 3.1 Project brief is reviewed for *production requirements*
- 3.2 Project brief is reviewed for hot runner or insulated hot runner system requirements

Melt flow and mould cooling analysis is conducted, results documented

- 3.3 *Project management methodologies* and *communication strategies* are applied to implementation
- 3.4 Designs for meeting *tool design requirements* for hot runner and insulated hot runner injection moulding tools are developed and *critically evaluated*
- 3.5 Project is reviewed against specified outcomes and findings used to inform improved processes, procedures and planning in consultation with relevant people

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REQUIRED SKILLS AND KNOWLEDGE

This describes the essential skills and knowledge and their level, required for this unit.

Required Skills

- interpersonal skills to work with clients, colleagues, management and stakeholders either under direction, independently, or within a team
- leadership and interpersonal skills to communicate design concepts, implications, requirements and parameters to stakeholders
- leadership and organisational skills to manage implementation and evaluation of design project
- research and strategic thinking skills to evaluate design methodologies for application to specific project outcomes
- manual and computer- aided design and drafting skills to develop, test and simulate designs
- calculation skills to determine tool design requirements
- problem-solving skills to identify potential barriers to projected outcomes, analyse risks and establish prevention strategies
- analytical and evaluation skills to assess tool design for plastics project and use results to inform future practice

Required Knowledge

- principles and processes of plastics product and tool design principles and processes of plastics injection moulding tool design
- design features and functions of plastics injection moulding machine operating systems
- mechanisms for heating and cooling mould tools
- methods for calculating dimensions of heating and cooling circuits to achieve specified heat loss requirements in given mould designs
- criteria to determine the need for hot runners
- techniques used to optimise the flow and cooling behaviour of polymer materials during processing
- methods for interpreting and applying melt flow and mould cooling analysis in injection mould tool design
- behaviour and applications of polymer materials
- operating principles of plastics processing methods
- implications of product design for tool design
- factors that affect decisions in the design process
- project management tools and methodologies
- risk management strategies
- quality procedures
- relevant Federal, State or Territory legislation and local government legislation, regulations and standards
- sustainability implications for tool design for plastics
- safe work practices

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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 in the Performance Criteria is detailed below. Add any 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.

Principles for achieving

temperature control may include:

Mechanisms for heating

and cooling mould tools

Dimensions of heating and

cooling circuits may

Techniques to optimise

of polymer materials may

flow and cooling behaviour

include:

include:

may include:

hot runners and insulated hot runners

- cooling the melt, such as:
 - o conduction in the mould wall
 - convection cooling in water lines
 - heat expansion on nozzles and manifolds
- heating mechanisms, such as:
 - electric and oil heating systems, including advantages and disadvantages of each
 - o heater bands
 - heated manifolds
 - o nozzle heaters
 - sheathed resistance wire heaters
 - o function and placement of thermocouples
 - o insulation materials and their position in mould design
 - cooling mechanisms, such as:
 - o operations and application of water tower
 - refrigerated and hot water applications
 - open and closed systems of temperature control
 - types of water channels and circuits, their location and position in mould design
 - flow rate / heat transfer
 - effect of cooling on cycle time
 - effect of location of hot runners
 - modelling of finite element analysis (FEA)
 - melt flow analysis, such as:
 - o techniques, including computerised flow analysis
 - applications to:
 - product design
 - mould design
 - fill pattern
 - gate locations and numbers



- runner system design
- o flow and heat transfer equations
- CAD applications to melt flow analysis, such as:
 - position and dimensions of part walls, weld lines and runner systems
 - runner balancing in multi-cavity moulds
 - flow control to position weld lines
 - analysis of multi gated cavities
 - two dimensional hot sprue modelling
- mould cooling, such as:
 - CAD applications to analyse the cooling requirements of injection mould tooling, such as:
 - mould cooling optimisation
 - heat transfer in moulds
 - design objectives
 - physical dimensions and cooling line layout
 - estimation of heat loads
 - cooling parameters, boundaries
 - meshing of cooling lines
 - analysis of cooling circuits
 - two dimensional modelling of cooling lines
 - cross sectional analysis
 - warpage prediction
- design modelling and analysis techniques using:
 - part creation
 - mass property analysis
 - o component parts and sub assembly groups to form assemblies
 - creating cross CAD/CAM system files using 2D and 3D image output files, such as:
 - wire frame construction
 - surface modelling
 - solids modelling
 - math model applications



Applications of melt flow and mould cooling analysis may include:

<i>Production requirements</i> may include:	 end-use that requires control over temperature tolerance, such as: food contact pharmaceuticals optical optimised material selection minimisation of waste and scrap number of cavities technician ability quality assurance optimised cycle times total tool cost
	budget constraints
	production capacity
Project management methodologies may refer to:	 description / definition / rationale outcomes and goal setting strategic planning resource requirements and allocation budget targets and milestones completion phases and timelines
	quality management policies and procedures
	• personnel
	responsibilities
	accountabilities
	agreed reporting procedures
	communication strategies
	 stakeholder engagement strategies, including critical consultation points
	• monitoring and evaluation
<i>Communication strategies</i> may refer to:	 team leadership consultative management participative management project evaluation stakeholders engagement critical consultation points, such as:
	× ·

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- feedback to client on initial design brief as early as possible
- consultation with all stakeholders to verify design
- consultation with all stakeholders when establishing project timeline
- consultation with client to confirm decisions regarding:
 - design
 - materials
 - process
 - equipment
- briefing of all stakeholders of necessary changes to design in time to minimise cost and loss of time
- end-use requirements of the product
- design fault finding and rectification
- preliminary mould designs optimised using melt flow and cooling analysis techniques
- material selection
- machine selection
- runner, vent and ejection systems
- detailed drawings of tool assembly
- necessary dimensions and labels
- necessary component drawings
- necessary calculations
- tool specifications to achieve the product requirements, such as:
 - o material
 - o equipment
 - \circ finish
 - construction
 - product design details
- mould quotation form and design process cost estimate
- project timeline
- description of tool operation
- completed mould design checklist
- customer requirements
- environmental costs
- risk management, including:
 - o limitations of raw materials
 - Failure Mode and Effects Analysis (FMEA)



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Tool design requirements may include:

Critically evaluated may	• functionality and fitness for end-use
include consideration of:	• manufacturability
	cost of production, including environmental costs

.

- minimising mould design complexity
- utilisation of strategies to eliminate or minimise faults •



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EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment Guidelines for this Training Package.

Critical aspects for assessment and evidence required to demonstrate competency in this unit

A person who demonstrates competency in this unit must provide evidence of:

- implementing injection moulding temperature control system design project across a range of contexts
- evaluating project outcomes to inform future practice
- knowledge of principles and processes of injection moulding tool design for heating and cooling that meet plastics product design requirements

Context of and specific resources for assessment

Assessment must ensure:

• activities are related to a tool for plastics design context

Resources implications for assessment include:

- access to suitable simulated or real workplace opportunities
- access to a range of plastics products/parts and associated injection moulding tooling
- access to material specification charts/data sheets
- access to Computer Aided Design and Tooling Design software

A range of assessment methods should be used to assess practical skills and knowledge. The following assessment methods are appropriate for this unit:

- evaluation of project in the heating and cooling requirements for a tool design; principles of melt flow and mould cooling analysis in tool design; need for a hot runner, or insulated hot runner, injection moulding tool
- evaluation of research project into principles and processes of temperature control
- practical exercises
- observation
- direct questioning
- presentations
- third party reports

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Method of assessment

Guidance information for assessment (Optional)	Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. Suggested units may include but are not limited to:		
	o VU21974: Implement plastics injection moulding tool design		
	• VU21975: Manage plastics injection moulding tool design		

- application
- VU21976: Implement injection moulding tool for plastics product details





VU21978 Implement plastics blow moulding tool design

Uni	it Descriptor	deci	s unit describes the skills and knowledge required to make optimal isions regarding the tool design requirements for a plastics blow alding tool.
			No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.
Em	ployability Skills	This	s unit contains Employability Skills.
		app Sun	required outcomes described in this unit of competency contain licable facets of Employability Skills. The Employability Skills mary of the qualification in which this unit is included will assist in htifying employability skill requirements.
Арј	plication of the Unit	pers desi indu strat	s unit supports the work of designers, managers, leaders and project sonnel who are responsible for development of blow moulding tool gn across a broad range of product design applications within the plastics ustry. Practitioners are typically engaged in implementing tool design tegies that are responsive to: product intent; stakeholder-specified; ilatory, and sustainability requirements.
EL	EMENT	PER	FORMANCE CRITERIA
out	ements describe the essential comes of a unit of mpetency.	achi deta	Formance criteria describe the required performance needed to demonstrate evement of the element. Where bold italicised text is used, further information is iled in the required skills and knowledge and/or the range statement. Assessment erformance is to be consistent with the evidence guide.
1	Determine principles and procedures for plastics product design project	1.1	Principles of operation of a range of blow moulding tools are researched and delineated
		1.2	Different applications and requirements of a range of blow moulding tool components and sub systems are researched and clarified
2	Analyse the interrelationship between blow moulding machine operating systems and tool design	2.1	<i>Design features and functions</i> of various types of <i>blow moulding machines</i> are analysed for effect on tool design
		2.2	<i>Main features of the blow moulding process</i> are analysed for effect on tool design
		2.3	Importance of <i>matching mould design and attachment features to machine operating systems</i> is researched and evaluated

2.4 **Calculation of design requirements** of a blow moulding tool is conducted



3

Select materials and tool construction methods to achieve production requirements and processing specifications	3.1	Effect of mould design and production requirements is appraised in determining selection of the <i>metal materials</i> and <i>finishing treatments</i> , according to their particular <i>properties</i> , used in mould construction
	3.2	Effect of mould design and production requirements is appraised in determining selection of <i>mould component construction methods</i>
	3.3	Effect of mould design, production requirements and <i>environmental costs</i> is appraised in determining selection of raw materials
Analyse and evaluate product design to determine tool design requirements	4.1	<i>Product design specifications</i> are evaluated to determine <i>blow</i> <i>moulding tool design requirements</i> and to select raw materials
	4.2	Optimal materials for mould construction to meet design and <i>production requirements</i> are selected
	4.3	Tool design concept proposals are developed and <i>critically evaluated</i> to achieve specified product outcomes
Implement and evaluate blow moulding tool design project	5.1	<i>Project management methodologies</i> and <i>communication</i> <i>strategies</i> are applied to implementation

- Tool design faults and their causes are analysed and prevention 5.2 strategies established and implemented
- Project is reviewed against specified outcomes and findings used to 5.3 inform improved processes, procedures and planning in consultation with *relevant people*



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5

REQUIRED SKILLS AND KNOWLEDGE

This describes the essential skills and knowledge and their level, required for this unit

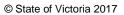
Required Skills

- interpersonal skills to work with clients, colleagues, management and stakeholders either under direction, independently, or within a team
- leadership and interpersonal skills to communicate design concepts, implications, requirements and parameters to stakeholders
- leadership and organisational skills to manage implementation and evaluation of design project
- research and strategic thinking skills to evaluate design methodologies for application to specific project outcomes
- manual and computer- aided design and drafting skills to develop, test and simulate designs
- calculation skills to determine tool design requirements
- problem-solving skills to identify potential barriers to projected outcomes, analyse risks and establish prevention strategies
- analytical and evaluation skills to assess product and tool design for plastics project and use results to inform future practice

Required Knowledge

- principles and processes of plastics product and tool design
- principles and processes of plastics blow moulding tool design
- design features and functions of plastics blow moulding machine operating systems
- blow moulding construction methods and finishing treatments
- behaviour and applications of polymer materials
- operating principles of plastics processing methods
- implications of product design for tool design
- factors that affect decisions in the design process
- causes and elimination strategies of common product faults
- project management tools and methodologies
- risk management strategies
- quality procedures
- relevant Federal, State or Territory legislation and local government legislation, regulations and standards
- sustainability implications for tool design for plastics
- safe work practices

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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 in the Performance Criteria is detailed below. Add any 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.

Blow moulding tools may include:

Mould tool components

and sub systems may

include:

- two-plate mould tools
- Dome Systems
- multiple heads
- solid neck and flexible neck
- handle wear
- uni neck parison
- moving cores
- co-extruded dies
- three dimensional blow moulding
- new technologies
- cavity design
 - neck ring
- flash pocket
- part removal system
- temperature control system
- standard part components
- actuating mechanism
- inserts and cores
- pinch off sections
- clamping systems
- in-mould functions
- mandrel and die bushing, such as:
 - o mandrel
 - o choke
 - o parison control
 - o accumulator
 - spider support arms
 - land length and angle
 - pressure ring
 - hydraulic ram



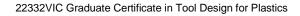
Design features and	• machine components and construction features, such as:
functions may include:	• multiple heads
	• trimming
	 parison programming
	• in-mould labelling
	• rotary moulds
	• shuttle moulds
	 parison cutting
	• tie bars
	• machine control systems, such as:
	• open loop system
	 closed loop system
	• shot size and correction capacity
	• extrusion speed
	• screw position
	• blow pressure
	• clamp pressure
	• blow time, exhaust time, cycle time, pre-blow time
	• screw speed
	 screw back pressure
	• screw back time
	 annular gap
	• temperatures
	 parison programming
	• chokes
Blow moulding machines	continuous blow moulding machine
may include:	• intermittent blow moulding machine
	reciprocal blow moulding machine
	• injection stretch blow moulding machine
	injection blow moulding machine
Main features of blow	• extrusion:
<i>moulding process</i> and	 importance of time, pressure and temperature on melt flow
their effect on tool design may include:	 screw/barrel designs
may mondae.	 tool design features, such as:
	 mandrel and die bushing profiles
	manufer and the busining promotion

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- die bushing ovalisation
- die shaping
- land length
- pressure drop
- the relationship between annular gap and part weight
- blow mould die, such as:
 - venting
 - o fixture to platens
- chilling and tool temperature, such as:
 - o effect on moulded product
 - o effect on machine cycle time
 - o methods adopted
- part removal, such as:
 - o robots
 - take out units
 - post moulding shrinkage (annealing)
- types and role of platens, such as:
 - o stationary
 - o moveable
- methods of fixing moulds to platens, such as:
 - o bolting
 - o clamps
 - \circ slides
 - o dogs
- purpose and operation of features, such as:
 - \circ single station
 - o shuttle
 - o rotary systems
- hydraulic pressure features
- use of single and multi-head systems
- clamp force calculations, such as:
 - o attachment to platens
 - o clamp tonnage in relation to mould size for safe machine operation
 - o requirements for mould closure during blow
 - o air pressure requirements





Matching mould design and attachment features to machine operating systems may include

<i>Calculation of design</i> <i>requirements</i> may include:	 die swell parison control accumulator control mould deformation under pressure and safe work limits capacity air pressure pinch-off compression strength thermal conductivity (mould cooling) requirements wall thickness / part weight
<i>Metal materials</i> may include:	 mandrel / die bushing low carbon steel tool steel surface hardened steel stainless steel aluminium steel kirksite copper brass beryllium copper
Finishing treatments may include:	 polishing texturing heat treatment processes, such as: normalising annealing quench hardening carburising nitriding tempering stress relieving plating and coating techniques etching
Properties may include:	 graining tensile strength thermal conductivity cost hardness surface finish

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 (\Box)

Mould component	• Numerical Control (NC) machining
construction methods may include:	Computer Numerical Control (CNC) machining
may include.	• Electronic Discharge Machining (EDM) – commonly called spark erosion
	masking tools
	• jigs and fixtures
	• wire cutting
	• zinc alloy casting (kirksite)
	• tool hardening / heat treatment
Environmental costs may	• recyclability
include:	• waste minimisation
	• waste disposal
	energy consumption used in processing
	carbon abatement
Product design	• samples
specifications may include:	drawings
	specifications
	customer requirements
	 moulding shop specifications
	 environmental issues
Blow moulding tool design requirements may	• die swell
include:	• parison control
	capacity air pressure
	radii / chamfer determination
	pinch off compression strength
	• shrinkage
	mould cooling
	• wall thickness / part weight
	mould to machine compatibility
	finishing for application
	• shrinkage
	stakeholder requirements
	sustainability issues
	 raw materials and their possible limitations

- raw materials and their possible limitations
- Failure Mode and Effects Analysis (FMEA)



Production requirements may refer to:	• production capacity
	production run specifications
	production method
	• end-use applications
Critically evaluated may	• functionality and fitness for end-use
refer to considerations of:	• manufacturability
	cost of production
	environmental costs and impact of production
	minimising product design complexity
	• utilisation of strategies to eliminate or minimise faults
Project management	description / definition / rationale
<i>methodologies</i> may refer to:	outcomes and goal setting
	strategic planning
	resource requirements and allocation
	• budget
	• targets and milestones
	completion phases and timelines
	quality management policies and procedures
	• personnel
	• responsibilities
	• accountabilities
	agreed reporting procedures
	communication strategies
	• stakeholder engagement strategies, including critical consultation points
	monitoring and evaluation
Communication strategies	• team leadership
may refer to:	consultative management
	participative management
	• project evaluation
	stakeholders engagement
	critical consultation points, such as:
	• feedback to client on initial design brief as early as possible
	 consultation with all stakeholders to verify design
	• consultation with all stakeholders when establishing project

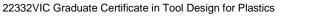
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timeline

- o consultation with client to confirm decisions regarding:
 - design
 - materials
 - process
 - equipment
- briefing of all stakeholders of necessary changes to design in time to minimise cost and loss of time

Tool design faults may include:

- poor tool design
- selection of inappropriate materials
- technical faults within production and processes, such as:
 - mandrel and die bushing:
 - tail length
 - die lines
 - stagnation points
 - part weight
 - curtaining
 - melt fracture
 - diameter swell
 - parison swinging
 - neck section
 - wall thickness
 - sticking parison
 - parison cooling
 - curtaining / webbing
 - mould cooling
 - tooling ovalisation
 - melt fracture
 - \circ mould:
 - weld strength
 - part position on opening
 - venting
 - radius/radii/chamfer
 - pinch off
 - thin sections in wall
 - trimming
 - parts sticking
 - mould misalignment
 - neck damage
 - weak corners
 - shear rates





(Fault) <i>Prevention</i> <i>strategies</i> may include:	•	careful initial evaluation of product requirements / specifications thorough analysis of the design constraints of different processes, materials and tools
	•	thorough and ongoing consultation with client / suppliers / other team members and stakeholders
	•	effective project management
	•	quality assurance procedures, including:
		• design checklist
		 production checklist
		• failure minimisation
		 zero defects methodology
		• process control
<i>Relevant people</i> may include:	•	management
	•	colleagues
	•	clients
	•	customers
	•	suppliers
	•	stakeholders
	•	technical experts
	•	industry professionals

- planners
- advisors
- consultants
- regulators



EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment Guidelines for this Training Package.

Critical aspects for assessment and evidence required to demonstrate competency in this unit

A person who demonstrates competency in this unit must provide evidence of:

- implementing blow moulding tool design project for a plastics product design concept
- determining prevention strategies for tool design faults
- evaluating project outcomes to inform future practice
- knowledge of principles and processes of blow moulding tool design including: capabilities of blow moulding machine operating systems and requisite materials and tool construction methods

Assessment must ensure:

• activities are related to a tool design for plastics context

Resources implications for assessment include:

- access to suitable simulated or real workplace opportunities
- access to a range of plastics products/parts and associated blow moulding tooling
- access to material specification charts/data sheets
- access to Computer Aided Design and Tooling Design software

A range of assessment methods should be used to assess practical skills and knowledge. The following assessment methods are appropriate for this unit:

- evaluation of project in blow moulding tool design that meets specified outcomes of a product design concept
- evaluation of research project into fundamentals of blow moulding tool design across a range of contexts
- practical exercises
- observation
- direct questioning
- presentations
- third party reports



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Context of and specific resources for assessment

Method of assessment

Guidance information for	Holistic assessment with other units relevant to the industry sector,
assessment	workplace and job role is recommended. Suggested units may
(Optional)	include but are not limited to:
	 VU21979: Manage plastics blow mould tool design application

- VU21980: Implement blow moulding tool design for plastics products design details
- VU21981: Implement advanced blow moulding tool design





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VU21979 Manage plastics blow moulding tool design application

	21575 Manage plastics i	w moulding tool design application	
Uni	t Descriptor	This unit describes the skills and knowledge required to develop and mplement mandrel and die bushing tool designs to achieve plastics produce pecifications across a range of contexts.	ct
		<i>No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.</i>	
Em	ployability Skills	This unit contains Employability Skills.	
		The required outcomes described in this unit of competency contain applicable facets of Employability Skills. The Employability Skills Summ of the qualification in which this unit is included will assist in identifying employability skill requirements.	nary
Арр	Dication of the Unit	This unit supports the work of designers, managers, leaders and project bersonnel who are responsible for development of blow moulding tool design across a broad range of product design applications within the plastics ndustry. Practitioners are typically engaged in implementing tool design strategies that are responsive to: product intent; stakeholder-specified; egulatory, and sustainability requirements.	sign
EL	EMENT	PERFORMANCE CRITERIA	
Ele out	EMENT ments describe the essential comes of a unit of npetency.	PERFORMANCE CRITERIA Performance criteria describe the required performance needed to demonstrate achievement of the element. Where bold italicised text is used, further information detailed in the required skills and knowledge and/or the range statement. Assess of performance is to be consistent with the evidence guide.	on is
Ele out	ments describe the essential comes of a unit of	Performance criteria describe the required performance needed to demonstrate achievement of the element. Where bold italicised text is used, further information detailed in the required skills and knowledge and/or the range statement. Assess	on is sment
Ele out cor	ments describe the essential comes of a unit of npetency. Apply the principles of die bushing and mandrel design to blow moulding	Performance criteria describe the required performance needed to demonstrate achievement of the element. Where bold italicised text is used, further information detailed in the required skills and knowledge and/or the range statement. Assess of performance is to be consistent with the evidence guide.	on is sment
Ele out cor	ments describe the essential comes of a unit of npetency. Apply the principles of die bushing and mandrel design to blow moulding	 Performance criteria describe the required performance needed to demonstrate achievement of the element. Where bold italicised text is used, further information detailed in the required skills and knowledge and/or the range statement. Assess of performance is to be consistent with the evidence guide. .1 Methods of translating product dimensions and specifications die bushing and mandrel designs are researched and delineated .2 Principles of mandrel and die bushing tool design are analysed 	on is sment
Ele out cor	ments describe the essential comes of a unit of npetency. Apply the principles of die bushing and mandrel design to blow moulding	 Performance criteria describe the required performance needed to demonstrate achievement of the element. Where bold italicised text is used, further information detailed in the required skills and knowledge and/or the range statement. Assess of performance is to be consistent with the evidence guide. .1 Methods of translating product dimensions and specifications die bushing and mandrel designs are researched and delineated .2 Principles of mandrel and die bushing tool design are analysed their different applications. 	on is sment Finto I for n

2.3 **Range of data** required to accurately design a mandrel and die bushing tool is calculated and documented



- 3 Determine requirements for die bushing and mandrel blow
 3.1 Product end-use requirements are analysed and appropriate material and machine process determined
 3.2 Methods to best meet *production and design requirements* are canvassed and selected
 3.3 Product specifications are analysed for possible *faults*, their causes analysed and *prevention strategies* established
 - 3.4 *Project management methodologies* and *communication strategies* are determined
 - 3.5 Die bushing and mandrel *tool design* to extrude a uniform parison is developed and *critically evaluated* against *tool design requirements*
- 4 Evaluate design project
- 4.1 Project is implemented and reviewed against specified outcomes
 - 4.2 Findings are used to inform improved processes, procedures and planning in consultation with *relevant people*

REQUIRED SKILLS AND KNOWLEDGE

This describes the essential skills and knowledge and their level, required for this unit .

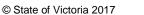
Required Skills

- interpersonal skills to work with clients, colleagues, management and stakeholders either under direction, independently, or within a team
- leadership and interpersonal skills to communicate design concepts, implications, requirements and parameters to stakeholders
- leadership and organisational skills to manage implementation and evaluation of design project
- research and strategic thinking skills to evaluate design methodologies for application to specific project outcomes
- manual and computer-aided design and drafting skills to develop, test and simulate designs
- calculation skills to determine tool design requirements
- problem-solving skills to identify potential barriers to projected outcomes, analyse risks and establish prevention strategies
- analytical and evaluation skills to assess tool design for plastics project and use results to inform future practice

Required Knowledge

- principles and processes of plastics product and tool design
- principles and processes of plastics blow moulding tool design
- design features and functions of plastics blow moulding machine operating systems
- principles of mandrel and die bushing design
- methods for translating product dimensions and specifications into die bushing and mandrel designs
- various die bushing and mandrel design types and their differing requirements in relation to polymer materials
- principles and practice of design for die bushing and mandrel tool design
- behaviour and applications of polymer materials
- operating principles of plastics processing methods
- implications of product design for tool design
- factors that affect decisions in the design process
- project management tools and methodologies
- risk management strategies
- quality procedures
- relevant Federal, State or Territory legislation and local government legislation, regulations and standards
- sustainability implications for tool design for plastics
- safe work practices

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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 in the Performance Criteria is detailed below. Add any 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.

Methods of translating product dimensions and

specifications, may include:

- product drawings
- product material and machine specifications
- product models for which drawings can be produced
- product models for which drawings are too difficult to produce, such as:
 - \circ carving
 - Sculpture
- CAD data
- CAD model
- prototype with some working measurements

Principles of mandrel and die bushing design may include

Simulation software may

Die bushing and mandrel

design types may include:

Principles and practice of

good design may include:

include:

- thin wall sections
- radii / chamfers
- no stagnation points in flow channels
- progressive increase in velocity along the flow channel
- simple approach angles
- multi-layer
- thickness swell ratio
- blow up ratio
- parison thickness determination
- final wall thickness determination
- Computational Fluid Dynamics (CFD) system
- CFD Flow Software
- Discrete element modelling (DEM)
- convergent / divergent systems
- tooling ovalisation
- angles to flow path
- use of generous internal / external radii on all corners
- maintenance of uniform wall thickness
- internal walls thinner than external walls for cooling wherever possible
- die swell considerations
- parison length / parison sag



- parison uniformity • flow characteristics • back pressure • blow ratio thickness swell consideration Range of data may refer to: polymer flow in the die, such as: • polymer viscoelastic behaviour of the polymer melt 0 shear thinning 0 steady state, isothermic flow 0 viscoelastic properties 0 shear rate 0 flow in the annulus 0 Newtonian and non-Newtonian (power law) fluids 0 use of representative data 0 viscosity and temperature distribution in extrusion dies, such as: continuity equation 0 flow channels with variable heights 0 pressure drop 0 large volume moulding Production and design • requirements problems mechanical and thermal properties of the material . may refer to: part to production requirements machine types production capacity Faults may refer to: 0 stagnation points restricted and uneven flow paths 0 damaged surfaces 0 weld lines associated with split flow paths 0 performance or physical properties of product 0 surface quality and treatment 0
 - thermal control and monitoring



(Fault) Prevention strategies may include:	• careful initial evaluation of product requirements / specifications
Strategies may include.	 thorough analysis of the design constraints of different processes, materials and tools
	• thorough and ongoing consultation with client / suppliers / other team members and stakeholders
	effective project management
	• quality assurance procedures, including:
	• design checklist
	 production checklist
	• failure minimisation
	 zero defects methodology
	• process control
Project management	description / definition / rationale
<i>methodologies</i> may refer to:	outcomes and goal setting
	strategic planning
	resource requirements and allocation
	• budget
	• targets and milestones
	completion phases and timelines
	quality management policies and procedures
	• personnel
	• responsibilities
	accountabilities
	agreed reporting procedures
	communication strategies
	• stakeholder engagement strategies, including critical consultation points
	monitoring and evaluation
Communication strategies	• team leadership
may refer to:	consultative management

- participative management
- project evaluation
- stakeholders engagement
- critical consultation points, such as:
 - feedback to client on initial design brief as early as possible
 - o consultation with all stakeholders to verify design
 - consultation with all stakeholders when establishing project timeline



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- consultation with client to confirm decisions regarding:
 - design
 - materials
 - process
 - equipment
- briefing of all stakeholders of necessary changes to design in time to minimise cost and loss of time
- circular parison
- incorporation of handles
- continuous or intermittent extrusion
- litre capacity
- weight
- targeted cycle time
- functionality and fitness for end-use
- manufacturability
- cost of production
- environmental costs and impact of production
- minimising product design complexity
- utilisation of strategies to eliminate or minimise faults
- detailed drawings of tool assembly
- necessary dimensions and labels
- necessary component drawings, such as:
 - o manual drafting techniques
 - Computer Aided Design (CAD)
- necessary calculations
- tool specifications to achieve the product requirements
 - o material
 - o equipment
 - o finish
 - construction
- tool quotation form and design process cost estimate
- project timeline
- description of operation
- analysis of material melt flow
- required parts list
- completed tool design check list
- customer requirements





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Tool design may address considerations such as:

Critically evaluated may

refer to considerations of:

Tool design requirements

may refer to:

- environmental costs
- raw materials and their possible limitations
- Failure Mode and Effects Analysis (FMEA)
- management
 - colleagues
 - clients
 - customers
 - suppliers
 - stakeholders
 - technical experts
 - industry professionals
 - planners
 - advisors
 - consultants
 - regulators

Relevant people may include:



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EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment Guidelines for this Training Package.

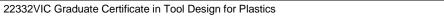
Critical aspects for assessment and evidence required to demonstrate competency in this unit	 A person who demonstrates competency in this unit must provide evidence of: managing blow moulding tool design project that addresses principles of die bushing and mandrel tooling determining prevention strategies for tool design faults evaluating project outcomes to inform future practice knowledge of principles and processes of blow moulding tool design to meets plastics product design requirements
Context of and specific resources for assessment	 Assessment must ensure: activities are related to a tool design for plastics context Resources implications for assessment include: access to suitable simulated or real workplace opportunities access to a range of plastics products/parts and associated blow moulding tooling access to material specification charts/data sheets access to Computer Aided Design and Tooling Design software
Method of assessment	 A range of assessment methods should be used to assess practical skills and knowledge. The following assessment methods are appropriate for this unit: evaluation of project in blow moulding tool design application that includes die bushing and mandrel principles evaluation of research project into what constitutes good tool design in blow moulding applications review of portfolio of research into principles and processes of blow moulding tool design practical exercises observation

- direct questioning
- presentations
- third party reports



Guidance information for	Holistic assessment with other units relevant to the industry sector,
assessment	workplace and job role is recommended. Suggested units may
(Optional)	include but are not limited to:
	• VU21978: Implement plastics blow moulding tool design

- VU21980: Implement blow moulding tool design for plastics products design details
- VU21981: Implement advanced blow moulding tool design





VU21980 Implement blow moulding tool design for plastics product design details

Uni	t Descriptor	imp pro	s unit describes the skills and knowledge required to develop and element blow moulding tools designs that address requirements of plastics duct design details, such as: thin wall sections; threaded sections, and dle ware. <i>No licensing, legislative, regulatory or certification requirements</i> <i>apply to this unit at the time of publication.</i>
Em	ployability Skills	app Sun	e required outcomes described in this unit of competency contain licable facets of Employability Skills. The Employability Skills nmary of the qualification in which this unit is included will assist in ntifying employability skill requirements.
Арр	plication of the Unit	pers des indu stra	s unit supports the work of designers, managers, leaders and project sonnel who are responsible for development of blow moulding tool ign across a broad range of product design applications within the plastics ustry. Practitioners are typically engaged in implementing tool design tegies that are responsive to: product intent; stakeholder-specified; ulatory, and sustainability requirements.
EL	EMENT	PER	FORMANCE CRITERIA
out	ments describe the essential comes of a unit of npetency.	ach deta	formance criteria describe the required performance needed to demonstrate ievement of the element. Where bold italicised text is used, further information is uiled in the required skills and knowledge and/or the range statement. essment of performance is to be consistent with the evidence guide.
1	Apply the principles for incorporating thin wall sections into blow moulding tool design	1.1	Applications and methods for incorporating thin wall sections into blow moulding tool design are researched and delineated
		1.2	<i>Range of data</i> required to meet given product specifications is calculated
		1.3	Blow moulding tool design sketches that incorporate thin wall sections are developed in consultation with <i>relevant people</i>
2	Apply the principles for incorporating threaded sections into blow moulding tool design	2.1	Applications and methods for incorporating threaded sections into moulding tool design are researched and delineated
		2.2	Range of data required to meet given product specifications is calculated

2.3 Blow moulding tool design sketches that incorporate thin wall sections are developed in consultation with relevant people



- **3** Apply the principles for 3.1 incorporating handle ware into blow moulding tool design.
 - 1 **Applications and methods for incorporating handle ware** into moulding tool design are researched and delineated
 - 3.2 Range of data required to meet given product specifications is calculated
 - 3.3 Blow moulding tool design sketches that incorporate thin wall sections are developed in consultation with relevant people
 - evaluate 4.1 *Tool design requirements* for blow moulding tools that meet product design details are determined and documented
 - 4.2 *Project management methodologies* and *communication strategies* are applied to implementation
 - 4.3 *Blow moulding tool design* concepts and sketches are developed and *critically evaluated* to achieve specified product outcomes

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Implement and evaluate blow moulding tool design project for plastic products with design details

REQUIRED SKILLS AND KNOWLEDGE

This describes the essential skills and knowledge and their level, required for this unit

Required Skills

- interpersonal skills to work with clients, colleagues, management and stakeholders either under direction, independently, or within a team
- leadership and interpersonal skills to communicate design concepts, implications, requirements and parameters to stakeholders
- leadership and organisational skills to manage implementation and evaluation of design project
- research and strategic thinking skills to evaluate design methodologies for application to specific project outcomes
- manual and computer-aided design and drafting skills to develop, test and simulate designs
- calculation skills to determine tool design requirements
- problem-solving skills to identify potential barriers to projected outcomes, analyse risks and establish prevention strategies
- analytical and evaluation skills to assess tool design for plastics project and use results to inform future practice

Required Knowledge

- principles and processes of plastics product and tool design
- principles and processes of plastics blow moulding tool design
- design features and functions of plastics blow moulding machine operating systems
- principles and processes for incorporating thin wall sections, threaded sections, and handle ware into blow mould tool design
- behaviour and applications of polymer materials
- operating principles of plastics processing methods
- implications of product design for tool design
- factors that affect decisions in the design process
- project management tools and methodologies
- risk management strategies
- quality procedures
- criteria for critically evaluating tool design solutions
- relevant Federal, State or Territory legislation and local government legislation, regulations and standards
- sustainability implications for tool design for plastics
- safe work practices



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 in the Performance Criteria is detailed below. Add any 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.

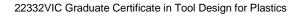
Applications and methods

for incorporating thin wall sections may include:

- use of appropriate internal/external radii/chamfers on all corners
- ensuring appropriate wall thickness profile for end-use application •
- appropriate pinch-off design •
- impact of polymer flow characteristics
- potential problems with flow characteristics •
- blow ratio •
- material application
- ribbings

Range of data may refer to:

- temperature distribution •
- flow channels •
- air capacity •
- volume capacity
- shrinkage •
- blow ratio
- maximum stress of inflated parison
- wall thickness of product
- pinch-off clamp force
- flash pocket depth
- Relevant people may include:
- management .
- colleagues
- clients
- customers
- suppliers
- stakeholders
- technical experts
- industry professionals
- planners
- advisors
- consultants
- regulators





- die swell

Applications and methods for incorporating threaded sections may include:	 pull-up pre-finish interface with injection moulded closures necks of blow moulded parts calibrated neck finishes inserts, such as: in-mould labelling heat transfer between aluminium mould and other metal inserts
Applications and methods for incorporating handle ware may include:	 use of appropriate internal/external radii/chamfers on all corners ensuring appropriate wall thickness profile for end-use application appropriate pinch-off design part removal impact of polymer flow characteristics potential problems with flow characteristics
<i>Tool design requirements</i> may include:	 detailed drawings of tool assembly necessary dimensions and labels necessary component drawings, such as: manual drafting techniques computer aided design (CAD) necessary calculations finishing for application shrinkage

- tool specifications to achieve the product requirements, such as:
 - o material
 - equipment
 - \circ finish
 - \circ construction
 - product / part design details, such as:
 - thin wall sections
 - threaded sections
 - handle ware
- tool quotation form and design process cost estimate
- project timeline
- description of operation
- analysis of material melt flow
- required parts list
- completed tool design check list
- stakeholder requirements
- sustainability issues



	 risk management, including: limitations of raw materials
	• Failure Mode and Effects Analysis (FMEA)
Project management	description / definition / rationale
<i>methodologies</i> may refer to:	outcomes and goal setting
	strategic planning
	resource requirements and allocation
	• budget
	• targets and milestones
	completion phases and timelines
	quality management policies and procedures
	• personnel
	responsibilities
	accountabilities
	agreed reporting procedures
	communication strategies
	 stakeholder engagement strategies, including critical consultation points
	monitoring and evaluation
Communication strategies may refer to:	• team leadership
	consultative management
	participative management
	• project evaluation
	stakeholders engagement
	critical consultation points, such as:
	• feedback to client on initial design brief as early as possible
	 consultation with all stakeholders to verify design
	 consultation with all stakeholders when establishing project timeline
	• consultation with client to confirm decisions regarding:
	– design
	– materials
	– process
	– equipment
	 briefing of all stakeholders of necessary changes to design in time to minimise cost and loss of time



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Blow moulding tool design • shape may address considerations of: • incorporation of: • handle

- \circ threaded section
- snap-on capable section
- \circ thin wall section
- litre capacity
- single layer extrusion
- minimum / maximum weight
- functionality and fitness for end-use
- manufacturability
- cost of production, including environmental costs
- minimising mould design complexity
- utilisation of strategies to eliminate or minimise faults

Critically evaluated may

include consideration of:



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EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment Guidelines for this Training Package.

Critical aspects for assessment and evidence required to demonstrate competency in this unit

A person who demonstrates competency in this unit must provide evidence of:

- implementing blow moulding tool design project that addresses plastics product requirements across a range of particular design details including: thin wall sections; threaded sections, and handle ware
- evaluating project outcomes to inform future practice
- knowledge of principles and processes of blow moulding tool design that meet plastics product design requirements

Assessment must ensure:

• activities are related to a tool design for plastics context

Resources implications for assessment include:

- access to suitable simulated or real workplace opportunities
- access to a range of plastics products/parts and associated blow moulding tooling
- access to material specification charts/data sheets
- access to Computer Aided Design and Tooling Design software
- A range of assessment methods should be used to assess practical skills and knowledge. The following assessment methods are appropriate for this unit:
- evaluation of project in applying principles for incorporating thin wall sections, threaded sections and/or handle ware into blow moulding tool design
- evaluation of calculations made in meeting tool design requirements
- evaluation of research project into current principles and processes of blow moulding tool design for plastic product with specific design details
- review of presentation of design project outcomes



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Context of and specific resources for assessment

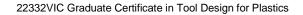
Method of assessment

- practical exercises
- observation
- direct questioning
- presentations
- third party reports

Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. Suggested units may include but are not limited to:

- VU21978: Implement plastics blow moulding tool design
- VU21979: Manage plastics blow mould tool design application
- VU21981: Implement advanced blow moulding tool design

Guidance information for assessment (Optional)



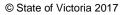


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VU21981 Implement advanced blow moulding tool design

Uni	t Descriptor	imple: requir	nit describes the skills and knowledge required to develop and ment designs for advanced blow moulding tools that address ements of complex plastics product design details to achieve product and specifications.
			<i>No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.</i>
Em	ployability Skills	This u	nit contains Employability Skills.
		facets qualif	equired outcomes described in this unit of competency contain applicable of Employability Skills. The Employability Skills Summary of the ication in which this unit is included will assist in identifying syability skill requirements.
Арј	blication of the Unit	are res range are tyj respor	init supports the work of managers, leaders and project personnel who sponsible for development of blow moulding tool design across a broad of product design applications within the plastics industry. Practitioners pically engaged in implementing tool design strategies that are nsive to: product intent; stakeholder-specified; regulatory, and nability requirements.
EL	EMENT	PER	FORMANCE CRITERIA
out	ments describe the essential comes of a unit of npetency.	achie detai	ormance criteria describe the required performance needed to demonstrate evement of the element. Where bold italicised text is used, further information is iled in the required skills and knowledge and/or the range statement. ssment of performance is to be consistent with the evidence guide.
out	comes of a unit of	achie detai	evement of the element. Where bold italicised text is used, further information is iled in the required skills and knowledge and/or the range statement.
out cor	comes of a unit of npetency. Apply the principles for incorporating advanced details into blow mould	achie detai Asse	evement of the element. Where bold italicised text is used, further information is iled in the required skills and knowledge and/or the range statement. ssment of performance is to be consistent with the evidence guide. Considerations for incorporating advanced details into blow mould
out cor	comes of a unit of npetency. Apply the principles for incorporating advanced details into blow mould	achia detai Asse 1.1	 evement of the element. Where bold italicised text is used, further information is iled in the required skills and knowledge and/or the range statement. ssment of performance is to be consistent with the evidence guide. Considerations for incorporating advanced details into blow mould tool design are researched and delineated. Range of <i>blow moulding processes</i> for incorporating advanced
out cor	comes of a unit of npetency. Apply the principles for incorporating advanced details into blow mould	achia detai Asse 1.1 1.2	 evement of the element. Where bold italicised text is used, further information is itled in the required skills and knowledge and/or the range statement. essment of performance is to be consistent with the evidence guide. Considerations for incorporating advanced details into blow mould tool design are researched and delineated. Range of <i>blow moulding processes</i> for incorporating advanced details are compared and analysed for their different applications <i>Range of data</i> required to meet given product specifications in
out cor 1	comes of a unit of npetency. Apply the principles for incorporating advanced details into blow mould tool design	achia detai Asse 1.1 1.2 1.3	 were the element. Where bold italicised text is used, further information is ited in the required skills and knowledge and/or the range statement. ssment of performance is to be consistent with the evidence guide. Considerations for incorporating advanced details into blow mould tool design are researched and delineated. Range of blow moulding processes for incorporating advanced details are compared and analysed for their different applications Range of data required to meet given product specifications in advance blow mould tool designs is calculated

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- 3 Implement and evaluate blow moulding tool design project for plastic products with advanced design details
- 3.1 *Product requirements* are determined and *tool design* and *production requirements* formulated
 - 3.2 Product specifications are analysed for possible faults, their causes analysed and *prevention strategies* established
 - 3.3 *Project management methodologies* and *communication strategies* are applied to implementation
 - 3.4 Blow moulding tool design concepts and sketches are developed and *critically evaluated* to achieve specified product outcomes
 - 3.5 Project is reviewed against specified outcomes and findings used to inform improved processes, procedures and planning in consultation with relevant people

REQUIRED SKILLS AND KNOWLEDGE

This describes the essential skills and knowledge and their level, required for this unit .

Required Skills

- interpersonal skills to work with clients, colleagues, management and stakeholders either under direction, independently, or within a team
- leadership and interpersonal skills to communicate design concepts, implications, requirements and parameters to stakeholders
- leadership and organisational skills to manage implementation and evaluation of design project
- research and strategic thinking skills to evaluate design methodologies for application to specific project outcomes
- manual and computer- aided design and drafting skills to develop, test and simulate designs
- calculation skills to determine tool design requirements
- problem-solving skills to identify potential barriers to projected outcomes, analyse risks and establish prevention strategies
- analytical and evaluation skills to assess tool design for plastics project and use results to inform future practice

Required Knowledge

- principles and processes of plastics product and tool design
- principles and processes of plastics blow moulding tool design
- range of advanced blow mould features
- principles and processes for incorporating advanced features into blow mould tool design
- design features and functions of plastics blow moulding machine operating systems
- behaviour and applications of polymer materials
- operating principles of plastics processing methods
- implications of product design for tool design
- factors that affect decisions in the design process
- project management tools and methodologies
- risk management strategies
- quality procedures
- relevant Federal, State or Territory legislation and local government legislation, regulations and standards
- sustainability implications for tool design for plastics
- safe work practices



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 in the Performance Criteria is detailed below. Add any 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.

Principles, for incorporating advanced design details, may include:

- moving core sections
- multiple parting lines
- moving sections
- dual wall
- structural shapes
- blow pin construction
- striker plates
- die bushing and mandrel
- square, rectangular or oval shaped part
- one or more handles incorporated into part
- threaded section or snap-on section
- no limit on volume capacity
- multi-layer extrusion
- view stripe incorporated into body of moulded article
- anti-glug neck
- double wall blow moulded products
- plastics product, such as:
 - 0 petrol tanks
 - compartment separators 0
 - cooler boxes 0
- high-density polyethylene (HDPE) drums
- multi-layer extrusion
 - injection blow moulding
 - parison programming •
 - view stripe co-extrusion
 - reciprocal blow moulding
 - intermittent blow moulding
 - continuous blow moulding
 - injection stretch blow mould machine
 - sequential blow moulding multi-material





Blow moulding processes

may include:

Range of data may include:	temperature distribution
	• flow channels (cooling)
	• air capacity
	clamp pressure
	volume capacity
	• shrinkage
	blow ratio
	maximum stress of inflated parison
	• wall thickness of product
	• pinch off clamp force
	• flash pocket depth
	• die swell
Relevant people may	• management
include:	• colleagues
	• clients
	• customers
	• suppliers
	• stakeholders
	• technical experts
	industry professionals
	• planners
	• advisors
	• consultants
	• regulators
Product requirements may	• product end-use
refer to:	• product intent
	• product with advanced details
	• materials selection
	• process selection
Tool design requirements	• detailed drawings of tool assembly
may include:	 necessary dimensions and labels
	• necessary component drawings, such as:
	 manual drafting techniques
	• computer aided design (CAD)
	necessary calculations



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- finishing for application
- shrinkage
- tool specifications to achieve the product requirements, such as:
 - material 0
 - equipment 0
 - finish 0
 - construction \cap
 - product design details 0
- tool quotation form and design process cost estimate
- project timeline
- description of operation
- analysis of material melt flow
- required parts list
- completed tool design checklist
- stakeholder requirements
- sustainability issues
- risk management, including:
 - limitations of raw materials 0
 - Failure Mode and Effects Analysis (FMEA) 0

Production requirements

may include:

(Fault) *Prevention* strategies may include:

production capacity

- material
- machine process
- large volume moulding
- mechanical and thermal properties of the material
- part to production requirements •
- machine types
- careful initial evaluation of product requirements / specifications
- thorough analysis of the design constraints of different processes, materials and tools
- thorough and ongoing consultation with client / suppliers / other team members and stakeholders
- effective project management
- quality assurance procedures, including:
 - design checklist 0
 - production checklist 0
 - failure minimisation 0
 - zero defects methodology 0
 - process control 0





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Project management	description / definition / rationale
methodologies may refer to:	outcomes and goal setting
	strategic planning
	resource requirements and allocation
	• budget
	• targets and milestones
	completion phases and timelines
	quality management policies and procedures
	• personnel
	responsibilities
	• accountabilities
	agreed reporting procedures
	communication strategies
	 stakeholder engagement strategies, including critical consultation points
	monitoring and evaluation
Communication strategies	• team leadership
may refer to:	consultative management
	• participative management
	project evaluation
	stakeholders engagement
	• critical consultation points, such as:
	• feedback to client on initial design brief as early as possible
	• consultation with all stakeholders to verify design
	 consultation with all stakeholders when establishing project timeline
	• consultation with client to confirm decisions regarding:
	– design
	– materials
	– process
	– equipment
	• briefing of all stakeholders of necessary changes to design in time to minimise cost and loss of time
Critically evaluated may	• functionality and fitness for end-use
include consideration of:	• manufacturability
	cost of production, including environmental costs
	 minimising mould design complexity
	• utilisation of strategies to eliminate or minimise faults



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EVIDENCE GUIDE

Context of and specific

Method of assessment

resources for assessment

The evidence guide provides advice on assessment and must be read in conjunction with the Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment Guidelines for this Training Package.

Critical aspects for assessment
and evidence required to
demonstrate competency in this
unit

A person who demonstrates competency in this unit must provide evidence of:

- implementing blow moulding tool design project that addresses plastics product requirements across a range of advanced design details
- evaluating project outcomes to inform future practice
- knowledge of principles and processes of blow moulding tool design that meet plastics product design requirements

Assessment must ensure:

activities are related to a tool design for plastics context

Resources implications for assessment include:

- access to suitable simulated or real workplace opportunities
- access to a range of plastics products/parts and associated blow moulding tooling
- access to material specification charts/data sheets
- access to Computer Aided Design and Tooling Design software

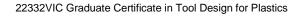
A range of assessment methods should be used to assess practical skills and knowledge. The following assessment methods are appropriate for this unit:

- evaluation of project in applying principles for incorporating advanced design details into blow moulding tool design
- evaluation of research project into current principles and processes of blow moulding tool for plastic product with advanced design details
- practical exercises
- observation
- direct questioning
- presentations
- third party reports

Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. Suggested units may include but are not limited to:

- VU21978: Implement plastics blow moulding tool design
- VU21979: Manage plastics blow mould tool design application
- VU21980: Implement blow moulding tool design for plastics products design details

Guidance information for assessment (Optional)

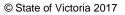




VU21982 Implement plastics extrusion tool design

Unit	t Descriptor	This unit describes the skills and knowledge required to make optimal decisions regarding tool design requirements for plastics extrusion tooling.		
			icensing, legislative, regulatory or certification requirements apply to unit at the time of publication.	
Emp	oloyability Skills	This unit contains Employability Skills.		
		The required outcomes described in this unit of competency contain applicabl facets of Employability Skills. The Employability Skills Summary of the qualification in which this unit is included will assist in identifying employability skill requirements.		
Арр	lication of the Unit	person design indust strateg	nit supports the work of designers, managers, leaders and project and who are responsible for development of plastics extrusion tool across a broad range of product design applications within the plastics ry. Practitioners are typically engaged in implementing tool design gies that are responsive to: product intent; stakeholder-specified; tory, and sustainability requirements.	
ELE	EMENT	PERI	FORMANCE CRITERIA	
oute	ments describe the essential comes of a unit of npetency.	achie detai	ormance criteria describe the required performance needed to demonstrate evement of the element. Where bold italicised text is used, further information is led in the required skills and knowledge and/or the range statement. ssment of performance is to be consistent with the evidence guide.	
1	Research extrusion tooling	1.1	<i>Principles of operation</i> of a range of commonly used <i>extrusion tooling</i> are researched and delineated	
		1.2	Different applications and requirements of a range of <i>extrusion tooling components</i> are researched and clarified	
2	Analyse the interrelationship between extrusion operating systems and tool design	2.1	Design features and functions of <i>extrusion machine control systems</i> are analysed for effect on tool design	
		2.2	Range of extrusion measuring instruments and extrusion service systems are analysed for role in optimising extrusion tool design and function	
		2.3	<i>Machine factors</i> are analysed for affect or limitation on extrusion tool design	
3	Select materials and tool construction methods to achieve production requirements and processing	3.1	Properties of <i>metal materials</i> and their <i>finishing treatments</i> are analysed for effect on extrusion tool design and construction	

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- 3.2 Effect of extrusion tool design and production requirements is appraised in determining selection of *die construction methods*
- 3.3 Impact, on tool design, of *material preparation* and *material melt behaviour* in the extrusion process is researched, evaluated and debated
- 3.4 Effect of extrusion tool design, production requirements and *environmental costs* is appraised in determining selection of raw materials
- 4.1 *Product design specifications* are evaluated to determine *extrusion tooling design requirements*
- 4.2 *Range of calculations* required to design an extrusion tool are completed and documented
- 4.3 Tool design concept proposals are developed and *critically evaluated* to achieve specified product outcomes
- 5.1 *Project management methodologies* and *communication strategies* are applied to implementation
- 5.2 **Tool design faults** and their causes are analysed and **prevention strategies** established and implemented
- 5.3 Project is reviewed against specified outcomes and findings used to inform improved processes, procedures and planning in consultation with *relevant people*

4 Analyse and evaluate product design to determine tool design requirements

5 Implement and evaluate injection extrusion tooling design project



REQUIRED SKILLS AND KNOWLEDGE

This describes the essential skills and knowledge and their level, required for this unit .

Required Skills

- interpersonal skills to work with clients, colleagues, management and stakeholders either under direction, independently, or within a team
- leadership and interpersonal skills to communicate design concepts, implications, requirements and parameters to stakeholders
- leadership and organisational skills to manage implementation and evaluation of design project
- research and strategic thinking skills to evaluate design methodologies for application to specific project outcomes
- manual and computer- aided design and drafting skills to develop, test and simulate designs
- calculation skills to determine tool design requirements
- problem-solving skills to identify potential barriers to projected outcomes, analyse risks and establish prevention strategies
- analytical and evaluation skills to assess tool design for plastics project and use results to inform future practice

Required Knowledge

- principles and processes of plastics product and tool design
- principles and processes of plastics extrusion tool design
- functions and operating principles of different types of extrusion dies and their component parts, including operating cycles of dies, properties of metal materials, construction methods and finishing treatments
- design features and functions of plastics extrusion machine operating systems
- implications of product design for tool design
- behaviour and applications of polymer materials
- operating principles of plastics processing methods
- factors that affect decisions in the design process
- project management tools and methodologies
- risk management strategies
- quality procedures
- causes of, and elimination strategies for, common product and design faults
- relevant Federal, State or Territory legislation and local government legislation, regulations and standards
- sustainability implications for tool design for plastics
- safe work practices



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 in the Performance Criteria is detailed below. Add any 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.

Principles of operation may refer to:

- types and function of extruder and extrusion line
- characteristics and capacity
- machine components and construction features
- importance of time, pressure and temperature on melt flow
- Volumetric Flow Rate (VFR)
- downstream equipment
- temperature rise in die
- rheological models for polymer melt flow
- isothermal flow in channels; Newtonian and non-Newtonian
- heat transfer during polymer processing
- screen packs
- filters
- die adjustment
- temperature prior to extrusion
- pressure versus drag
- mono layer extrusion
- multi-layer extrusion
- sheet
- blown film
- cable
- pipe and tube
- profile

Extrusion tooling components may refer to:

Extrusion tooling may refer

to:

- product:
 - o surface finish
 - o texture
 - o laminates
 - \circ weld line
 - wall thickness
 - o dimensional stability
 - o extrudes / die characteristics
- production:
 - o online operations
 - o calibration equipment





- o vacuum sizing
- o forming devices
- o internal pressures
- **Extrusion machine control systems** may refer to:

Extrusion measuring

instruments may include:

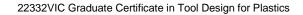
- basic controls
- open loop system
- extrusion speed (line speed)
- screw speed
- screw design versus material
- back, head, die pressure
- ammeters
- temperatures sensing devices
- thermocouples and pyrometers
- pressure transducers
- pressure gauges
- vacuum gauges
- vacuum tanks
- flow meters
- tachometers
- gravimetric material hoppers
- dimensional monitoring and control
- X-ray measuring devices
- thermal imaging devices
- water (chilled and ambient)
- electrical
- hydraulic
- compressed air
- heating and cooling (internal and external)
- material handling systems

Machine factors may refer to:

Extrusion service systems

may refer to:

- processability, such as:
 - Length per Diameter (LD) ratio of screws
- size of extruder screws
- weight
- maximum production output capacity





ection C: Units of Competency	VU21982: Implement plastics extrusion too
	 low carbon steel surface hardened steel (nitride hardening) stainless steel tool steel aluminium kirksite copper brass beryllium copper interpretation of mould steel data sheets and property tables polishing texturing heat treatment processes, such as: normalising annealing
	 quench hardening carburising nitriding tempering stress relieving plating and coating techniques etching graining photo-etching spark eroding
<i>Die construction methods</i> may refer to:	 Numerical Control (NC) machining Computer Numerical Control (CNC) machining Electronic Discharge Machining (EDM) – commonly called spark erosion wire cutting casting zinc alloy casting (kirksite) tool hardening / heat treatment
<i>Material preparation</i> may refer to:	 drying colouring agents additives and fillers

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may refer to:

include:

Material melt behaviour

Environmental costs may

- pre-heating •
- blending •
- high speed mixing
- vacuuming volatiles
- shrinkage •
- impact of die swell and temperature •
- extrude quality •
- melt temperature ranges .
- recyclability •
- waste management •
- waste minimisation •
- waste disposal
- resource management
- energy consumption used in processing, such as:
 - services required for production, such as: 0
 - _ cooling supply
 - _ power supply
 - heating supply _
- carbon abatement ٠
- melt density •
- shear viscosity •
- shear modulus •
- tensile viscosity •
- tensile modulus
- isothermal flow in channels; Newtonian and non-Newtonian fluids
- specifications may include:

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- samples •
- drawings •
- specifications •
- customer requirements •
- moulding shop specifications
- environmental issues



Range of calculations may

include:

- Product design

Extrusion tooling design requirements may include:	 detailed drawings of tool assembly necessary dimensions and labels necessary component drawings, such as: manual drafting techniques computer aided design (CAD) necessary calculations finishing for application shrinkage tool specifications to achieve the product requirements, such as: material equipment finishing construction product design details tool quotation form and design process cost estimate project timeline description of operation analysis of material melt flow required parts list completed tool design check list stakeholder requirements sustainability issues risk management, including:
	 limitations of raw materials Evilore Mode and Effects Analysis (EMEA)
	• Failure Mode and Effects Analysis (FMEA)
Critically evaluated may refer to considerations of:	functionality and fitness for end-use
	• testing, such as:
	 bursting impact
	 impact 21 ° and zero
	 hydrostatic; 21 degree to boiling static and dynamic
	• static and dynamic
	 softening point

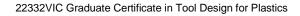
- o melt flow index
- \circ X-ray and/or infrared

- manufacturability
- cost of production
- environmental costs and impact of production
- minimising product design complexity
- utilisation of strategies to eliminate or minimise faults

Project management

methodologies may refer to:

- description / definition / rationale
- outcomes and goal setting
- strategic planning
- resource requirements and allocation
- budget
- targets and milestones
- completion phases and timelines
- quality management policies and procedures
- personnel
- responsibilities
- accountabilities
- agreed reporting procedures
- communication strategies
- stakeholder engagement strategies, including critical consultation points
- monitoring and evaluation
- team leadership
- consultative management
- participative management
- project evaluation
- stakeholders engagement
- critical consultation points, such as:
 - o feedback to client on initial design brief as early as possible
 - o consultation with all stakeholders to verify design
 - consultation with all stakeholders when establishing project timeline
 - o consultation with client to confirm decisions regarding:
 - design
 - materials
 - process
 - equipment
 - briefing of all stakeholders of necessary changes to design in time to minimise cost and loss of time





Communication strategies may refer to:

Section C: Units of Competency	VU21982: Implement plastics extrusion tool des
<i>Tool design faults</i> may refer to:	 ovality product weight pigment dispersion die lines weld strength burn marks radii swell trimming poor flow melt fracture draw down ratio surface finish reversion material degradation dimension control thickness variability methylene dichloride (MDC) attack
Fault) <i>Prevention strategies</i> may include:	 careful initial evaluation of product requirements / specifications thorough analysis of the design constraints of different processes, materials and tools thorough and ongoing consultation with client / suppliers / other team members and stakeholders effective project management quality assurance procedures, including: design checklist production checklist failure minimisation zero defects methodology process control
<i>Relevant people</i> may include:	 management colleagues clients customers suppliers stakeholders technical experts industry professionals planners

- advisors
- consultants
- regulators

EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment Guidelines for this Training Package.

Critical aspects for assessment and evidence required to demonstrate competency in this unit

A person who demonstrates competency in this unit must provide evidence of:

- implementing extrusion tool design project for a plastics product design concept
- determining prevention strategies for tool design faults
- evaluating project outcomes to inform future practice
- knowledge of principles and processes of extrusion tool design including: capabilities of extrusion machine operating systems and requisite materials and tool construction methods

Assessment must ensure:

- activities are related to a tool design for plastics context
- resources implications for assessment include:
- access to suitable simulated or real workplace opportunities
- access to a range of plastics products/parts and associated extrusion tooling
- access to material specification charts/data sheets
- access to Computer Aided Design and Tooling Design software
- A range of assessment methods should be used to assess practical skills and knowledge. The following assessment methods are appropriate for this unit:
- evaluation of project in extrusion tool design that meets specified outcomes of a product design concept
- evaluation of research project into fundamentals of extrusion tool design across a range of contexts
- practical exercises
- observation
- direct questioning
- presentations
- third party reports



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Context of and specific resources for assessment

Method of assessment

Guidance information for assessment (Optional)	• Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. Suggested units may include but are not limited to:
	 VU21983: Manage extrusion sheet and blown film tool design
	 VU21984: Manage extrusion pipe, tube and cable tool design

• VU21985: Manage extrusion profile tool design



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VU21983 Manage extrusion sheet and film tool design

Uni	t Descriptor	imple	unit describes the skills and knowledge required to develop and ement sheet and film extrusion tool designs to achieve plastics product fications across a range of contexts. <i>No licensing, legislative, regulatory or certification requirements</i> <i>apply to this unit at the time of publication.</i>	
Employability Skills		This unit contains Employability Skills.		
		The appli of the	required outcomes described in this unit of competency contain cable facets of Employability Skills. The Employability Skills Summary e qualification in which this unit is included will assist in identifying oyability skill requirements.	
p d in s		perso desig indus strate	This unit supports the work of designers, managers, leaders and project personnel who are responsible for development of plastics extrusion tool design across a broad range of product design applications within the plastics industry. Practitioners are typically engaged in implementing tool design strategies that are responsive to: product intent; stakeholder-specified; regulatory, and sustainability requirements.	
ELEMENT		PERFORMANCE CRITERIA		
Elements describe the essential outcomes of a unit of competency.		Performance criteria describe the required performance needed to demonstrate achievement of the element. Where bold italicised text is used, further information is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.		
1	Apply the principles of extruded sheet design to tool design	1.1	<i>Methods of translating product dimensions and specifications</i> into extruded sheet tool designs are researched and delineated	
		1.2	Principles and main elements of extrusion sheet tool design are analysed for their different applications	
		1.3	Appropriate material and machine process are selected based on analysis of <i>relevant factors</i>	
2	Apply the principles of blown film tool design	2.1	Methods of translating product dimensions and specifications into blown film tool design are researched and delineated	
	-	2.2	Principles and main elements of blown film tool design are analysed for their different applications	
		2.3	Appropriate material and machine process are selected based on analysis of relevant factors	
3	Determine requirements for sheet extrusion and/or blown film tool design	3.1	Methods to best meet <i>production and design requirements</i> are canvassed and selected	

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project



- 3.2 Possible *faults* in sheet extrusion and blown film applications, their causes are analysed and *prevention strategies* established
- 3.3 *Project management methodologies* and *communication strategies* are determined
- 3.4 Sheet extrusion and blown film tool designs are developed and *critically evaluated* against *tool design requirements*
- 3.5 *Material flow and temperature control* for sheet extrusion and blown film tool designs are calculated
- **4** Evaluate design project 4.1 Project is implemented and reviewed against specified outcomes
 - 4.2 Findings are used to inform improved processes, procedures and planning in consultation with *relevant people*



REQUIRED SKILLS AND KNOWLEDGE

This describes the essential skills and knowledge and their level, required for this unit .

Required Skills

- interpersonal skills to work with clients, colleagues, management and stakeholders either under direction, independently, or within a team
- leadership and interpersonal skills to communicate design concepts, implications, requirements and parameters to stakeholders
- leadership and organisational skills to manage implementation and evaluation of design project
- research and strategic thinking skills to evaluate design methodologies for application to specific project outcomes
- manual and computer- aided design and drafting skills to develop, test and simulate designs
- calculation skills to determine tool design requirements
- problem-solving skills to identify potential barriers to projected outcomes, analyse risks and establish prevention strategies
- analytical and evaluation skills to assess tool design for plastics project and use results to inform future practice

Required Knowledge

- principles and processes of plastics product and tool design
- principles and processes of plastics extrusion tool design including extruded sheet and blown film tool design
- design features and functions of plastics extrusion machine operating systems
- methods for translating product dimensions and specifications into designs for extruded sheet and blown film tools
- operating principles of plastics processing methods, including strategies to optimise extrusion and cooling conditions in extruded sheet and blown film die design
- implications of product design for tool design
- behaviour and applications of polymer materials
- factors that affect decisions in the design process
- · project management tools and methodologies
- risk management strategies
- quality procedures
- relevant Federal, State or Territory legislation and local government legislation, regulations and standards
- sustainability implications for tool design for plastics
- safe work practices



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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 in the Performance Criteria is detailed below. Add any 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.

Methods of translating product dimensions and

specifications may include:

- product drawings
- product material and machine specifications
- product models for which drawings can be produced
- product models for which drawings are too difficult to produce, such as:
 - carving
 - o sculpture
- using Computer Aided Drafting (CAD) data
- Computational Fluid Dynamics (CFD) data
- Computer Aided Engineering (CAE)data
- using CAD/ CFD/CAE models
- using a prototype with some working measurements
- temperature control
- measuring instruments and their functions
- service systems
- finishing treatments
- tool and calibration temperature control
- roller temperature
- roller pincher
- haul-off equipment
- end product sizing equipment
- product end-use
- aesthetic requirements
- processing specifications, such as:
 - \circ volume of run
- environmental costs, such as:
 - o resource management
 - waste management
 - recycling
 - energy consumption

types of blown film dies, such as:

• carbon abatement

Principles and main elements of blown film tool design may include:

- co-extrusion
- adaptor type
- o side-fed

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Principles and main elements of extruded sheet tool design may include:

Relevant factors may

include:

<i>Production and design</i> <i>requirements</i> may include:	 bottom-fed air-ring design internal cooling pressure control internal cooling temperature control nip-roller control large volume mechanical and thermal properties of the material part to production requirements machine types cost constraints production capacity
Faults may include:	 extruded sheet faults, such as: physical performance of product stagnation spots restricted and uneven flow paths damaged surfaces weld lines associated with split flow paths surface quality and treatment thermal control and monitoring gauge thickness blown film faults, such as: physical performance of product stagnation spots gauge thickness blown film faults, such as: physical performance of product stagnation spots gauge thickness bi-axial orientation delamination excessive haul-off die-centring bubble shape bubble variation internal air temperature uneven frost lines nip-roller pressure
(Fault) <i>Prevention</i> <i>strategies</i> may include:	 careful initial evaluation of product requirements / specifications thorough analysis of the design constraints of different processes, materials and tools thorough and ongoing consultation with client / suppliers / other team members and stakeholders effective project management

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- quality assurance procedures, including:
 - design checklist
 - production checklist
 - failure minimisation
 - zero defects methodology
 - o process control

Project management

methodologies may refer to:

- description / definition / rationale
- outcomes and goal setting
- strategic planning
- resource requirements and allocation
- budget
- targets and milestones
- completion phases and timelines
- quality management policies and procedures
- personnel
- responsibilities
- accountabilities
- agreed reporting procedures
- communication strategies
- stakeholder engagement strategies, including critical consultation points
- monitoring and evaluation

Communication strategies

may refer to:

team leadership

•

- consultative management
- participative management
- project evaluation
- stakeholders engagement
- critical consultation points, such as:
 - feedback to client on initial design brief as early as possible
 - o consultation with all stakeholders to verify design
 - consultation with all stakeholders when establishing project timeline
 - consultation with client to confirm decisions regarding:
 - design
 - materials
 - process
 - equipment
- briefing of all stakeholders of necessary changes to design in time to minimise cost and loss of time



	·
<i>Critically evaluated</i> may refer to considerations of:	 functionality and fitness for end-use manufacturability cost of production environmental costs and impact of production minimising product design complexity
Tool design requirements may refer to:	 utilisation of strategies to eliminate or minimise faults detailed drawings of tool assembly necessary dimensions and labels necessary component drawings, such as: manual drafting techniques Computer Aided Design (CAD) necessary calculations finishing for application shrinkage tool specifications to achieve the product requirements material equipment finish construction
	 tool quotation form and design process cost estimate project timeline description of operation analysis of material melt flow required parts list completed tool design check list customer requirements environmental costs raw materials and their possible limitations Failure Mode and Effects Analysis (FMEA)
<i>Material flow and temperature control</i> may include:	 steady state / isothermic flow flow in an annulus Newtonian and non-Newtonian (power law) fluids viscoelastic behaviour of the polymer melt use of representative data continuity equation



- flow channels with variable height
- regression equation
- apparent viscosity

Relevant people may include:

- management
- colleagues
- clients
- customers
- suppliers
- stakeholders
- technical experts
- industry professionals
- planners
- advisors
- consultants
- regulators



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EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment Guidelines for this Training Package.

Critical aspects for assessment and evidence required to demonstrate competency in this unit

A person who demonstrates competency in this unit must provide evidence of:

- managing extrusion sheet and/or blown film tool design project
- determining prevention strategies for tool design faults
- evaluating project outcomes to inform future practice
- knowledge of principles and processes of extrusion tool design to meet plastics product design requirements

Assessment must ensure:

- activities are related to a tool design for plastics context Resources implications for assessment include:
- access to suitable simulated or real workplace opportunities
- access to a range of plastics products/parts and associated extrusion tooling
- access to material specification charts/data sheets
- access to Computer Aided Design and Tooling Design software

A range of assessment methods should be used to assess practical skills and knowledge. The following assessment methods are appropriate for this unit:

- evaluation of project in tool design solutions for a range of extruded sheet and blown film products
- evaluation of project in selection of appropriate materials for extruded sheet and blown film tooling
- evaluation of calculations necessary to optimise material flow and control temperature in extruded sheet and blown film tooling
- review of portfolio of research into principles and processes of extrusion sheet and blown film tool design
- practical exercises
- observation
- direct questioning
- presentations
- third party reports



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Context of and specific resources for assessment

Method of assessment

Guidance information for	Holistic assessment with other units relevant to the industry sector,
assessment	workplace and job role is recommended. Suggested units may
(Optional)	include but are not limited to:
	• VU21982: Implement plastics extrusion tool design

- VU21984: Manage extrusion pipe, tube and cable tool design
- VU21985: Manage extrusion profile tool design



VU21984 Manage extrusion pipe, tube and cable tool design

		p.p.,		
Uni	t Descriptor	imple	nit describes the skills and knowledge required to develop and ment extrusion pipe, tube and cable tool designs to achieve plastics ct specifications across a range of contexts.	
		No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.		
Em	ployability Skills	This unit contains Employability Skills.		
		The required outcomes described in this unit of competency contain applicable facets of Employability Skills. The Employability Skills Summary of the qualification in which this unit is included will assist in identifying employability skill requirements.		
Application of the Unit		This unit supports the work of designers, managers, leaders and project personnel who are responsible for development of plastics extrusion tool design across a broad range of product design applications within the plastics industry. Practitioners are typically engaged in implementing tool design strategies that are responsive to: product intent; stakeholder-specified; regulatory, and sustainability requirements.		
EL	EMENT	PER	FORMANCE CRITERIA	
out	ments describe the essential comes of a unit of npetency.	achi deta	Formance criteria describe the required performance needed to demonstrate evement of the element. Where bold italicised text is used, further information is iled in the required skills and knowledge and/or the range statement. essment of performance is to be consistent with the evidence guide.	
1	Apply the principles of extruded pipe and tube to tool design	1.1	<i>Methods of translating product dimensions and specifications</i> into extruded pipe and tube tool designs are researched and delineated	
		1.2	<i>Principles and main elements of extruded pipe and tube tool design</i> are analysed for their different applications	
		1.3	Appropriate material and machine process are selected based on analysis of <i>relevant factors</i>	
2	Apply the principles of extruded cable tool design	2.1	Methods of translating product specifications into extruded cable designs are researched and delineated	
		2.2	<i>Principles and main elements of extruded cable tool design</i> are analysed for their different applications	
		2.3	Appropriate material and machine process are selected based on analysis of relevant factors	
3	Determine requirements for extruded pipe, tube and cable tool design project	3.1	Methods to best meet <i>production and design requirements</i> are canvassed and selected	



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- 3.2 Possible *faults* in extruded pipe, tube and cable applications, their causes are analysed and *prevention strategies* established
- 3.3 *Project management methodologies* and *communication strategies* are determined
- 3.4 Extruded pipe, tube and cable tool designs are developed and *critically evaluated* against tool design requirements.
- 3.5 Material flow and temperature control for extruded pipe, tube and cable tool designs are calculated.
- Evaluate design project 4.1 Project is implemented and reviewed against specified outcomes
 - 4.2 Findings are used to inform improved processes, procedures and planning in consultation with *relevant people*



REQUIRED SKILLS AND KNOWLEDGE

This describes the essential skills and knowledge and their level, required for this unit .

Required Skills

- interpersonal skills to work with clients, colleagues, management and stakeholders either under direction, independently, or within a team
- leadership and interpersonal skills to communicate design concepts, implications, requirements and parameters to stakeholders
- leadership and organisational skills to manage implementation and evaluation of design project
- research and strategic thinking skills to evaluate design methodologies for application to specific project outcomes
- manual and computer- aided design and drafting skills to develop, test and simulate designs
- calculation skills to determine tool design requirements
- problem-solving skills to identify potential barriers to projected outcomes, analyse risks and establish prevention strategies
- analytical and evaluation skills to assess tool design for plastics project and use results to inform future practice

Required Knowledge

- principles and processes of plastics product and tool design
- principles and processes of plastics extrusion tool design, including extruded pipe, tube and cable tool design
- design features and functions of plastics extrusion machine operating systems
- methods for translating product dimensions and specifications into designs for pipe, tube and cable extrusion tools
- behaviour and applications of polymer materials
- operating principles of plastics processing methods
- implications of product design for tool design
- factors that affect decisions in the design process
- causes of, and elimination strategies for, faults in extruded pipe, tube and cable products
- project management tools and methodologies
- risk management strategies
- quality procedures
- relevant Federal, State or Territory legislation and local government legislation, regulations and standards
- sustainability implications for tool design for plastics
- safe work practices



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 in the Performance Criteria is detailed below. Add any 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.

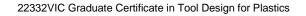
Methods of translating • product dimensions and specifications may

include:

- product drawings
- product material and machine specifications
- product models for which drawings can be produced
- product models for which drawings are too difficult to produce, such as:
 - carving
 - o sculpture
 - o toy
- using Computer Aided Drafting (CAD) data
- Computational Fluid Dynamics (CFD) data
- Computer Aided Engineering (CAE)data
- using CAD/ CFD/CAE models
- using a prototype with some working measurements
- temperature control
- measuring devices and their functions
- services
- finishing treatments
- wall thickness
- die swell and draw down
- back pressure
- hollow sections
- sharp radius / edge
- elimination of stagnation points in flow channels
- progressive increase in velocity along the flow channel
- simple approach angles
- mono layer or co-extrusion

Relevant factors may include:

- product end-use
- aesthetic requirements
- processing specifications, such as:
 - o volume of run
- environmental costs, such as:





Principles and main elements of pipe and tube design may include:

Principles and main • multi-layer elements of cable tool • foaming design may include: • temperature control measuring devices and their functions services • finishing treatments • wall thickness die swell and draw down · back pressure • sharp radius / edge • elimination of stagnation points in flow channels • progressive increase in velocity along the flow channel • simple approach angles Production and design • large volume *requirements* may include: • mechanical and thermal properties of the material • part to production requirements • machine types • cost constraints production capacity *Faults* may include: • Common extruded pipe and tube faults, such as: 0 inadequate mechanical and physical performance of product restricted and uneven flow paths 0 damaged surfaces 0 weld lines associated with split flow paths 0 surface quality and treatment 0 thermal control and monitoring 0 thermal degradation 0 thickness variation 0 • common extruded cable faults, such as: inadequate mechanical and physical performance of product 0

recyclability

waste management

resource management

energy consumption

carbon abatement

0

0

0

0

0

• restricted and uneven flow paths



	 damaged surfaces
	• weld lines associated with split flow paths
	 surface quality and treatment
	• thermal control and monitoring
	• thermal degradation
	• thickness variation
(Fault) Prevention	careful initial evaluation of product requirements / specifications
strategies may include:	 thorough analysis of the design constraints of different processes, materials and tools
	• thorough and ongoing consultation with client / suppliers / other team members and stakeholders
	effective project management
	• quality assurance procedures, including:
	 design checklist
	 production checklist
	 failure minimisation
	 zero defects methodology
	 process control
Project management	description / definition / rationale
<i>methodologies</i> may refer	• outcomes and goal setting
to:	strategic planning
	resource requirements and allocation
	• budget
	• targets and milestones
	completion phases and timelines
	 quality management policies and procedures
	• personnel
	• responsibilities
	accountabilities
	agreed reporting procedures
	communication strategies
	 stakeholder engagement strategies, including critical consultation points
	monitoring and evaluation
Communication	• team leadership
strategies may refer to:	consultative management
	participative management
	project evaluation

- stakeholders engagement
- critical consultation points, such as:

- o feedback to client on initial design brief as early as possible
- o consultation with all stakeholders to verify design
- consultation with all stakeholders when establishing project timeline
- o consultation with client to confirm decisions regarding:
 - design
 - materials
 - process
 - equipment
- briefing of all stakeholders of necessary changes to design in time to minimise cost and loss of time
- functionality and fitness for end-use

Critically evaluated may refer to considerations of:

• manufacturability

_

- cost of production
- environmental costs and impact of production
- minimising product design complexity
- utilisation of strategies to eliminate or minimise faults

Relevant people may include:

- management
- colleagues
- clients
- customers
- suppliers
- stakeholders
- technical experts
- industry professionals
- planners
- advisors
- consultants
- regulators



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EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment Guidelines for this Training Package.

Critical aspects for assessment and evidence required to demonstrate competency in this unit	 A person who demonstrates competency in this unit must provide evidence of: managing extrusion pipe, tube and cable tool design project determining prevention strategies for tool design faults evaluating project outcomes to inform future practice knowledge of principles and processes of extrusion tool design to meet plastics product design requirements
Context of and specific resources for assessment	 Assessment must ensure: activities are related to a tool design for plastics context Resources implications for assessment include: access to suitable simulated or real workplace opportunities access to a range of plastics products/parts and associated extrusion tooling access to material specification charts/data sheets access to Computer Aided Design and Tooling Design software
Method of assessment	 A range of assessment methods should be used to assess practical skills and knowledge. The following assessment methods are appropriate for this unit: evaluation of project in tool design solutions for a range of extruded pipe, tube and cable products evaluation of project in selection of appropriate materials for extruded pipe, tube and cable tooling evaluation of calculations necessary to optimise material flow and control temperature in extruded pipe, tube and cable tooling review of portfolio of research into principles and processes of extruded pipe, tube and cable tool design practical exercises observation direct questioning presentations



Guidance information for	Holistic assessment with other units relevant to the industry sector,
assessment (Optional)	workplace and job role is recommended. Suggested units may include but are not limited to:

- VU21982: Implement plastics extrusion tool design
- VU21983: Manage extrusion sheet and blown film tool design
- VU21985: Manage extrusion profile tool design



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VU21985 Manage extrusion profile tool design

		-	
Uni	t Descriptor	imple	unit describes the skills and knowledge required to develop and ment extruded basic and advanced profile tool designs to achieve cs product specifications across a range of contexts.
			No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.
Em	ployability Skills	This	unit contains Employability Skills.
		The required outcomes described in this unit of competency contain applicable facets of Employability Skills. The Employability Skills Summary of the qualification in which this unit is included will assist in identifying employability skill requirements.	
Арг	blication of the Unit	This unit supports the work of designers, managers, leaders and project personnel who are responsible for development of plastics extrusion tool design across a broad range of product design applications within the plastics industry. Practitioners are typically engaged in implementing tool design strategies that are responsive to: product intent; stakeholder-specified; regulatory, and sustainability requirements.	
EL	EMENT	PERFORMANCE CRITERIA	
out	ments describe the essential comes of a unit of npetency.	achi deta	formance criteria describe the required performance needed to demonstrate evement of the element. Where bold italicised text is used, further information is iled in the required skills and knowledge and/or the range statement. ssment of performance is to be consistent with the evidence guide.
out	comes of a unit of	achi deta	evement of the element. Where bold italicised text is used, further information is iled in the required skills and knowledge and/or the range statement.
out con	comes of a unit of npetency. Apply the principles of extruded basic profile to	achia deta Asse	evement of the element. Where bold italicised text is used, further information is iled in the required skills and knowledge and/or the range statement. ssment of performance is to be consistent with the evidence guide. Methods of translating product specifications into extruded basic
out con	comes of a unit of npetency. Apply the principles of extruded basic profile to	achi deta Asse	evement of the element. Where bold italicised text is used, further information is iled in the required skills and knowledge and/or the range statement. ssment of performance is to be consistent with the evidence guide. Methods of translating product specifications into extruded basic profile tool designs are researched and delineated Principles and main elements of extruded basic profile tool design
out con	comes of a unit of npetency. Apply the principles of extruded basic profile to	achi deta Asse 1.1 1.2	 evement of the element. Where bold italicised text is used, further information is iled in the required skills and knowledge and/or the range statement. ssment of performance is to be consistent with the evidence guide. Methods of translating product specifications into extruded basic profile tool designs are researched and delineated Principles and main elements of extruded basic profile tool design are analysed for their different applications Appropriate material and machine process are selected based on
out con 1	Apply the principles of tool design	achi deta Asse 1.1 1.2 1.3	 evement of the element. Where bold italicised text is used, further information is iled in the required skills and knowledge and/or the range statement. ssment of performance is to be consistent with the evidence guide. Methods of translating product specifications into extruded basic profile tool designs are researched and delineated Principles and main elements of extruded basic profile tool design are analysed for their different applications Appropriate material and machine process are selected based on analysis of relevant factors Methods of translating product specifications into extruded



- 3 Determine requirements for extruded basic and advanced profile tool design project
 3.1 Methods to best meet *production and design requirements* are canvassed and selected
 3.2 Possible *faults* in extruded pipe, tube and cable applications, their causes are analysed and *prevention strategies* established
 3.3 *Project management methodologies* and *communication strategies* are determined
 - 3.4 Extruded pipe, tube and cable tool designs are developed and *critically evaluated* against *tool design requirements*
 - 3.5 *Material flow and temperature control* for extruded pipe, tube and cable tool designs are calculated
- 4 Evaluate design project
- 4.1 Project is implemented and reviewed against specified outcomes
 - 4.2 Findings are used to inform improved processes, procedures and planning in consultation with *relevant people*

REQUIRED SKILLS AND KNOWLEDGE

This describes the essential skills and knowledge and their level, required for this unit .

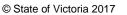
Required Skills

- interpersonal skills to work with clients, colleagues, management and stakeholders either under direction, independently, or within a team
- leadership and interpersonal skills to communicate design concepts, implications, requirements and parameters to stakeholders
- leadership and organisational skills to manage implementation and evaluation of design project
- research and strategic thinking skills to evaluate design methodologies for application to specific project outcomes
- manual and computer- aided design and drafting skills to develop, test and simulate designs
- calculation skills to determine tool design requirements
- problem-solving skills to identify potential barriers to projected outcomes, analyse risks and establish prevention strategies
- analytical and evaluation skills to assess tool design for plastics project and use results to inform future practice

Required Knowledge

- principles and processes of plastics product and tool design
- principles and processes of plastics extrusion tool design
- principles and processes of basic and advanced profile tool design
- methods for translating product dimensions and specifications into designs for basic and advanced profile tools
- design features and functions of plastics extrusion machine operating systems
- behaviour and applications of polymer materials
- operating principles of plastics processing methods
- implications of product design for tool design
- factors that affect decisions in the design process
- causes of, and elimination strategies for, faults in basic and advanced profile extrusion products
- project management tools and methodologies
- risk management strategies
- quality procedures
- relevant Federal, State or Territory legislation and local government legislation, regulations and standards
- sustainability implications for tool design for plastics
- safe work practices

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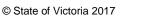
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RANGE STATEMENT

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 in the Performance Criteria is detailed below. Add any 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.

industry and regional contex	llS.
Methods of translating product dimensions and	• product drawings
specifications may include:	 product material and machine specifications
	 product models for which drawings can be produced
	• product models for which drawings are too difficult to produce, such as:
	• carving
	• sculpture
	o toy
	• using Computer Aided Drafting (CAD) data
	Computational Fluid Dynamics (CFD) data
	Computer Aided Engineering (CAE)data
	• using CAD/ CFD/CAE models
	• using a prototype with some working measurements
Extruded basic profile	• J sections
may refer to:	• U sections (or channel sections)
	• L sections
Principles and main	• temperature control
elements of basic profile	• measuring devices and their functions
<i>design</i> may include:	• services
	• finishing treatments
	• wall thickness
	• die swell and draw down
	 back pressure
	• Dack pressure

- hollow sections
- sharp radius / edge
- elimination of stagnation points in flow channels
- progressive increase in velocity along the flow channel
- simple approach angles
- plate dies / button dies
- tuning of the die
- downstream processes





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ection C: Units of Competency	VU21985: Manage extrusion profile tool des
Relevant factors may	• product end-use
include:	aesthetic requirements
	• processing specifications, such as:
	• volume of run
	• environmental costs, such as:
	• waste minimisation
	• waste disposal
	• recycling
	 energy consumption
	• carbon abatement
Extruded advanced	• co-extrusion profiles
profile may refer to:	• other complex profiles , such as equipment that may change the initial profile, such as:
	• external corrugation over smooth pipe
	 complex shape of windscreen wiper blades
	• corflute (plastic cardboard)
Principles and main	• co-extrusion
<i>elements of advanced</i> <i>profile design</i> may include:	downstream equipment
prome design may moldae.	• profile gauge
	• die swell and draw down
	• back pressure
	hollow sections
	• sharp radius / edge
	• elimination of stagnation points in flow channels
	• progressive increase in velocity along the flow channel
	• simple approach angles
Production and design	large volume
requirements may include:	• mechanical and thermal properties of the material
	• part to production requirements
	• machine types
	• cost constraints
Faults may include:	• mechanical and physical performance of product
	stagnation points
	• restricted and uneven flow paths

• damaged surfaces



- weld lines associated with split flow paths
- surface quality and treatment
- thermal control and monitoring
- thermal degradation
- thickness variation

(Fault) *Prevention strategies* may include:

- careful initial evaluation of product requirements / specifications
- thorough analysis of the design constraints of different processes, materials and tools
- thorough and ongoing consultation with client / suppliers / other team members and stakeholders
- effective project management
- quality assurance procedures, including:
 - o design checklist
 - production checklist
 - failure minimisation
 - o zero defects methodology
 - process control
- description / definition / rationale
- outcomes and goal setting
- strategic planning
- resource requirements and allocation
- budget
- targets and milestones
- completion phases and timelines
- quality management policies and procedures
- personnel
- responsibilities
- accountabilities
- agreed reporting procedures
- communication strategies
- stakeholder engagement strategies, including critical consultation points
- monitoring and evaluation

Communication strategies may refer to:

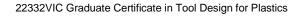
- team leadership
- consultative management
- participative management



Project management methodologies may refer to:

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- project evaluation •
- stakeholders engagement .
- critical consultation points, such as:
 - feedback to client on initial design brief as early as possible 0
 - consultation with all stakeholders to verify design 0
 - consultation with all stakeholders when establishing project 0 timeline
 - consultation with client to confirm decisions regarding: 0
 - _ design
 - materials
 - process _
 - equipment _
- briefing of all stakeholders of necessary changes to design in time to minimise cost and loss of time
- functionality and fitness for end-use .
- manufacturability •
- cost of production •
- environmental costs and impact of production .
- minimising product design complexity •
- utilisation of strategies to eliminate or minimise faults
- preliminary tool designs optimised by using melt flow and cooling Tool design requirements • analysis techniques
 - detailed drawings of tool assembly •
 - necessary dimensions and labels
 - necessary component drawings, such as:
 - manual drafting techniques 0
 - 0 Computer Aided Design (CAD)
 - necessary calculations
 - finishing for application ٠
 - shrinkage
 - tool specifications to achieve the product requirements
 - material \circ
 - equipment 0
 - finish 0
 - construction \cap
 - tool quotation form and design process cost estimate
 - project timeline





Critically evaluated may

refer to considerations of:

may refer to:

Material flow and

include:

temperature control may

- description of operation •
- analysis of material melt flow
- required parts list •
- completed tool design check list ٠
- stakeholder requirements •
- sustainability issues ٠
- raw materials and their possible limitations •
- Failure Mode and Effects Analysis (FMEA) •

steady state / isothermic flow •

- flow in an annulus •
- ٠ Newtonian and non-Newtonian (power law) fluids
- viscoelastic behaviour of the polymer melt ٠
- material suppliers' data •
- continuity equation ٠
- flow channels with variable height ٠
- isothermal flow in channels Newtonian and non-Newtonian fluids •
- regression equation •
- apparent viscosity •
- management ٠
 - colleagues
 - clients
 - customers
 - suppliers •
 - stakeholders
 - technical experts •
 - industry professionals •
 - planners ٠
- advisors
- consultants
- regulators



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Relevant people may include:

- - - .
 - •

 - •

EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment Guidelines for this Training Package.

Critical aspects for assessment and evidence required to demonstrate competency in this unit

Context of and specific

resources for assessment

A person who demonstrates competency in this unit must provide evidence of:

- managing extrusion tool design project for basic and advanced profile contexts
- determining prevention strategies for tool design faults
- evaluating project outcomes to inform future practice
- knowledge of principles and processes of extrusion tool design to meet plastics product design requirements

Assessment must ensure:

activities are related to a tool design for plastics context

Resources implications for assessment include:

- access to suitable simulated or real workplace opportunities
- access to a range of plastics products/parts and associated extrusion tooling
- access to material specification charts/data sheets
- access to Computer Aided Design and Tooling Design software

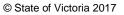
Method of assessment Guidance information for assessment (Optional) Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. Suggested units may include but are not limited to:

- VU21982: Implement plastics extrusion tool design
- VU21983: Manage extrusion sheet and film tool design
- VU21984: Manage extrusion pipe, tube and cable tool design



VU21986 Utilise 3D printing for plastic product manufacturing

Unit	Descriptor	tools / produc	nit describes the skills and knowledge required to design and fabricate tool parts by additive manufacturing processes (3D printing) for plastics t production. No licensing, legislative, regulatory or certification requirements			
			apply to this unit at the time of publication.			
Employability Skills		This unit contains Employability Skills.				
		The required outcomes described in this unit of competency contain applicable facets of Employability Skills. The Employability Skills Summary of the qualification in which this unit is included will assist in identifying employability skill requirements.				
Application of the Unit		This unit supports the work of designers, managers, leaders and project personnel who are responsible for the development of plastics products and the design and fabrication of tools for manufacturing. It has application across a broad range of plastics processing methodologies, such as: injection moulding; blow moulding, and/or extrusion. Practitioners are typically engaged in implementing tool design and tool fabrication strategies utilising additive manufacturing technologies.				
ELE	MENT	PERFORMANCE CRITERIA				
Elements describe the essential outcomes of a unit of competency.		Performance criteria describe the required performance needed to demonstrate achievement of the element. Where bold italicised text is used, further information is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.				
1	Analyse plastic product characteristics and production parameters	1.1	Design for <i>plastic product</i> is analysed to determine <i>tool requirements</i>			
		1.2	Production parameters are analysed to determine tool requirements			
		1.3	<i>Manufacture and assembly implications</i> are analysed to determine tool requirements			
2	Enhance plastic product design for manufacture	2.1	Alterations to plastic product design are recommended and communicated with <i>relevant people</i> to enable tool fabrication by <i>additive manufacturing technologies</i>			
		2.2	Agreed modifications are incorporated into product design			
3	Determine suitability of additive manufacturing for tool fabrication	3.1	Additive manufacturing technologies are analysed to determine suitability for <i>tool fabrication</i> for the production of plastic product			
		3.2	Additive manufacturing technology suitable for tool fabrication for the production of plastic product is selected			



- 4 Design tool for fabrication by additive manufacturing
- 4.1 **CAD software** is utilised to develop tool design from plastic product design
 - *Translation software* is utilised to prepare additive manufacturing4.2 machine files
 - Additive manufacturing machine parameters are confirmed
 - 4.3

5.1

5 Commission tool fabrication by additive manufacturing Additive manufacturing machine files are sent to in-house or external fabrication facility

Completed tool is *verified* to ensure compliance with product design and *specifications*



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REQUIRED SKILLS AND KNOWLEDGE

This describes the essential skills and knowledge and their level, required for this unit.

Required Skills:

- interpersonal skills to work with clients, colleagues, management and stakeholders either under direction, independently, or within a team
- leadership and interpersonal skills to communicate opportunities presented by emerging additive manufacturing processes in relation to tool fabrication
- leadership and organisational skills to manage implementation and evaluation of additive manufacturing processes of tool fabrication
- research and analytical skills to identify methodologies to achieve optimal tool fabrication
- strategic thinking skills to evaluate emerging additive manufacturing methodologies for application to specific project outcomes
- computer-aided design and drafting skills to develop, test and simulate tool designs
- calculation skills to determine tool requirements
- problem-solving skills to identify potential barriers to projected outcomes, analyse risks and establish prevention strategies
- analytical and evaluation skills to assess tool design and tool fabrication for plastics manufacturing and use results to inform future practice

Required Knowledge:

- behaviour and applications of polymer materials
- operating principles of plastics processing methods
- principles and processes of plastics product and tool design
- product design detailing
- implications of product design for tool design
- factors that affect decisions in the design process
- principles of design for manufacture and assembly
- capabilities and limitations of additive manufacturing technologies
- additive manufacturing file types, printing parameters, support requirements
- aspects of tool design; cooling, mounting
- risk management strategies
- quality procedures
- relevant Federal, State or Territory legislation and local government legislation, regulations and standards
- sustainability implications for tool design for plastics
- safe work practices



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 in the Performance Criteria is detailed below. Add any 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.

Plastic product	Products produced from polymer materials across a broad range of processing applications, such as: injection moulding; blow moulding, and/or extrusion, within the plastics industry.		
Tool requirements		ools or part tools required to form plastics products which may le details of:	
	•	gating methods, such as:	
		o standard gate	
		o valve gate	
		• edge gate	
		o fan gate	
		o submarine gate	
	•	taper / draft angles	
	•	cooling	
	•	ejection / release methods	
	•	tolerance / shrinkage	
	•	moveable cores	
	•	insert moulding	
	•	over moulding	
Production parameters may	•	production capacity	
refer to:		length of run / number of products	
	• size and complexity of product		

- process equipment available
- dimensional precision of product
- product simplification, such as:
- design for minimum number of parts
- competitive benchmarking of both local and global costs
- early and accurate costing of method of assembly, material, process and tooling to enable optimal design decisions
- updating of costs as tolerances, surface finishes and other part details are determined
- consultation on design, cycle times and costs with suppliers, customer and other stakeholders

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Manufacture and assembly

implications may include:

Relevant people may refer to:	• management	
	• colleagues	
	• clients	
	• customers	
	• suppliers	
	• stakeholders	
	technical experts	
	industry professionals	
	• planners	
	• advisors	
	• consultants	
	• regulators	
Additive manufacturing technologies may include:	Fused deposition modelling (FDM) or Fused filament fabrication (FFF), Electron-beam melting (EBM), Selective laser melting (SLM), Selective laser sintering (SLS), Direct metal laser sintering (DMLS), Directed Energy Deposition	
Tool fabrication	The creation of tools or part tools required to form plastics products which may include details of:	
	materialssurface finish	
CAD software	Computer Aided Design software	
Translation software	Software used to convert CAD files to files utilised by additive manufacturing equipment	
Additive manufacturing machine parameters	Machine settings	
Additive manufacturing machine files	Files utilised by additive manufacturing equipment	
In-house or external fabrication facility	Tooling may be fabricated in the facility where design has been undertaken or sent to a specialist additive manufacturing facility	
Verified	The completed tool is measured, scanned or in other ways checked to ensure specification is met	
Specifications may include	tolerances surface finish cooling attributes	

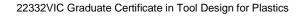


EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment Guidelines for this Training Package.

Critical aspects for assessment and evidence required to demonstrate competency in this unit	 A person who demonstrates competency in this unit must provide evidence of: knowledge of principles and process of plastics product design including design details and subsequent implications for manufacture, assembly, processing, materials and tool design working from designs for plastic products to develop appropriate tool design
	 selecting an additive manufacturing technology suitable for tool fabrication preparing CAD of tooling to enable fabrication by additive manufacturing technology verifying tool meets requirements
Context of and specific resources for assessment	Assessment must ensure:activities are related to a tool design for plastics context
	Resources implications for assessment include:
	 access to suitable simulated or real workplace opportunities access to a range of plastics products/parts and associated tool access to Computer Aided Design and Tool Design software
Method of assessment	A range of assessment methods should be used to assess practical skills and knowledge. The following assessment methods are appropriate for this unit:
	 evaluation of tools produced by additive manufacturing to produce plastics products
	• practical exercises, such as: Computer-Aided Design (CAD), tool fabrication
	• observation
	direct questioningpresentations
	 third party reports
Guidance information for assessment (Optional)	Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. Suggested units may include but are not limited to:

VU21973: Manage plastics tool design

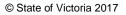




VU21987 Utilise 3D printing for plastic product prototyping

Uni	t Descriptor		it describes the skills and knowledge required to produce prototype products by additive manufacturing processes (3D printing).	
			No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.	
Employability Skills		This unit contains Employability Skills.		
		The required outcomes described in this unit of competency contain applicable facets of Employability Skills. The Employability Skills Summary of the qualification in which this unit is included will assist in identifying employability skill requirements.		
Application of the Unit		This unit supports the work of designers, managers, leaders and project personnel who are responsible for the development of plastics products. It has application across a broad range of plastics processing methodologies, such as: injection moulding; blow moulding, and/or extrusion. Practitioners are typically engaged in plastics product design utilising additive manufacturing technologies.		
EL	EMENT	PERF	FORMANCE CRITERIA	
Elements describe the essential outcomes of a unit of competency.		Performance criteria describe the required performance needed to demonstrate achievement of the element. Where bold italicised text is used, further information is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.		
1	Confirm product requirements	1.1	Product requirements are discussed with relevant people to confirm design parameters	
		1.2	Specifications are confirmed and documented according to organisational requirements	
		1.3	Product prototype is designed using CAD software	
		1.4	Product prototype design is reviewed with relevant people to ensure it meets specifications	
2	Determine suitability of additive manufacturing to produce product prototype	2.1	Additive manufacturing technologies are analysed to determine suitability	
		2.2	Additive manufacturing technology to produce product prototype is selected	
3	Prepare to produce product prototype by additive manufacturing	3.1	Translation software is utilised to prepare machine files	
		3.2	Additive manufacturing machine parameters are confirmed	

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- Additive manufacturing machine files are sent to in-house or Commission production of 4.1 4 external fabrication facility product prototype by additive manufacturing Completed prototype is *verified* to ensure compliance with product 4.2 design and specifications 5 Review product design 5.1 Product prototype is presented to relevant people 5.2 Required modifications are confirmed as required 5.3 Product design and specification are amended
 - 5.4 Amended prototype is produced
 - 5.5 Final design is confirmed and documented.





REQUIRED SKILLS AND KNOWLEDGE

This describes the essential skills and knowledge and their level, required for this unit.

Required Skills:

- interpersonal skills to work with clients, colleagues, management and stakeholders either under direction, independently, or within a team
- leadership and interpersonal skills to communicate opportunities presented by emerging additive manufacturing processes in relation to tool fabrication
- leadership and organisational skills to manage implementation and evaluation of additive manufacturing processes of tool fabrication
- research and analytical skills to identify methodologies to achieve optimal tool fabrication
- strategic thinking skills to evaluate emerging additive manufacturing methodologies for application to specific project outcomes
- computer-aided design and drafting skills to develop, test and simulate tool designs
- calculation skills to determine tool requirements
- problem-solving skills to identify potential barriers to projected outcomes, analyse risks and establish prevention strategies
- analytical and evaluation skills to assess tool design and tool fabrication for plastics manufacturing and use results to inform future practice

Required Knowledge:

- behaviour and applications of polymer materials
- operating principles of plastics processing methods
- principles and processes of plastics product and tool design
- product design detailing
- implications of product design for tool design
- factors that affect decisions in the design process
- principles of design for manufacture and assembly
- capabilities and limitations of additive manufacturing technologies
- additive manufacturing file types, printing parameters, support requirements
- aspects of tool design; cooling, mounting
- risk management strategies
- quality procedures
- relevant Federal, State or Territory legislation and local government legislation, regulations and standards
- sustainability implications for tool design for plastics
- safe work practices



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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 in the Performance Criteria is detailed below. Add any 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.

Product requirements may

Specifications may include:

Additive manufacturing

Translation software

Additive manufacturing

Additive manufacturing

machine parameters

In-house or external

fabrication facility

machine files

Verified

technologies may include:

Product prototype

CAD software

include:

Relevant people may refer to:

- management
- colleagues
- clients
- customers
- suppliers
- stakeholders
- technical experts
- industry professionals
- planners
- advisors
- consultants
- regulators
- tolerances, surface finish, cooling attributes
- a facsimile of the finished plastic product

Computer Aided Design software

Fused deposition modeling (FDM) or Fused filament fabrication (FFF), Composite Filament Fabrication (CFF), Stereolithography (SLA), Digital Light Processing (DLP), Powder bed and inkjet head 3D printing (3DP), Selective heat sintering (SHS)

Software used to convert CAD files to files utilised by additive manufacturing equipment

Machine settings

Files utilised by additive manufacturing equipment

Prototype may be fabricated in the facility where design has been undertaken or sent to a specialist additive manufacturing facility

The completed prototype is measured, scanned or in other way checked to ensure specification is met

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EVIDENCE GUIDE

The evidence guide provides advice on assessment and must be read in conjunction with the Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment Guidelines for this Training Package.

Critical aspects for assessment and evidence required to demonstrate competency in this unit	 A person who demonstrates competency in this unit must provide evidence of: working from a plastic product design to produce a prototype of the design utilising additive manufacturing technologies knowledge of principles and process of plastics product design including design details and subsequent implications for manufacture, assembly, processing, materials and tool design
Context of and specific resources for assessment	 Assessment must ensure: activities are related to design for plastics context resources implications for assessment include: access to suitable simulated or real workplace opportunities access to a range of plastics products/parts access to Computer Aided Design and additive manufacturing equipment
Method of assessment	 A range of assessment methods should be used to assess practical skills and knowledge. The following assessment methods are appropriate for this unit: evaluation of plastics product prototype that meets specific outcomes and that includes a range of distinctive features and design details practical exercises, such as: Computer-Aided Design (CAD) observation direct questioning presentations third party reports
Guidance information for assessment (Optional)	Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. Suggested units may include but are not limited to:

VU21973: Manage plastics tool design



