SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Occupation: Senior Engineer

Occupation Description:

The Senior Engineer plans, conducts and directs research and/or development work on complex projects, necessitating the origination and application of new and unique approaches. He/She also engages with internal and external parties in the design and development, costing and recommendations of new machinery and/or components.

He/She manages, trains and mentors a team of Engineers and/or Assistant Engineers. The Senior Engineer works in consultation with other department heads as an advisor of technologies which may lead to improvements in productivity and efficiency.

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

The skills expected of the Senior Engineer are summarised as below:

Skill Category	Skill Sub-Category	Skills	
Technical and Engineering Fundamentals	Numerical and Analysis Methods	**PRE-TEF-6037-1**	Apply Finite Element Method/Analysis to Analyse Manufacturing Problems
		PRE-TEF-6038-1	Review Advanced Metrology Systems to Determine Measurement Requirements
	Materials and Metallurgy	**PRE-TEF-6039-1**	Evaluate Characterisation of Advanced Materials to Determine Suitability of Materials for Manufacturing
		PRE-TEF-6040-1	Review Advanced Metal Heat Treatment Process to Determine Suitability of Treatment Process for Improving Characteristics
	Computer Technology	**PRE-TEF-6041-1**	Apply Computer-integrated Manufacturing to Support Precision Engineering Manufacturing Processes
		PRE-TEF-6042-1	Evaluate Embedded Systems to Apply in Manufacturing Systems
Technical and Engineering Design	Components and Modules	**PRE-TED-6016-1**	Evaluate New Product Designs for Manufacture and Assembly to Satisfy Project and Product Requirements
		PRE-TED-6017-1	Manage Product Design and Development to Satisfy Project and Product Requirements
	Machinery and Systems	**PRE-TED-6018-1**	Design Precision Machinery to Satisfy Manufacturing Requirements

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Skill Category	Skill Sub-Category	Skills	
Precision Manufacturing Processes	Machining Processes	**PRE-PMP-6066-1**	Evaluate and Apply Non-Traditional Machining Processes to Satisfy Precision Machining Requirements
		PRE-PMP-6067-1	Evaluate Machining Process Plan to Determine Appropriate Precision Machining Process for Manufacturing
	Forming Processes	**PRE-PMP-6068-1**	Evaluate Forming Process Plan to Determine Appropriate Forming Process for Manufacturing
		PRE-PMP-6069-1	Review Integrated Forming Process Technology for Metals to Optimise Forming Process
	Joining Processes	**PRE-PMP-6070-1**	Evaluate Application of Advanced Joining Processes to Enhance Joining Process for Manufacturing
		PRE-PMP-6071-1	Evaluate Application of Advanced Metal Welding Processes to Enhance Welding Process for Manufacturing
	Finishing Processes	**PRE-PMP-6072-1**	Evaluate Advanced Surface Coating Technologies to Satisfy Corrosion Prevention Requirements
		PRE-PMP-6073-1	Evaluate Component Cleaning Process Plan to Determine Appropriate Cleaning Process for Manufacturing
		PRE-PMP-6074-1	Evaluate Finishing Process Plan to Determine Appropriate Finishing Process for Manufacturing
Quality		**PRE-QUA-6016-1**	Integrate Quality Principles and Methodology into Manufacturing Processes to Enhance Engineering Performance

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Skill Category	Skill Sub-Category	Skills	
Value Engineering		**PRE-VEN-6002-1**	Evaluate Organisation's Value Stream to Reduce Waste
Additive Manufacturing		**PRE-AMA-6008-1**	Develop Integration Plan for Additive Manufacturing Processes to Satisfy Manufacturing Requirements
		PRE-AMA-6009-1	Review High Speed Additive Manufacturing Process to Determine Suitability of Manufacturing Metallic Components
		PRE-AMA-6010-1	Review Liquid-based Polymeric Additive Manufacturing to Determine Suitability of Manufacturing Components
Laser and Optics		**PRE-LOP-6006-1**	Develop Integration Plan for Advanced Optical Metrology Processes to Satisfy Manufacturing Requirements
Robotics and Automation		**PRE-RAU-6005-1**	Enhance Control Performance of Precision Machines to Satisfy Manufacturing Requirements
Manufacturing Productivity and Innovation		**PRE-MPI-6022-1**	Evaluate Organisation's Approach to Lean Enterprise to Enhance Competitiveness
		PRE-MPI-6023-1	Perform Virtual Modelling and Simulation to Achieve Manufacturing Productivity Improvements
Workplace Safety and Health		**PRE-WSH-4006-1**	Manage Workplace Safety and Health Systems
New Product Development		**PRE-NPD-6001-1**	Create Engineering Designs
		PRE-NPD-6002-1	Identify Engineering Design Requirements of Clients

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Skill Category	Skill Sub-Category	Skills	
Business Analytics		**PRE-BAN-6005-1**	Analyse Data and Identify Business Insights
Business Negotiation		**BM-BN-502E-1**	Manage Dispute Mediation
Change Management		**BM-CM-501E-1**	Direct End-to-End Change Management
Communication		**BM-COM-505E-1**	Resolve Conflicts with Stakeholders
Design Thinking		**PRE-DTH-6002-1**	Apply a Holistic User-centric Approach for Strategic Design Thinking
Human Resource Management		**PRE-HRM-6006-1**	Conduct Interviews and Make Hiring Decisions
Info-Communication Technologies		**PRE-ICT-5002-1**	Produce Advanced Spreadsheet Outputs using Spreadsheet Applications
Intellectual Property		**PRE-IPR-5001-1**	Apply Basic Knowledge of Intellectual Property (IP) to support IP-related Organisational Procedures
Leadership and People Management		**LPM-PER-501C-0**	Develop Self to Maintain Professional Competence at Senior Management Level
		LPM-RLT-501C-0	Foster Business Relationships and Organisational Diversity
Project Management		**BM-PM-505E-1**	Lead Programme and Project After Action Review

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Skill Category	Skill Sub-Category	Skills	
Strategy Planning and Implementation		**BM-SPI-509E-1**	Establish Business Strategies for the Business Function

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

<table>
<tr><td rowspan="2">Skill Code</td><td rowspan="2">PRE-TEF-6037-1</td><td>Skill Category</td><td>Technical and Engineering Fundamentals</td></tr>
<tr><td>Skill Sub-Category
(where applicable)</td><td>Numerical and Analysis Methods</td></tr>
<tr><td>Skill</td><td colspan="3">Apply Finite Element Method/Analysis to Analyse Manufacturing Problems</td></tr>
<tr><td>Skill Description</td><td colspan="3">This skill describes the ability to apply Finite Element Method/Analysis (FEM/FEA) to analyse manufacturing problems. It also includes leveraging on computing technologies to develop component models and applying FEM/FEA analysis to the effects of thermals and damping.</td></tr>
<tr><td>Knowledge and Analysis

It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.</td><td colspan="3">The ability to understand:

• Principles of precision engineering
• Principles of Computer-aided Design (CAD)
• Effects of thermodynamics
• Effects of structural damping
• Effects of dynamic loading
• Principles, application, types and limitations of Finite Element Method/Analysis (FEM/FEA)
• Concept of safety factors in FEM/FEA
• Engineering optimisation methods
• Multi-disciplinary Design Optimisation (MDO) approach
• Organisational and legislative requirements</td></tr>
<tr><td>Application and Adaptation

It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.</td><td colspan="3">The ability to:

• Perform CAD modelling in accordance to requirements
• Apply FEM/FEA to analyse the effects of thermodynamics on requirements
• Apply FEM/FEA to analyse the effects of structural damping on requirements
• Apply FEM/FEA to analyse the effects of dynamic loading on requirements
• Apply optimisation techniques to optimise manufacturing results</td></tr>
<tr><td>Innovation and Value Creation

It refers to the ability to generate purposive ideas to improve work</td><td colspan="3">The ability to:

• Perform analyses using MDO approach to improve manufacturing quality</td></tr>
</table>

performance and/or enhance business values that are aligned to organisational goals.	
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Communicate with customers, colleagues and teams to establish timeframes and requirements
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Engage in self-reflection on effectiveness of FEM/FEA optimisation processes on meeting requirements • Update own learning in FEM/FEA analysis by subscribing to diverse learning channels and participating in peer review platforms
Range of Application *(where applicable)* *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	Principles of precision engineering must include: • Advanced concepts of mechanics • Advanced concepts of thermodynamics • Advanced concepts of material science • Advanced concepts of engineering mathematics • Concepts of design and drafting • Concepts of computing and programming Applications of FEM/FEA in analysis must include: • Analysis of dynamic response (stress) • Analysis of heat transfer/ thermal distortion • Analysis of mechanical structural resonance frequencies and motional control bandwidth distinct frequency responses Organisational and legislative requirements must include: • Economics, environment requirements • Workplace Safety and Health Act

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Skill Code	PRE-TEF-6038-1	**Skill Category**	Technical and Engineering Fundamentals
		Skill Sub-Category *(where applicable)*	Numerical and Analysis Methods
Skill	Review Advanced Metrology Systems to Determine Measurement Requirements		
Skill Description	This skill describes the ability to review advanced measurement systems to achieve measurement requirements. This includes reviewing applications for scanning electron microscope, electron microprobe and atomic force microscopy technologies.		
Knowledge and Analysis *It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.*	The ability to understand: • Principles of precision engineering • Precision metrology technology • Principles and applications of scanning electron microscopes • Principles and applications of electron microprobes • Principles and applications of atomic force microscopy		
Application and Adaptation *It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.*	The ability to: • Analyse measurement requirements to determine need for advanced metrology systems • Review scanning electron microscope technology to evaluate suitability of application for meeting measurement requirements • Review electron microprobe technology to evaluate suitability of application for meeting measurement requirements • Review atomic force microscopy technology to evaluate suitability of application for meeting measurement requirements • Develop plans to implement advanced metrology systems in manufacturing processes to meet measurement requirements		
Innovation and Value Creation *It refers to the ability to generate*	The ability to: • Propose alternative methods of measurements in different situations to optimise measurement activities' value • Monitor and evaluate continuous improvement processes to identify		

purposive ideas to improve work performance and/or enhance business values that are aligned to organisational goals.	further refinements to measurement procedures and processes
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Deliver appropriate messages to metrology reports' target audiences, using appropriate presentation modes • Seek buy-in from relevant stakeholders on recommendations and plans for continuous improvement
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Reflect on previous measurements and incorporate learning points into next measurement task to ensure continuous improvement • Update own learning in advanced metrology by subscribing to diverse learning channels and participating in peer review platforms
Range of Application *(where applicable)* *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	Principles of precision engineering must include: • Advanced concepts of geometric error budgeting • Advanced concepts of calibration • Advanced concepts of measurements

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

<table>
<tr><td rowspan="2">Skill Code</td><td rowspan="2">PRE-TEF-6039-1</td><td>Skill Category</td><td>Technical and Engineering Fundamentals</td></tr>
<tr><td>Skill Sub-Category
(where applicable)</td><td>Material and Metallurgy</td></tr>
<tr><td>Skill</td><td colspan="3">Evaluate Characterisation of Advanced Materials to Determine Suitability of Materials for Manufacturing</td></tr>
<tr><td>Skill Description</td><td colspan="3">This skill describes the ability to characterise advanced materials and assess the suitability of metals for components. It also includes using different methods to characterise and assess materials.</td></tr>
<tr><td>Knowledge and Analysis

It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.</td><td colspan="3">The ability to understand:

• Principles of precision engineering
• Types, properties and applications of ceramics and transparent ceramics
• Types, properties and applications of Advanced Composite Materials (AMC)
• Types, properties and applications of superalloys
• Types, properties and applications of biomaterials, liquid crystals and liquid-crystal polymers
• Methods for measuring mechanical properties
• Methods for measuring thermal properties
• Methods for measuring optical properties
• Methods for measuring chemical properties, corrosion and microstructure characteristics
• Methods to relate material property measurements to component requirements</td></tr>
<tr><td>Application and Adaptation

It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.</td><td colspan="3">The ability to:

• Review the required properties of components to shortlist the range of advanced materials that can meet the requirements
• Select appropriate methods and instruments to measure mechanical and electrical properties
• Select appropriate methods and instruments to measure thermal properties
• Select appropriate methods and instruments to measure optical properties
• Select appropriate methods and instruments to measure chemical properties, corrosion and microstructure characteristics
• Perform measurements to analyse and determine characteristics
• Assess the suitability of materials in accordance to requirements</td></tr>
</table>

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Innovation and Value Creation *It refers to the ability to generate purposive ideas to improve work performance and/or enhance business values that are aligned to organisational goals.*	The ability to: • Apply systematic approaches to materials characterisation processes, to facilitate knowledge management and optimisation
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Communicate with customers, colleagues and teams to establish timeframes and requirements
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Plan material characterisation tasks with intention to learn and reflect after the task by monitoring comprehension and evaluating progress while carrying out task • Engage in self-reflection to review resources spent, and accuracy of measurements and material assessment • Update own learning in material science and measuring technologies by subscribing to diverse learning channels and participating in peer review platforms
Range of Application *(where applicable)* *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	Principles of precision engineering must include: • Advanced concepts of material science • Advanced concepts of mechanics • Advanced concepts of thermodynamics • Advanced concepts of optics and wave theory • Advanced concepts of measurements Types of AMCs must include: • Metal matrix composites

	• Polymer matrix composites • Ceramic matrix composites Properties of materials must include: • Mechanical properties • Electrical properties • Thermal properties • Optical properties • Chemical properties and microstructure characteristics • Corrosion characteristics Methods of measurement must include: • X-ray diffraction and fluorescence techniques • Scanning electron microscopy • Energy dispersive spectroscopy

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Skill Code	PRE-TEF-6040-1	**Skill Category**	Technical and Engineering Fundamentals
		Skill Sub-Category *(where applicable)*	Material and Metallurgy
Skill	Review Advanced Metal Heat Treatment Process to Determine Suitability of Treatment Process for Improving Characteristics		
Skill Description	This skill describes the ability to review advanced heat treatment processes. It also includes applying computational analyses on heat treatment processes.		
Knowledge and Analysis *It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.*	The ability to understand: • Principles of precision engineering • Concepts and techniques of heat treatment processes • Principles, application, types and limitations of finite element heat treatment simulation and analysis • Concepts and techniques of weldment heat treatment processes • Relationships between distortion and material parameters after heat treatment • Methods to analyse and minimise distortion • Organisational and legislative requirements		
Application and Adaptation *It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.*	The ability to: • Review the required properties of components to shortlist the range of materials and heat treatment processes that can meet requirements • Perform theoretical analysis on the effects of heat treatment processes • Perform finite element simulations and analysis on the effects of heat treatment processes • Perform analysis on the effects of heat treatment on weldments • Select the optimal materials and heat treatment processes to meet the component properties requirements • Report on selected materials and heat treatment processes used to meet the components' properties requirements, including economics, environment and safety considerations		
Innovation and Value Creation *It refers to the ability to generate purposive ideas to*	The ability to: • Evaluate and refine parameters of heat treatment processes using advanced metrology to improve component properties		

improve work performance and/or enhance business values that are aligned to organisational goals.	
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Communicate with customers, colleagues and teams to establish timeframes and requirements
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Engage in self-reflection on effectiveness of alternative heat treatment processes • Update own learning in advanced heat treatment technologies by subscribing to diverse learning channels and participating in peer review platforms • Reflect and collaboratively establish knowledge and skills gaps of engineering team in heat treatment, and coach team members to improve team capabilities in heat treatment processes
Range of Application *(where applicable)* *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	Principles of precision engineering must include: • Advanced concepts of mechanics • Advanced concepts of thermodynamics • Advanced concepts of material science • Advanced concepts of design and drafting • Concepts of computing and programming • Advanced concepts of measurements Advanced heat treatment processes must include: • Laser hardening • Induction hardening • Vacuum heat treatment • Vacuum carburizing • Pre-nit-carburizing

	Heat Treatment of weldments must include: • Pre- and post-welding heat treatments • Cryogenic treatments • Sintering • Furnace brazing • Shot peening • Hydrogen annealing • Stress relieving Minimising distortion must include: • Parameters of furnaces • Parameters of distortion Computational analysis must include: • Finite element modelling • DEFORM simulation Organisational and legislative requirements must include: • Economics, environment requirements • Workplace Safety and Health Act

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

<table>
<tr><td rowspan="2">Skill Code</td><td rowspan="2">PRE-TEF-6041-1</td><td>Skill Category</td><td>Technical and Engineering Fundamentals</td></tr>
<tr><td>Skill Sub-Category
(where applicable)</td><td>Computer Technology</td></tr>
<tr><td>Skill</td><td colspan="3">Apply Computer-integrated Manufacturing to Support Precision Engineering Manufacturing Processes</td></tr>
<tr><td>Skill Description</td><td colspan="3">This skill describes the ability to implement Computer-integrated Manufacturing (CIM) technology to support precision engineering manufacturing processes. It also includes the integration of CIM into Manufacturing Execution Systems (MES).</td></tr>
<tr><td>Knowledge and Analysis

It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.</td><td colspan="3">The ability to understand:

• Principles of precision engineering
• Manufacturing objectives, operations and challenges
• Basic components, architecture and functionalities of Computer-integrated Manufacturing (CIM) system
• Manufacturing production and product tracking methodologies
• Manufacturing and product quality control techniques
• Manufacturing automation technologies
• Supporting applications of CIM
• Supporting hardware systems supporting CIM operations
• ID technologies to CIM
• CIM IT systems architecture and software
• Software programming languages
• Interactions between hardware and software components of CIM systems with Manufacturing Execution Systems (MES)
• Industry safety and sustainability guidelines</td></tr>
<tr><td>Application and Adaptation

It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.</td><td colspan="3">The ability to:

• Perform reviews of organisational manufacturing objectives, operations and challenges to identify areas suitable for CIM implementation
• Perform analyses on organisational manufacturing operations to determine appropriate production and product tracking methodologies
• Perform analyses on organisational manufacturing operations to determine appropriate manufacturing and product quality control techniques for maintaining and achieving continuous quality improvements
• Perform analyses on organisational manufacturing operations to determine appropriate automation technology to improve quality and productivity</td></tr>
</table>

	• Implement supporting applications of CIM, based on requirements of organisational manufacturing operations, for tracking, quality control and automation • Implement supporting hardware systems supporting CIM operations based on requirements of organisational manufacturing operations for tracking, quality control and automation • Implement ID technologies to CIM, based on requirements of organisational manufacturing operations, for tracking, quality control and automation • Implement CIM IT systems and software, based on requirements of organisational manufacturing operations, for tracking, quality control and automation • Perform software programming to enable CIM system operationalisation • Integrate respective hardware and software components of CIM systems with MES
Innovation and Value Creation *It refers to the ability to generate purposive ideas to improve work performance and/or enhance business values that are aligned to organisational goals.*	The ability to: • Perform analyses on interactions between hardware and software components of CIM systems to further improve integration and productivity • Review emerging sensor and network technologies for integration into CIM systems to improve responsiveness
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Communicate with customers, colleagues and teams to establish timeframes and requirements • Select hardware and software components of CIM systems in consideration of safety and sustainability guidelines
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Engage in self-reflection to explore alternative CIM technology solutions • Update own learning in CIM technology by subscribing to diverse learning channels and participating in peer review platforms

	• Reflect and collaboratively establish knowledge and skills gaps of engineering team in computer technology, and coach team members to improve team capabilities in computer technology
Range of Application *(where applicable)* *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	Principles of precision engineering must include: • Advanced concepts of mechanics and mechatronics • Advanced concepts of electricity and magnetism • Concepts of thermodynamics • Concepts of fluids and fluid dynamics • Concepts of optics and wave theory • Advanced concepts of engineering mathematics • Concepts of design and drafting • Advanced concepts of control systems • Concepts of computing and programming • Concepts of calibration • Concepts of measurements Supporting applications of CIM must include: • Expert • Knowledge base • Artificial intelligence • Scheduling systems ID technologies to CIM must include: • Bar-coding • Optical character reader(OCR) • RFID CIM system architecture must include: • ISA95 • SEMI framework • Computer Integrated Manufacturing Open System Architecture (CIMOSA) IT system and software programming languages must include: • Networking, client/server, multi-tier, load balancing, high availability, high reliability, system performance

	• OSI/ MAP/ TOP, database, DBMS, PLC programming, SQL, XML, application/UI development languages, API, SOA SECS/ GEMS Organisational and industry safety and sustainability guidelines must include: • Organisational safety rules for operating the CIM system • CIM system manufacturers' safety rules for operating the CIM system • Workplace Safety and Health Act

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

<table>
<tr><td rowspan="2">Skill Code</td><td rowspan="2">PRE-TEF-6042-1</td><td>Skill Category</td><td>Technical and Engineering Fundamentals</td></tr>
<tr><td>Skill Sub-Category
(where applicable)</td><td>Computer Technology</td></tr>
<tr><td>Skill</td><td colspan="3">Evaluate Embedded Systems to Apply in Manufacturing Systems</td></tr>
<tr><td>Skill Description</td><td colspan="3">This skill describes the ability to evaluate embedded systems, and their characteristics, to make decisions regarding selection of processing elements and hardware. It also includes evaluating the design of safe and adaptive controllers to increase the autonomy of systems that operate in unstructured environments.</td></tr>
<tr><td>Knowledge and Analysis

It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.</td><td colspan="3">The ability to understand:

• Principles of precision engineering
• Applications and characteristics of embedded systems
• Processing elements used in embedded systems
• Advantages and limitations of processing elements
• Requirements of sensors for different applications
• Requirements of actuators used in different applications
• Aspects of machine intelligence used in embedded systems
• Interfaces between different embedded systems
• Characteristics of software architecture and operating systems used in embedded systems
• Organisational and legislative requirements</td></tr>
<tr><td>Application and Adaptation

It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.</td><td colspan="3">The ability to:

• Perform analyses on manufacturing system control requirements, and shortlist appropriate embedded systems
• Perform analyses to classify embedded systems, with regard to their operation and scheduling functions, for selection to meet manufacturing system requirements
• Evaluate needs, and appraise embedded intelligence systems, for used in embedded systems
• Evaluate interacting embedded systems, within manufacturing systems, for compatibility
• Evaluate characteristics of embedded system software architecture
• Evaluate and characterise man-machine user interface methods
• Review characteristics of selected embedded systems and software architecture to determine selection of embedded systems for application</td></tr>
</table>

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Innovation and Value Creation *It refers to the ability to generate purposive ideas to improve work performance and/or enhance business values that are aligned to organisational goals.*	The ability to: • Evaluate applications of 'Internet of Things' principles for embedded systems in manufacturing, to improve productivity
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Communicate with customers, colleagues and teams to establish timeframes and requirements
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Engage in self-reflection to review necessity and costs of all controls performed by embedded systems • Update own learning in embedded systems by subscribing to diverse learning channels and participating in peer review platforms • Reflect and collaboratively establish knowledge and skills gaps of engineering teams in computer technology, and coach team members to improve team capabilities in computer technology
Range of Application *(where applicable)* *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	Principles of precision engineering must include: • Advanced concepts of mechanics and mechatronics • Advanced concepts of control systems • Concepts of computing and programming Characteristics of embedded systems must include: • User interfaces • Processing elements • Type of peripherals, sensors, actuators • Tools

	• Debugging methods • Reliability • High versus low volume Machine intelligence reflection must include: • Operational performance • Usage load • Environmental conditions Characteristics of software architecture must include: • Simple control loops • Interrupt-controlled systems • Cooperative multitasking • Pre-emptive multitasking or multi-threading Organisational and legislative requirements include: • Economics, environment requirements • Workplace Safety and Health Act

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

<table>
<tr><td rowspan="2">Skill Code</td><td rowspan="2">PRE-TED-6016-1</td><td>Skill Category</td><td>Technical and Engineering Design</td></tr>
<tr><td>Skill Sub-Category
(where applicable)</td><td>Components and Modules</td></tr>
<tr><td>Skill</td><td colspan="3">Evaluate New Product Designs for Manufacture and Assembly to Satisfy Project and Product Requirements</td></tr>
<tr><td>Skill Description</td><td colspan="3">This skill describes the ability to review and evaluate build plans for the manufacture and assembly of new product designs, using systematic approaches to design. It also includes evaluation of design practicality.</td></tr>
<tr><td>Knowledge and Analysis

It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.</td><td colspan="3">The ability to understand:

• Principles of precision engineering
• Types of manufacturing processes
• Components and parts design
• Principle of design rules
• Product and process design for easy assembly
• Design for easy assembly
• Design of assembly systems</td></tr>
<tr><td>Application and Adaptation

It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.</td><td colspan="3">The ability to:

• Review engineering components’ build plans for structural integrity and Design for Manufacturing and Assembly (DFMA)
• Evaluate material selection, in accordance with DFMA principles
• Evaluate machining plans, in accordance with DFMA principles
• Evaluate assembly plans, in accordance with DFMA principles
• Formulate and propose engineering solutions to deal with complex and/or vaguely defined design tasks
• Submit full evaluation reports on whether the engineering design meet functional requirements</td></tr>
<tr><td>Innovation and Value Creation

It refers to the ability to generate purposive ideas to improve work performance and/or enhance business</td><td colspan="3">The ability to:

• Reduce production costs by analysing, and eliminating, factors that affect time, cost, and quality of manufacturing, assembly and service processes</td></tr>
</table>

values that are aligned to organisational goals.	
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Coach teams on the concepts and principles of DFMA, considering efficiency in costs and quality, managing variability and integrating design with downstream manufacturing operations
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Review international best practices used in manufacturing and assembly processes to improve own knowledge
Range of Application *(where applicable)* *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	Principles of precision engineering must include: • Advanced concepts of mechanics • Advanced concepts of material science • Advanced concepts of design and drafting • Advanced concepts of control systems Product and process design for easy assembly must include: • Assembly tasks, methods and systems • Rules and axioms for the design of components for ease of assembly • Rules and axioms for the design of assembly processes Design for Easy Assembly must include: • Techniques and methods to assure fool-proof assembly • Design for effective manual assembly • DFMA methodology to assess ease of manual assembly • Boothroyd-Dewhurst analysis methods Design of assembly systems must include: • Design for high speed automatic assembly

	• Principle of balancing an assembly line for equitable task allocation • Parts feeding and orienting • Vibratory and non-vibratory orienting devices • Escapements • Robotic assembly

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

<table>
<tr><td rowspan="2">Skill Code</td><td rowspan="2">PRE-TED-6017-1</td><td>Skill Category</td><td>Technical and Engineering Design</td></tr>
<tr><td>Skill Sub-Category
(where applicable)</td><td>Components and Modules</td></tr>
<tr><td>Skill</td><td colspan="3">Manage Product Design and Development to Satisfy Project and Product Requirements</td></tr>
<tr><td>Skill Description</td><td colspan="3">This skill describes the ability to evaluate engineering designs in accordance with functional requirements. It also includes establishing criteria for evaluation and presenting the evaluation results along with recommendations.</td></tr>
<tr><td>Knowledge and Analysis

It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.</td><td colspan="3">The ability to understand:

• Principles of precision engineering
• Process of product development
• Management of effective design
• Relationship between tangible product and brand
• Management of creativity
• Processes of concurrent engineering
• Types of organisation style for effective product design and development
• Fundamentals of intellectual property rights
• Type of tools, techniques, and technologies, including concept generation and selection
• Design for assembly/manufacture life cycle costing
• Principles of design to cost design validation
• Management of innovative products</td></tr>
<tr><td>Application and Adaptation

It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.</td><td colspan="3">The ability to:

• Identify and define the roles of product design and development processes in the manufacturing industry
• Define the components of product design and development processes, and their relationships, from concept to customer
• Establish design management processes and effective customer satisfaction through innovation
• Evaluate methodical approaches to the management of product development
• Review the differentiating approaches between the important methods, technologies, latest trends, tools and techniques of product design and development and their effective utilisation</td></tr>
</table>

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Innovation and Value Creation *It refers to the ability to generate purposive ideas to improve work performance and/or enhance business values that are aligned to organisational goals.*	The ability to: • Conduct costs of quality analyses related to the products, and identify areas for improvement, in accordance with organisational quality system requirements
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Collaborate with stakeholders to identify, discuss and develop effective ways of working
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Monitor emerging incidences of innovative design, to discern trends for incorporation into pro-active strategies • Update own learning in product development by subscribing to diverse learning channels and participating in peer review platforms
Range of Application *(where applicable)* *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	Principles of precision engineering must include: • Advanced concepts of mechanics and mechatronics • Advanced concepts of thermodynamics • Advanced concepts of material science • Advanced concepts of engineering mathematics • Advanced concepts of design and drafting • Advanced concepts of control systems • Concepts of computing and programming • Advanced concepts of calibration • Advanced concepts of measurements

	Product design and development processes in the manufacturing industry must include: • Importance of design • Overview of design • Kano model • Factors to consider in design • Quality function deployment Components of product design and development processes, and their relationships, from concept to customer must include: • Product design considerations • New product introduction process • Key activities in a design process • Product introduction process • Business evaluation for - Engineering components Evaluating a methodical approach to the management of product development must include: • Brand and its importance • Product branding, organisational branding • Re-branding. • Benefits of a successful brand

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

<table>
<tr><td rowspan="2">Skill Code</td><td rowspan="2">PRE-TED-6018-1</td><td>Skill Category</td><td>Technical and Engineering Design</td></tr>
<tr><td>Skill Sub-Category
(where applicable)</td><td>Machinery and Systems</td></tr>
<tr><td>Skill</td><td colspan="3">Design Precision Machinery to Satisfy Manufacturing Requirements</td></tr>
<tr><td>Skill Description</td><td colspan="3">This skill describes the ability to apply engineering design principles to design equipment and products of higher precision, accuracy and reliability. It also includes application of the key mechanical components and practical design and analytical approaches for machine structures and precisions mechanisms.</td></tr>
<tr><td>Knowledge and Analysis

It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.</td><td colspan="3">The ability to understand:

• Principles of precision engineering
• Concepts of precision machine design
• Principles of precision machine design
• Concepts of exact constrains and over-constraints
• Principles of elastic averaging and Herzian stress
• Types of materials for precision machine structures
• Characteristics of rotary and linear bearings
• Characteristics of couplings
• Characteristics of gears and gear transmissions
• Characteristics of linear drives
• Principles of guideway design to achieve precision linear motion
• Types of guideway systems and their characteristics
• Concepts of degrees of freedom for planar linkage mechanisms
• Kinematic design procedures of linkage mechanisms
• Performance characteristics of flexure-based mechanisms
• Design procedures of flexure mechanisms
• Homogeneous Transformation Matrix (HTM) model of a machine
• Combinational rules of errors</td></tr>
<tr><td>Application and Adaptation

It refers to the ability to perform the work tasks and activities required of the occupation, and the</td><td colspan="3">The ability to:

• Perform analyses to determine precision machine requirement performance of required operations
• Perform performance specification analyses on selection of sensors and actuators
• Perform performance specification analyses on selection of automation control system</td></tr>
</table>

ability to react to and manage the changes at work.	• Perform performance specification analyses on selection of electrical system • Perform performance specification analyses on selection of human machine interface system • Design system integration for selected components in accordance to precision machine requirements • Report on the selected components used to meet the machine system requirements, including economics, environment and safety considerations • Develop machine design specification drawings
Innovation and Value Creation *It refers to the ability to generate purposive ideas to improve work performance and/or enhance business values that are aligned to organisational goals.*	The ability to: • Suggest modifications to existing systems and develop new and/or alternative systems to improve performance
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Communicate with customers, colleagues and teams to establish timeframes and design requirements
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Update own learning in precision machine design by subscribing to diverse learning channels and participating in peer review platforms • Monitor past designs of precision machines to discern trends to incorporate into pro-active design strategies

Range of Application *(where applicable)* *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	Principles of precision engineering must include: • Advanced concepts of mechanics and mechatronics • Advanced concepts of electricity and magnetism • Advanced concepts of thermodynamics • Advanced concepts of material science • Advanced concepts of engineering mathematics • Advanced concepts of design and drafting • Advanced concepts of control systems • Concepts of computing and programming • Advanced concepts of geometric error budgeting • Advanced concepts of calibration • Advanced concepts of measurements

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Skill Code	PRE-PMP-6066-1	**Skill Category**	Precision Manufacturing Processes
		Skill Sub-Category *(where applicable)*	Machining Processes
Skill	Evaluate and Apply Non-Traditional Machining Processes to Satisfy Precision Machining Requirements		
Skill Description	This skill describes the ability to evaluate non-traditional machining processes to produce components in accordance to specifications. It also includes evaluating non-traditional finishing of metals.		
Knowledge and Analysis *It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.*	The ability to understand: • Principles of precision engineering • Principles of metal cutting and machining behaviour • Metal machining mechanics and characterisations • Stable and chatter conditions and stability lobes • Types of unbalances and methodologies of balancing • Principles of laser cutting and drilling, processes and applications • Surface roughness and its measurement • Machining accuracy and efficiency • Grinding heat generation, major effects and coolant functions • Abrasion and abrasive tools, wheel wear mechanism and topography characterisation • Lapping and polishing principles and methods • Types of media finishing processes and their processing characteristics • Flexible automation methods • Organisational and legislative requirements		
Application and Adaptation *It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.*	The ability to: • Perform analyses on functional requirements of high-performance alloy components and shortlist machining processes • Perform analyses on characteristics of cutting tools for precision machining applications • Perform analyses on laser cutting and drilling processes to assess suitability for finishing high-performance alloy components • Perform analyses on abrasion properties and characteristics of abrasive tools and grinding systems • Perform analyses on lapping and polishing mechanisms to determine appropriate lapping and polishing equipment		

	• Determine media finishing for freeform surfaces and hard-to-reach surfaces • Evaluate the effects of grinding heat and wheel wear on components • Review automation methods for materials removal
Innovation and Value Creation *It refers to the ability to generate purposive ideas to improve work performance and/or enhance business values that are aligned to organisational goals.*	The ability to: • Perform productivity review on selected cutting and finishing processes
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • The ability to discuss with customers, colleagues and team to assist in establishing timeframes and requirements
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Engage in self-reflection to review effectiveness of machining process • Update own learning in advanced metal precision machining by subscribing to diverse learning channels and participating in peer review platforms
Range of Application *(where applicable)* *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	Principles of precision engineering must include: • Advanced concepts of mechanics and mechatronics • Advanced concepts of electricity and magnetism • Advanced concepts of thermodynamics • Advanced concepts of optics • Advanced concepts of material science • Advanced concepts of control systems • Advanced concepts of measurements

	Principles of metal cutting and machining behaviour must include: • Types of cutting tools, tool materials and tool wear and failure characteristics • Machining dynamics • High speed machining • Fixturing and machining simulation Non-traditional finishings must include: • Abrasive media finishing (abrasive flow machining, vibratory finishing and magnetic field-assisted finishing) • Laser cutting and drilling • Electrical discharge machining (EDM) Organisational and legislative requirements must include: • Economics, environment requirements • Workplace Safety and Health Act

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Skill Code	PRE-PMP-6067-1	**Skill Category**	Precision Manufacturing Processes
		Skill Sub-Category *(where applicable)*	Machining Processes
Skill	Evaluate Machining Process Plan to Determine Appropriate Precision Machining Process for Manufacturing		
Skill Description	This skill describes the ability to evaluate and optimise machining parameters and process plans for materials used in mould, tool-making and precision component manufacturing to achieve the optimum required product specifications. It also includes evaluation of quality control procedures.		
Knowledge and Analysis *It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.*	The ability to understand: • Principles of precision engineering • Methods and tools for evaluating the engineering process • Evaluation criteria for engineering processes • Types and impact of recommendations on engineering processes • Organisational and legislative requirements		
Application and Adaptation *It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.*	The ability to: • Evaluate machining process objectives, in accordance to workplace procedures and legislative requirements • Evaluate machining process plans, in accordance with workplace procedures • Review and evaluate proposals on the selection of unnecessary processes toeliminate, in accordance with workplace procedures • Evaluate quality control procedures on the aspects of quality and compliance to regulatory requirement		
Innovation and Value Creation *It refers to the ability to generate purposive ideas to improve work*	The ability to: • Analyse and propose opportunities of improved machining approaches in workplace		

performance and/or enhance business values that are aligned to organisational goals.	
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Explain the evaluation criteria to team members • Communicate the improved work processes to relevant stakeholders
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Keep abreast of new methods or processes, which may potentially lead to reduction in costs • Update own learning in machining processes by subscribing to diverse learning channels and participating in peer review platforms
Range of Application *(where applicable)* *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	Principles of precision engineering must include: • Advanced concepts of mechanics and mechatronics • Advanced concepts of electricity and magnetism • Advanced concepts of thermodynamics • Advanced concepts of material science • Advanced concepts of engineering mathematics • Advanced concepts of design and drafting • Advanced concepts of control systems • Concepts of computing and programming • Advanced concepts of geometric error budgeting • Advanced concepts of calibration • Advanced concepts of measurements Evaluating engineering processes must include evaluation of the following: • Standard operating procedures and work instructions • Process and quality control and assurance documentation • Organisation documentation • IT systems

	Organisational and legislative requirements must include: • Economics, environment requirements • Workplace Safety and Health Act

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

<table>
<tr><td rowspan="2">Skill Code</td><td rowspan="2">PRE-PMP-6068-1</td><td>Skill Category</td><td>Precision Manufacturing Processes</td></tr>
<tr><td>Skill Sub-Category
(where applicable)</td><td>Forming Processes</td></tr>
<tr><td>Skill</td><td colspan="3">Evaluate Forming Process Plan to Determine Appropriate Forming Process for Manufacturing</td></tr>
<tr><td>Skill Description</td><td colspan="3">This skill describes the ability to evaluate and optimise applications of different advanced forming methodologies for materials used in precision manufacturing, to achieve the optimum required shape in accordance with design specifications. It also includes cost analyses.</td></tr>
<tr><td>Knowledge and Analysis

It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.</td><td colspan="3">The ability to understand:

• Principles of precision engineering
• Methods and tools for evaluating the engineering process
• Evaluation criteria for engineering processes
• Types and impact of recommendations on engineering processes
• Organisational and legislative requirements</td></tr>
<tr><td>Application and Adaptation

It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.</td><td colspan="3">The ability to:

• Evaluate methods of analysis on finishing requirements, in accordance with design specifications
• Review selections of finishing processes to suit application requirements
• Evaluate selections of finishing applications, in accordance with design specifications
• Evaluate finishing process plans for particular applications
• Evaluate quality control procedures to address aspects of product quality and compliance to regulatory requirements
• Submit full evaluation reports on whether the engineering process plans meet functional requirements</td></tr>
<tr><td>Innovation and Value Creation

It refers to the ability to generate</td><td colspan="3">The ability to:

• Analyse and propose opportunities of improved forming approaches in workplace</td></tr>
</table>

purposive ideas to improve work performance and/or enhance business values that are aligned to organisational goals.	
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Explain the evaluation criteria to team members Communicate the improved work processes to relevant stakeholders in accordance with organisational procedures
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Keep abreast of new methods or processes which may potentially lead to reduction in costs. • Update own learning in forming engineering by subscribing to diverse learning channels and participating in peer review platforms
Range of Application *(where applicable)* *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	Principles of precision engineering must include: • Advanced concepts of mechanics and mechatronics • Advanced concepts of electricity and magnetism • Advanced concepts of thermodynamics • Advanced concepts of material science • Advanced concepts of engineering mathematics • Advanced concepts of design and drafting • Advanced concepts of control systems • Concepts of computing and programming • Advanced concepts of geometric error budgeting • Advanced concepts of calibration • Advanced concepts of measurements Evaluating engineering processes include evaluation of the following • Standard operating procedures and work instructions • Process and quality control or assurance documentation • Organisation documentation • IT system s

	Organisational and legislative requirements must include: • Economics, environment requirements • Workplace Safety and Health Act

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

<table>
<tr><td rowspan="2">Skill Code</td><td rowspan="2">PRE-PMP-6069-1</td><td>Skill Category</td><td>Precision Manufacturing Processes</td></tr>
<tr><td>Skill Sub-Category
(where applicable)</td><td>Forming Processes</td></tr>
<tr><td>Skill</td><td colspan="3">Review Integrated Forming Process Technology for Metals to Optimise Forming Process</td></tr>
<tr><td>Skill Description</td><td colspan="3">This skill describes the ability to review applications of basic metal forming process simulations, process and tooling designs for high strength and light weight alloys. It also includes integrated forming process technology for metals for manufacturing of high performance parts.</td></tr>
<tr><td>Knowledge and Analysis

It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.</td><td colspan="3">The ability to understand:

• Concepts and characteristics of typical bulk forming processes
• Characteristics of material deformation
• Types and characteristics of cold forging
• Critical process parameters and design guidelines for the cold forging process
• Types of defects related to forming modes
• Procedures for designing spin forming processes and the basics of design concepts to pre-form, tooling and roller
• Cold forging process and tooling for performing cold forging
• Concepts of different sheet metal forming processes, strengths and typical processing routes
• Design guidelines for sheet metal forming processes
• Basics of bending-based processes and their limitations
• Reasons of spring back in sheet metal forming
• Basics of stamping processes and their limitations
• Basics of deep drawing processes and their limitations
• Strategy of forming using combined stamping and forging technology
• Concepts of finite element methods applied to metal forming processes
• Material failure mechanisms and mechanical testing methods
• Organisational and legislative requirements</td></tr>
<tr><td>Application and Adaptation

It refers to the ability to perform the work tasks and activities required of the occupation, and the</td><td colspan="3">The ability to:

• Develop manufacturing plans for bulk forming processes, based on selected materials and product shapes
• Develop manufacturing plans for the process parameters and tooling required for forming processes
• Perform material testing post-manufacturing processes, using</td></tr>
</table>

ability to react to and manage the changes at work.	approved defect control plans • Review failed processes and perform corrective actions • Submit full evaluation reports on whether engineering process plans meet functional requirements
Innovation and Value Creation *It refers to the ability to generate purposive ideas to improve work performance and/or enhance business values that are aligned to organisational goals.*	The ability to: • Perform analyses on applications of different forming processes to achieve the most effective results
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Communicate with customers, colleagues and teams to assist in establishing timeframes and requirements
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Update own learning in material forming processes by subscribing to diverse learning channels and participating in peer review platforms • Engage in self-reflection to review effectiveness of corrective actions
Range of Application *(where applicable)* *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	Forming process must include: • Cold forging operations • Spin forming • Sheet metal forming • Bending and roll forming • Stamping and deep drawing processes Defect control must include: • Analysing metal forming defects

	• Identifying the source of defects • Preventing the defects in forming processes • Metal forming of defect free parts Design in forming must include: • Process selection guidelines • Design of forming process • Mechanical testing for obtaining material properties • Friction tests Simulation in casting must include: • Analysing simulation results • Application of forming simulation in real work Organisational and legislative requirements must include: • Economics, environment requirements • Workplace Safety and Health Act

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

<table>
<tr><td rowspan="2">Skill Code</td><td rowspan="2">PRE-PMP-6070-1</td><td>Skill Category</td><td>Precision Manufacturing Processes</td></tr>
<tr><td>Skill Sub-Category
(where applicable)</td><td>Joining Processes</td></tr>
<tr><td>Skill</td><td colspan="3">Evaluate Application of Advanced Joining Processes to Enhance Joining Process for Manufacturing</td></tr>
<tr><td>Skill Description</td><td colspan="3">This skill describes the ability to evaluate and optimise applications of different joining methodologies for materials used in precision manufacturing to achieve the optimum required shape, in accordance with design specifications. It also includes quality control procedures for joining processes.</td></tr>
<tr><td>Knowledge and Analysis

It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.</td><td colspan="3">The ability to understand:

• Principles of precision engineering
• Methods and tools for evaluating the engineering process
• Evaluation criteria for engineering processes
• Types and impact of recommendations on engineering processes
• Organisational and legislative requirements</td></tr>
<tr><td>Application and Adaptation

It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.</td><td colspan="3">The ability to:

• Review analyses of joint requirements, in accordance with design specifications
• Evaluate selection of appropriate joining processes to suit application requirements
• Evaluate accuracy of joint strength calculations, in accordance with design specifications
• Evaluate joining process plans for particular applications
• Evaluate quality control procedures to address the aspect of product quality and compliance to regulatory requirements
• Submit full evaluation reports on whether engineering process plans meet functional requirements</td></tr>
<tr><td>Innovation and Value Creation

It refers to the ability</td><td colspan="3">The ability to:

• Analyse and propose opportunities of improved forming approaches at</td></tr>
</table>

to generate purposive ideas to improve work performance and/or enhance business values that are aligned to organisational goals.	the workplace
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Explain evaluation criteria to team members • Communicate the improved work processes to relevant stakeholders
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Keep abreast of new methods or processes, which may potentially lead to reduction in costs. • Update own learning in material joining by subscribing to diverse learning channels and participating in peer review platforms
Range of Application *(where applicable)* *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	Principles of precision engineering must include: • Advanced concepts of mechanics and mechatronics • Advanced concepts of electricity and magnetism • Advanced concepts of thermodynamics • Advanced concepts of material science • Advanced concepts of engineering mathematics • Advanced concepts of design and drafting • Advanced concepts of control systems • Concepts of computing and programming • Advanced concepts of geometric error budgeting • Advanced concepts of calibration • Advanced concepts of measurements Evaluating the engineering process must include evaluation of the following: • Standard operating procedures and work instructions

	• Process and quality control and assurance documentation • Organisation documentation • IT systems Organisational and legislative requirements include: • Economics, environment requirements • Workplace Safety and Health Act

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Skill Code	PRE-PMP-6071-1	**Skill Category**	Precision Manufacturing Processes
		Skill Sub-Category *(where applicable)*	Joining Processes
Skill	Evaluate Application of Advanced Metal Welding Processes to Enhance Welding Process for Manufacturing		
Skill Description	This skill describes the ability to evaluate and optimise applications of welding technology, electrode arc welding, laser beam welding, brazing and welding metallurgy. It also includes weldment monitoring, development of welding procedure specifications and testing of welding joints.		
Knowledge and Analysis *It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.*	The ability to understand: • Principles of precision engineering • Types of welding heating sources and mechanisms • Welding process techniques and equipment • Characteristics of laser welding processes • Characteristics of blazing processes • Characteristics of electro arc welding processes • Welding metallurgy concepts and weld defects • Parameters and factors affecting the joining of stainless steels • Selection criteria for weld types and identification of weld defects • Types of welding joint configurations, welding processes, non-destructive testing (NDT), and welding joint evaluation • Principles of welding metallurgy and weld property requirements • Organisational and legislative requirements		
Application and Adaptation *It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.*	The ability to: • Perform analyses on joint requirements, in accordance with design specifications • Review and evaluate advanced welding processes to suit application requirements • Design and develop welding procedure specification plans, in accordance with workplace and legislative procedures • Review accuracy on calculation, and ensure scientific principles are applied in a consistent and appropriate manner, to obtain the required welding solutions • Ensure coherent units are used in the solution of engineering calculations		

	• Design and set up quality control procedures to address the aspect of product quality and compliance to regulatory requirement
Innovation and Value Creation *It refers to the ability to generate purposive ideas to improve work performance and/or enhance business values that are aligned to organisational goals.*	The ability to: • Contrast the properties of different welding technologies and systems to review their relevance to different components
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Consultations with colleagues to determine welding applications requiring metallurgical specification and analysis • Communicate with customers, colleagues and teams to assist in establishing timeframes and requirements
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Update own learning in welding technologies by subscribing to diverse learning channels and participating in peer review platforms • Monitor past designs of weldment and discern trends to incorporate into pro-active strategies
Range of Application *(where applicable)* *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	Principles of precision engineering must include: • Advanced concepts of thermodynamics • Advanced concepts of material science • Advanced concepts of engineering mathematics • Advanced concepts of measurements Non-destructive testing methods must include: • Visual inspections • Radiographics

	• Magnetic-particles
	• Liquid-penetrants
	• Ultrasonic tests
	
	Weld processing related issues must include:
	
	• Cracking
	• Porosity
	• Dilution
	  ○ Slag inclusions
	  ○ Insufficient penetration
	  ○ Incomplete fusions
	  ○ Undercuts
	  ○ Spatters
	  ○ Distortions
	
	Organisational and legislative requirements must include:
	
	• Economics, environment requirements
	• Workplace Safety and Health Act

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Skill Code	PRE-PMP-6072-1	**Skill Category**	Precision Manufacturing Processes
		Skill Sub-Category *(where applicable)*	Finishing Processes
Skill	Evaluate Advanced Surface Coating Technologies to Satisfy Corrosion Prevention Requirements		
Skill Description	This skill describes the ability to evaluate quality control methods for corrosion prevention. It also includes having in-depth knowledge of coating materials, their application and processes		
Knowledge and Analysis *It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.*	The ability to understand: • Industry performance requirements for surface treatment and coatings • Common and special cleaning processes • Surface inspection methods to evaluate surface cleanliness • Surface mass finishing techniques • Gaseous plasma coating, surface treatment technologies and cleaning processes • Electroplating coating and surface treatment technology • Electroless plating coating and surface treatment technology • Electrolysis coating and surface treatment processes • Anodizing chemistry, coating and surface treatment processes • Sol-gel chemistry, coating and surface treatment processes • Thermal spray coating and surface treatment processes • Vacuum vapour deposition coating and surface treatment processes • Surface morphology techniques (analyse composition, optical properties and crystalline structure) • Economics, environment and safety considerations		
Application and Adaptation *It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.*	The ability to: • Review functional requirements to shortlist the range of coating and surface treatment technologies that can meet the requirements • Identify factors affecting coating and surface treatment adhesion • Identify factors affecting surface contamination and abrasive wear • Perform analyses on the effects of using plasma surface modification treatment processes to meet functional requirements • Perform analyses on the effects of using electrochemical and/or anodizing processes to meet functional requirements • Perform analyses on the effects of using sol-gel coating processes to meet functional requirements • Perform analyses on the effects of using thermal spray processes to		

	meet functional requirements • Perform analyses on the effects of using high vacuum systems such as Chemical Vapour Deposition (CVD) and Physical Vapour Deposition (PVD) to meet functional requirements • Use PVD magnetron sputtering systems with appropriate selections of electrical power for different kinds of targets • Measure wear rate of coating and surface treatments • Report on the selected coating and surface treatment processes used to meet functional requirements, including economics, quality control, environment and safety considerations
Innovation and Value Creation *It refers to the ability to generate purposive ideas to improve work performance and/or enhance business values that are aligned to organisational goals.*	The ability to: • Perform surface morphology analyses to determine, and enhance, characterisations and quality of future coating and surface treatments
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Communicate with customers, colleagues and teams to assist in establishing timeframes and requirements • Select coating and surface treatment processes, in consideration of environment and safety guidelines
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Engage in self-reflection on effectiveness of coating and surface treatments, based on results of surface morphology analyses • Update own learning in coating and surface treatment technologies by subscribing to diverse learning channels and participating in peer review platforms
Range of Application *(where applicable)*	Applications of coating and surface treatments must include: • Metallic

It refers to the critical circumstances and contexts that the skill may be demonstrated.	• Ceramic • Organic • Polymeric • Surface mass finishing must include: • Two and three body abrasive wear and granular flow • High and low energy mass finishing techniques Chemical coating technologies must include: • Electro-plating • Electroless-plating • Anodizing processes • Sol-gel processes Vacuum deposition processes and thermal spray coatings must include: • Evaporation • Sputtering • Arc deposition • Thermal CVD • Plasma enhanced CVD Surface morphology analysis and coating characterisation must include: • Surface topography observations • Elemental composition analysis and identification of functional groups in coating materials • Crystalline structure analyses • Mechanical and tribological properties measurement • Measurement of optical constants of the coatings Safety considerations include: • Workplace Safety and Health Act • Organisational requirements

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

<table>
<tr><td rowspan="2">Skill Code</td><td rowspan="2">PRE-PMP-6073-1</td><td>Skill Category</td><td>Precision Manufacturing Processes</td></tr>
<tr><td>Skill Sub-Category
(where applicable)</td><td>Finishing Processes</td></tr>
<tr><td>Skill</td><td colspan="3">Evaluate Component Cleaning Process Plan to Determine Appropriate Cleaning Process for Manufacturing</td></tr>
<tr><td>Skill Description</td><td colspan="3">This skill describes the ability to evaluate cleaning plans. It also includes considerations of risk analysis in the selected procedures and types of evaluation tools.</td></tr>
<tr><td>Knowledge and Analysis

It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.</td><td colspan="3">The ability to understand:

• Principles of precision engineering
• Methods and tools for evaluating the engineering process
• Evaluation criteria for engineering processes
• Types and impact of recommendations on engineering processes
• Workplace Safety and Health regulations</td></tr>
<tr><td>Application and Adaptation

It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.</td><td colspan="3">The ability to:

• Apply analysis methods to determine cleaning requirements, in accordance with work specification
• Review cleaning processes to suit application requirements
• Evaluate selection of cleaning applications, in accordance with work specifications
• Evaluate cleaning process plans for particular applications
• Evaluate quality control procedures to address the aspect of product quality and compliance to regulatory requirements</td></tr>
<tr><td>Innovation and Value Creation

It refers to the ability to generate purposive ideas to improve work performance and/or enhance business values that are aligned to</td><td colspan="3">The ability to:

• Analyse and propose opportunities of improved forming approaches in workplace</td></tr>
</table>

organisational goals.	
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Explain evaluation criteria to team members • Communicate the improved work processes to relevant stakeholders
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Keep abreast of new methods or processes, which may potentially lead to reduction in costs. • Update own learning in material finishes by subscribing to diverse learning channels and participating in peer review platforms
Range of Application *(where applicable)* *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	Principles of precision engineering must include: • Advanced concepts of mechanics and mechatronics • Advanced concepts of electricity and magnetism • Advanced concepts of thermodynamics • Advanced concepts of material science • Advanced concepts of engineering mathematics • Advanced concepts of design and drafting • Advanced concepts of control systems • Concepts of computing and programming • Advanced concepts of geometric error budgeting • Advanced concepts of calibration • Advanced concepts of measurements Evaluating engineering processes must include evaluation of the following: • Standard operating procedures and work instructions • Process and quality control and assurance documentation • Organisation documentation • IT systems

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

<table>
<tr><td rowspan="2">Skill Code</td><td rowspan="2">PRE-PMP-6074-1</td><td>Skill Category</td><td>Precision Manufacturing Processes</td></tr>
<tr><td>Skill Sub-Category
(where applicable)</td><td>Finishing Processes</td></tr>
<tr><td>Skill</td><td colspan="3">Evaluate Finishing Process Plan to Determine Appropriate Finishing Process for Manufacturing</td></tr>
<tr><td>Skill Description</td><td colspan="3">This skill describes the ability to evaluate and optimise applications of finishing methodologies for materials used in precision manufacturing, to achieve the optimum finishes in accordance with design specifications. It also includes quality control procedures.</td></tr>
<tr><td>Knowledge and Analysis

It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.</td><td colspan="3">The ability to understand:

• Principles of precision engineering
• Methods and tools for evaluating the engineering process
• Evaluation criteria for engineering processes
• Types and impact of recommendations on engineering processes
• Workplace Safety and Health regulations</td></tr>
<tr><td>Application and Adaptation

It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.</td><td colspan="3">The ability to:

• Apply analysis methods on finishing requirements, in accordance with design specification
• Review selection of finishing processes to suit application requirements
• Evaluate selection of finishing applications, in accordance with design specifications
• Evaluate finishing process plans for particular applications
• Evaluate quality control procedures to address the aspect of product quality and compliance to regulatory requirement
• Submit full evaluation reports on whether engineering process plans meet functional requirements</td></tr>
<tr><td>Innovation and Value Creation

It refers to the ability to generate purposive ideas to improve work performance and/or</td><td colspan="3">The ability to:

• Analyse and propose opportunities for improved finishing approaches at the workplace</td></tr>
</table>

enhance business values that are aligned to organisational goals.	
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Explain evaluation criteria to team members • Communicate the improved work processes to relevant stakeholders
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Keep abreast of new methods or processes, which may potentially lead to reduction in costs. • Update own learning in material finishes by subscribing to diverse learning channels and participating in peer review platforms
Range of Application *(where applicable)* *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	Principles of precision engineering must include: • Advanced concepts of mechanics and mechatronics • Advanced concepts of electricity and magnetism • Advanced concepts of thermodynamics • Advanced concepts of material science • Advanced concepts of engineering mathematics • Advanced concepts of design and drafting • Advanced concepts of control systems • Concepts of computing and programming • Advanced concepts of geometric error budgeting • Advanced concepts of calibration • Advanced concepts of measurements Evaluating engineering processes must include evaluation of the following • Standard operating procedures and work instructions • Process and quality control and assurance documentation • Organisation documentation • IT systems

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Skill Code	PRE-QUA-6016-1	**Skill Category**	Quality
		Skill Sub-Category *(where applicable)*	N/A
Skill	Integrate Quality Principles and Methodology into Manufacturing Processes to Enhance Engineering Performance		
Skill Description	This skill describes the ability to integrate quality principles and methodology to engineering products and processes, in accordance to requirements. It also includes controlling resources and providing solutions to problems.		
Knowledge and Analysis *It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.*	The ability to understand: • Engineering processes and operating procedures in the area associated with the quality issues • Types, effects and impact of quality improvement models • Factors to be considered when selecting solutions to quality problems • Methods and techniques for quality improvement implementation • Methods and techniques for evaluating information • Workplace Safety and Health regulations		
Application and Adaptation *It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.*	The ability to: • Plan the introduction of quality improvements to engineering products or processes • Perform assessments to confirm suitable conditions for integrating quality models and improvements • Review to ensure improvements are implemented according to plan • Identify and resolve any implementation problems that occur • Assess the impact of improvements on the quality of engineering products and processes		
Innovation and Value Creation *It refers to the ability to generate purposive ideas to improve work performance and/or enhance business values that are*	The ability to: • Perform analyses on applications of different quality and resource models to determine which models lead to maximum value creation		

aligned to organisational goals.	
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Communicate with customers, colleagues and teams to establish timeframes and requirements • Build trust by providing clear vision and accurate direction to achieve quality improvements and performance enhancements
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Engage in self-reflection on the value of effective quality improvement plans • Update own learning in quality concepts by subscribing to diverse learning channels and participating in peer review platforms • Reflect and collaboratively establish knowledge and skills gaps in quality assurance, and coach team members to improve team capabilities in quality improvements
Range of Application *(where applicable)* *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	Quality improvement models must include: • Plan, Do, Check, Act (PDCA) cycle • ISO 9001/9004 Quality Management Systems • Six Sigma • Lean manufacturing • Total Quality Management (TQM) Improvement plans must include: • New products and processes • Legal requirements • Standard operating procedures • Revisions to existing products and processes • International and national standards and requirements Assessing the impact of improvements on quality must include:

	• Cost effectiveness • Effect of changes to quality assurance methods and procedures • Quality of data held in information systems • Effectiveness of reporting procedures • Lessons learned

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Skill Code	PRE-VEN-6002-1	**Skill Category**	Value Analysis
		Skill Sub-Category *(where applicable)*	N/A
Skill	Evaluate Organisation's Value Stream to Reduce Waste		
Skill Description	This skill describes the ability to analyse and evaluate an organisation's value stream, including the clear identification of the place of an organisation in the value stream and its contribution to the value stream. It also includes the identification of an organisation in a value stream, their relationships and the activities undertaken by value stream organisations.		
Knowledge and Analysis *It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.*	The ability to understand: • Value stream mapping • Purpose of value stream analysis • Method to identify the organisation's place in the value stream • Flow of materials along value stream • Classification of steps and processes into value-adding and non-value-adding methods to measure value-add • Concept of waste and value in terms of customer benefit • Types of waste and methods of reducing it • Processes and operations used in own organisation to make products or deliver services to internal and external customers • Processes used by other members of the value stream		
Application and Adaptation *It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.*	The ability to: • Map the organisation's value stream taking into account the organisation's ultimate supplier, ultimate customer, and all organisations between the ultimate supplier and ultimate customer • Determine the features obtained by the customers from the organisation's products or processes • Identify data sources to determine the measurement of contribution to features or benefits		
Innovation and Value Creation *It refers to the ability*	The ability to: • Identify the benefits obtained by the customers from the organisation's products or processes		

to generate purposive ideas to improve work performance and/or enhance business values that are aligned to organisational	• Determine the value added to the organisation's products or processes by each internal step • Identify activities on value stream map which do not add to customer features or benefits
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Liaise with external value stream members to determine methods to reduce overall waste
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	N/A
Range of Application (where applicable) *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	N/A

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

<table>
<tr><td rowspan="2">Skill Code</td><td rowspan="2">PRE-AMA-6008-1</td><td>Skill Category</td><td>Additive Manufacturing</td></tr>
<tr><td>Skill Sub-Category
(where applicable)</td><td>N/A</td></tr>
<tr><td>Skill</td><td colspan="3">Develop Integration Plan for Additive Manufacturing Processes to Satisfy Manufacturing Requirements</td></tr>
<tr><td>Skill Description</td><td colspan="3">This skill describes the ability to integrate additive manufacturing within manufacturing processes. It also includes collaborating with stakeholders for implementation of additive manufacturing.</td></tr>
<tr><td>Knowledge and Analysis

It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.</td><td colspan="3">The ability to understand:

• Principles of precision engineering
• Precision manufacturing processes and operating procedures
• Characteristics, techniques and systems of additive manufacturing
• Requirements of different additive manufacturing processes
• Factors to be considered when selecting additive manufacturing solutions
• Additive manufacturing set up and operational procedures
• Methods and techniques for evaluating additive manufacturing implementation
• Workplace Safety and Health regulations
• Principles of collaboration
• Principles of conflict management</td></tr>
<tr><td>Application and Adaptation

It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.</td><td colspan="3">The ability to:

• Perform analyses on requirements of manufacturing processes
• Evaluate additive manufacturing techniques and systems to compare their strengths and limitations
• Perform assessments to confirm suitable conditions for the integration of additive manufacturing
• Plan the integration of additive manufacturing into manufacturing processes
• Pilot additive manufacturing implementation and review results to determine effectiveness
• Integrate additive manufacturing and ensure procedures and operations are implemented according to plan and WSH requirements
• Identify and resolve any implementation problems that occur
• Assess the impact of improvements on the engineering products and processes</td></tr>
</table>

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Innovation and Value Creation *It refers to the ability to generate purposive ideas to improve work performance and/or enhance business values that are aligned to organisational goals.*	The ability to: • Compare additive manufacturing processes with traditional precision manufacturing processes to assess value-add of additive manufacturing to meet manufacturing requirements
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Communicate with colleagues and teams to establish timeframes and requirements • Collaborate with manufacturing process colleagues during planning and integration of additive manufacturing processes to obtain buy-in • Identify and act on possible concerns of using additive manufacturing as a new manufacturing process to prevent conflict • Seek endorsement on the plan to use additive manufacturing within manufacturing processes
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Engage in self-reflection to explore alternative manufacturing techniques to best meet manufacturing requirements • Update own learning in additive manufacturing technologies by subscribing to diverse learning channels and participating in peer review platforms
Range of Application *(where applicable)* *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	Principles of precision engineering must include: • Advanced concepts of mechatronics • Advanced concepts of thermodynamics • Advanced concepts of fluids and fluid dynamics • Advanced concepts of optics and wave theory • Advanced concepts of material science • Advanced concepts of engineering mathematics • Advanced concepts of control systems Types of additive manufacturing must include: • Extrusion

	• Light polymerised • Powder bed • Laminated • Wire Assessing integration must include: • Modelling • Printing • Post processing Integration plans must include: • Legislative requirements • Standard operating procedures • Revisions to existing products and processes Assessing the impact of improvements to manufacturing processes must include: • Cost effectiveness • Effect of changes to manufacturing methods or procedures • Lessons learned

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Skill Code	PRE-AMA-6009-1	**Skill Category**	Additive Manufacturing
		Skill Sub-Category *(where applicable)*	N/A
Skill	Review High Speed Additive Manufacturing Process to Determine Suitability of Manufacturing Metallic Components		
Skill Description	This skill describes the ability to review high speed additive manufacturing processes to determine their suitability for manufacturing complex metallic components. It also includes using electron beams and laser machines for manufacturing metallic components.		
Knowledge and Analysis *It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.*	The ability to understand: • Principles of precision engineering • Fundamentals of high speed metallic additive manufacturing techniques, processes and applications • Metallic powder characterisation • Metallic powder production techniques • Applications and operational parameters of electron beam melting (EBM) machines • Applications and operational parameters of laser-aided additive manufacturing (LAAM) machines • Post-processing of high speed additive manufacturing products and their equipment • Principles of self-reflection		
Application and Adaptation *It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.*	The ability to: • Review methodologies for high speed additive manufacturing of metallic components • Analyse and determine material considerations and metallurgy of metallic components to be manufactured via high speed additive manufacturing • Analyse and determine requirements of metal powders for additive processes • Evaluate the suitability of EBM for additive manufacturing • Evaluate the suitability of LAAM for additive manufacturing • Plan and determine processes and procedures for manufacturing metallic components using high speed additive manufacturing • Plan and determine post-processing procedures for manufacturing metallic components using high speed additive manufacturing		

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Innovation and Value Creation *It refers to the ability to generate purposive ideas to improve work performance and/or enhance business values that are aligned to organisational goals.*	The ability to: • Compare high speed additive manufacturing with other additive manufacturing processes for meeting metallic component requirements, to assess value add of high speed additive manufacturing
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Communicate with colleagues and teams to establish timeframes and requirements • Identify and act on possible concerns of using high speed additive manufacturing as a new manufacturing technique to prevent conflict • Obtain buy-in and seek endorsement on the plan to use high speed additive manufacturing for manufacturing components
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Engage in self-reflection to explore alternative manufacturing techniques to best meet component requirements • Update own learning in additive manufacturing requirements by subscribing to diverse learning channels and participating in peer review platforms
Range of Application *(where applicable)* *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	Principles of precision engineering must include: • Concepts of thermodynamics • Concepts of fluids and fluid dynamics • Concepts of optics and wave theory • Concepts of material science Materials consideration and metallurgy must include: • Powder production and mixing • Analysis of EBM materials • Analysis of LAAM materials

	Process related issues affecting additive manufacturing plans must include: • Oxygen contamination • Delamination • Support structures • Distortion • Porosity • Cracking • Warpage Post-processing must include: • Clean products • Remove support structures • Heat treatment • Improve product finishing • Microstructure examination

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Skill Code	PRE-AMA-6010-1	**Skill Category**	Additive Manufacturing
		Skill Sub-Category *(where applicable)*	N/A
Skill	Review Liquid-based Polymeric Additive Manufacturing to Determine Suitability of Manufacturing Components		
Skill Description	This skill describes the ability to review liquid-based polymeric additive manufacturing processes to determine suitability of manufacturing polymeric components. It also includes using stereolithography (SLA), 3D polymer jetting, fused filament fabrication and 3D bioprinting for manufacturing polymeric components.		
Knowledge and Analysis *It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.*	The ability to understand: • Principles of precision engineering • Fundamentals of liquid-based polymeric additive manufacturing techniques, processes and applications • Material characterisation and analysis • Applications and operational parameters of SLA machines • Applications and operational parameters of 3D polymer jetting machines • Applications and operational parameters of fused filament fabrication machines • Applications and operational parameters of 3D bioprinting machines • Product performance, strengths and limitations of liquid-based polymeric additive manufacturing • Post-processing of liquid-based polymeric additive manufacturing products and their equipment • Principles of self-reflection		
Application and Adaptation *It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.*	The ability to: • Review methodology for liquid-based polymeric additive manufacturing of components • Analyse and determine the physical and chemical property requirements of components • Analyse and determine appropriate additive manufacturing materials and recipes, based on component property requirements • Evaluate use of SLA for additive manufacturing • Evaluate use of 3D polymer jetting for additive manufacturing • Evaluate use of fused filament fabrication for additive manufacturing • Evaluate use of and 3D bioprinting for additive manufacturing of		

	spatially-controlled cell patterns • Plan and determine processes and procedures for manufacturing polymeric components • Plan and determine post-processing procedures for manufacturing polymeric components
Innovation and Value Creation *It refers to the ability to generate purposive ideas to improve work performance and/or enhance business values that are aligned to organisational goals.*	The ability to: • Review liquid-based polymeric additive manufacturing with other additive manufacturing processes for meeting polymetric component requirements, to assess value add of liquid-based polymeric additive manufacturing
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Communicate with colleagues and teams to establish timeframes and requirements • Identify and act on possible concerns of using liquid-based polymeric additive manufacturing as a new manufacturing technique to prevent conflict • Obtain buy-in and seek endorsement on the plan to use liquid-based polymeric additive manufacturing for manufacturing components
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Engage in self-reflection to explore alternative manufacturing techniques to best meet polymeric component requirements • Update own learning in additive manufacturing requirements by subscribing to diverse learning channels and participating in peer review platforms
Range of Application *(where applicable)* *It refers to the critical circumstances and contexts that the skill may be*	Principles of precision engineering must include: • Concepts of thermodynamics • Concepts of fluids and fluid dynamics • Concepts of optics and wave theory • Concepts of material science

demonstrated.	Additive manufacturing methodology selection criteria must include: • Technical parameters • Economical parameters Product performance parameters must include: • Product quality • Cost • Building time Post-processing must include: • Cleaning products • Removing support structures • Improving product finishing • Microstructure examinations

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

<table>
<tr><td rowspan="2">Skill Code</td><td rowspan="2">PRE-LOP-6006-1</td><td>Skill Category</td><td>Laser and Optics</td></tr>
<tr><td>Skill Sub-Category
(where applicable)</td><td>N/A</td></tr>
<tr><td>Skill</td><td colspan="3">Develop Integration Plan for Advanced Optical Metrology Processes to Satisfy Manufacturing Requirements</td></tr>
<tr><td>Skill Description</td><td colspan="3">This skill describes the ability to integrate advanced optical metrology within manufacturing processes. It also includes collaborating with stakeholders for implementation.</td></tr>
<tr><td>Knowledge and Analysis

It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.</td><td colspan="3">The ability to understand:

• Principles of precision engineering
• Precision manufacturing processes and operating procedures
• Advanced optical metrology characteristics, techniques and systems
• Requirements of different, advanced optical metrology
• Factors to be considered when selecting advanced optical metrology solutions
• Types of set up and operational procedures
• Methods and techniques for evaluating implementation of advanced optical metrology
• Principles of collaboration
• Principles of conflict management
• Organisational and legislative requirements</td></tr>
<tr><td>Application and Adaptation

It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.</td><td colspan="3">The ability to:

Perform analysis on requirements of manufacturing processes

• Evaluate various advanced optical metrology systems to compare their strengths and limitations
• Perform assessments to confirm suitable conditions for the integration of advanced optical metrology
• Plan the integration of advanced optical metrology into manufacturing processes
• Pilot implementation and review results to determine effectiveness of advanced optical metrology
• Integrate advanced optical metrology and ensure procedures and operations are implemented according to plan and WSH requirements
• Identify and resolve any implementation problems that occur
• Assess the impact of improvements on the engineering products and processes</td></tr>
</table>

Innovation and Value Creation *It refers to the ability to generate purposive ideas to improve work performance and/or enhance business values that are aligned to organisational goals.*	The ability to: • Compare advanced optical metrology with traditional precision metrology processes for meeting manufacturing requirements, to assess value add of implementation
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Communicate with colleagues and teams to establish timeframes and requirements • Collaborate with manufacturing process colleagues during planning and integration of advanced optical metrology to obtain buy-in • Identify and act on possible concerns of using advanced optical metrology as a new manufacturing process to prevent conflict • Seek endorsement on the plan to use advanced optical metrology for manufacturing processes
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Engage in self-reflection to review effectiveness of new metrology processes • Update own learning in advanced optical metrology by subscribing to diverse learning channels and participating in peer review platforms

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Range of Application *(where applicable)* *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	Principles of precision engineering must include: • Advanced concepts of mechanics and mechatronics • Advanced concepts of thermodynamics • Advanced concepts of optics • Advanced concepts of material science • Advanced concepts of control systems • Advanced concepts of measurements Organisational and legislative requirements must include: • Economics, environment requirements • Workplace Safety and Health Act

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

<table>
<tr><td rowspan="2">Skill Code</td><td rowspan="2">PRE-RAU-6005-1</td><td>Skill Category</td><td>Robotics and Automation</td></tr>
<tr><td>Skill Sub-Category
(where applicable)</td><td>N/A</td></tr>
<tr><td>Skill</td><td colspan="3">Enhance Control Performance of Precision Machines to Satisfy Manufacturing Requirements</td></tr>
<tr><td>Skill Description</td><td colspan="3">This skill describes the ability to analyse, design and tune controllers. It also includes the , key considerations for precision control, and increasing manufacturing performance in terms of precision, accuracy, speed and reliability.</td></tr>
<tr><td>Knowledge and Analysis

It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.</td><td colspan="3">The ability to understand:

• Principles of precision engineering
• Principles and applications of Proportional-Integral-Derivative (PID) controllers
• Concept of bode plot
• Concepts of metrology
• Principles of thermal modelling and analysis
• Design of PID control
• Applications of high resolution transducers
• Concepts of motion control systems
• Applications of servo control systems
• Organisational and legislative requirements</td></tr>
<tr><td>Application and Adaptation

It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.</td><td colspan="3">The ability to:

• Perform analyses to determine suitability of manufacturing systems for PID controller closed or open loop application
• Perform analyses to distinguish between repeatability, resolution, and accuracy control parameters
• Build mathematical models of thermal control systems
• Design PID controls using model-based approaches
• Apply servo control principles to construct servo motor drive systems to use in conjunction with PID controllers
• Apply thermodynamics principles to select heating elements to use in conjunction with PID controllers
• Apply PID controllers for closed or open loop control, in accordance to manufacturers’ manuals</td></tr>
</table>

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Innovation and Value Creation *It refers to the ability to generate purposive ideas to improve work performance and/or enhance business values that are aligned to organisational goals.*	The ability to: • Perform steps to calibrate PID controllers and improve manufacturing performance
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Communicate with customers, colleagues and teams to establish timeframes and requirements
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Engage in self-reflection to review effectiveness of machine controls • Update own learning in machine precision control by subscribing to diverse learning channels and participating in peer review platforms
Range of Application *(where applicable)* *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	Principles of precision engineering must include: • Advanced concepts of mechanics and mechatronics • Advanced concepts of electricity and magnetism • Advanced concepts of thermodynamics • Advanced concepts of material science • Advanced concepts of engineering mathematics • Advanced concepts of design and drafting • Advanced concepts of control systems • Concepts of computing and programming • Advanced concepts of geometric error budgeting • Advanced concepts of calibration • Advanced concepts of measurements

	Concepts of metrology must include: • Machine calibration • Geometric error compensation Concepts of motion control system must include: • Lorentz-force actuation in precision motion systems • PZT phenomenon • Linear motor phenomenon Organisational and legislative requirements must include: • Economics, environment requirements • Workplace Safety and Health Act

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

<table>
<tr><td rowspan="2">Skill Code</td><td rowspan="2">PRE-MPI-6022-1</td><td>Skill Category</td><td>Manufacturing Productivity and Innovation</td></tr>
<tr><td>Skill Sub-Category
(where applicable)</td><td>N/A</td></tr>
<tr><td>Skill</td><td colspan="3">Evaluate Organisation’s Approach to Lean Enterprise to Enhance Competitiveness</td></tr>
<tr><td>Skill Description</td><td colspan="3">This skill describes the ability to examine the principles, techniques, key tools of ‘Lean’ and how they might apply in a variety of processes and sectors. It also includes exploring the strategic importance of creating ‘lean enterprise’ as well as the challenges associated with achieving and sustaining this.</td></tr>
<tr><td>Knowledge and Analysis

It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.</td><td colspan="3">The ability to understand:

• Evolution of ‘Lean’
• Framework for Lean Thinking
• Creating ‘lean’ enterprise
• Illustrations of ‘lean’ in different sectors
• Principles and applications of Lean Six Sigma
• ‘Lean’ audits
• ‘Lean’ implementation and sustainability
• Tools and techniques of ‘lean’</td></tr>
<tr><td>Application and Adaptation

It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.</td><td colspan="3">The ability to:

• Identify a framework for Lean Thinking and the benefits a ‘lean’ approach can afford
• Apply an approach to designing ‘lean’ enterprise
• Identify, select and apply appropriately relevant tools and techniques to support ‘lean’ enterprise
• Critically evaluate how Lean Thinking might apply in different sectors, processes and levels within the enterprise
• Recommend an appropriate approach to implementing sustainable Lean Enterprise</td></tr>
<tr><td>Innovation and Value Creation

It refers to the ability to generate</td><td colspan="3">N/A</td></tr>
</table>

purposive ideas to improve work performance and/or enhance business values that are aligned to organisational	
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	N/A
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	N/A
Range of Application (where applicable) *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	Framework for 'lean' and the benefits of lean approach must include: • Introduction, 'lean' foundations and business priorities • 'Lean' simulation runs • Understanding customers' needs (Specifying value) • Principles of Scientific Management that were developed by F.W. Taylor • Henry Ford's approach in the development of the paced, moving assembly line • Toyota production system (Ohno '88) • Standardisation and interchangeability of parts • Total quality management system (TMS) • Total productive maintenance (TPM) system Application of appropriate approach to designing lean enterprise must

	include: • Underlying concepts: Muda, Mura and Muri • Identifying value and eliminating waste • Identifying the value stream • Mapping the current state • 'Lean' simulation • Concepts of Lean • Value stream mapping • Lean responses to customer needs • Process improvement • Lean Management Recommending an appropriate approach to implementing sustainable Lean Enterprise must include: • Future state mapping • Lean in the extended enterprise • Preparing for implementation, 5S • Lean Management: Respect for humanity • Lean management: Hoshin planning • Development of a 'lean' culture • Toyota Kata

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

<table>
<tr><td rowspan="2">Skill Code</td><td rowspan="2">PRE-MPI-6023-1</td><td>Skill Category</td><td>Manufacturing Productivity and Innovation</td></tr>
<tr><td>Skill Sub-Category
(where applicable)</td><td>N/A</td></tr>
<tr><td>Skill</td><td colspan="3">Perform Virtual Modelling and Simulation to Achieve Manufacturing Productivity Improvements</td></tr>
<tr><td>Skill Description</td><td colspan="3">This skill describes the ability to carry out machining productivity improvements. It also includes virtual machining simulations, machining dynamics and optimisation.</td></tr>
<tr><td>Knowledge and Analysis

It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.</td><td colspan="3">The ability to understand:

• Principles of precision engineering
• Principles and concepts of virtual machining processes
• Concepts of in-process models
• Types of Computer Numerical Control (CNC) errors
• Methods of machining vibration: forced and chatter vibrations
• Definition of chatter frequency
• Influence of spindle speed and cutting depth in machining chatter
• Effects of tool run-out on machining vibrations
• Influences of cutting tools’ geometries to machining vibrations
• Characteristics of transfer functions on machining units
• Relationship between work piece materials and machining stability
• Factors to improve machining stability
• Methods to identify productive cutting conditions, using machining dynamic toolkits
• Methods for improving the material removal rate, based on stability lobes
• Functions of machining dynamic toolkits
• Procedures of machining optimisation, using machining dynamic toolkits
• Principles of dynamic databases of machine tools and tooling
• Procedure of numerical control (NC) verification using QuickCNC
• Virtual CNC training plans and structure of virtual CNC training labs
• Organisational and legislative requirements</td></tr>
<tr><td>Application and Adaptation

It refers to the ability to perform the work tasks and activities required of the</td><td colspan="3">The ability to:

• Perform analyses on the causes of machining chatter in manufacturing
• Characterise cutting tools’ properties and select appropriate tools to minimise machining chatter
• Analyse the dynamic characteristics of the tooling using modal tests</td></tr>
</table>

occupation, and the ability to react to and manage the changes at work.	• Analyse machining units to generate stability lobes using a machining dynamic toolkit • Analyse machining stability lobes to prevent machining chatter • Perform analyses using dynamic and stability lobe analysis to improve material removal rates • Configure machining dynamic toolkits for optimising machining processes • Develop dynamic databases of machine tools and tooling for productivity • Perform virtual machining simulations to validate NC codes before performing machining
Innovation and Value Creation *It refers to the ability to generate purposive ideas to improve work performance and/or enhance business values that are aligned to organisational goals.*	The ability to: • Formulate virtual CNC training plans to reduce operation errors and enhance safety
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Communicate with customers, colleagues and teams to assist in establishing timeframes and requirements
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Engage in self-reflection to review sufficiency of productivity improvement • Update own learning in dynamic analysis and simulation by subscribing to diverse learning channels and participating in peer review platforms
Range of Application *(where applicable)* *It refers to the critical*	Principles of precision engineering must include: • Advanced concepts of mechanics • Advanced concepts of engineering mathematics

circumstances and contexts that the skill may be demonstrated.	• Advanced concepts of design and drafting • Concepts of computing and programming Virtual machine simulations, certifications and optimisation must include: • CNC simulation fundamentals • Analysis of CNC machining errors • CNC verification • Reduction of trial and error using virtual training labs Machining dynamics analysis and prevention of machining chatter must include: • Fundamentals of machining dynamics • Influences of tooling's geometry to machining stability • Dynamic analysis of machining units using modal tests • Dynamic characteristics and databases of work materials • Analysis and application of machining stability lobes • Composition and operation of machining dynamic toolkits Application of machining dynamic toolkits must include: • Application of hammer tests and vibration analysis for complex parts machining • Development of dynamic databases of machine tools and tooling • Improving material removal rates • Improve productivity using dynamic toolkit for actual machining parts Organisational and legislative requirements must include: • Economics, environment requirements • Workplace Safety and Health Act

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Skill Code	PRE-WSH-4006-1	**Skill Category**	Workplace Safety and Health
		Skill Sub-Category *(where applicable)*	N/A
Skill	Manage Workplace Safety and Health Systems		
Skill Description	This skill describes the ability to apply Workplace Safety and Health (WSH) procedures and practices to ensure the safety of the production teams. It also includes ensuring compliance with standards and managing the identification of hazards and assessment of risks.		
Knowledge and Analysis *It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.*	The ability to understand: • Organisational policies and procedures relating to Workplace Safety and Health (WSH) • Personal Protective Equipment (PPE) • Safety signs and symbols • Industry Codes of Practice (CP) and Singapore Standards (SS) • Rules and regulations • Workplace Safety and Health regulations		
Application and Adaptation *It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.*	The ability to: • Manage the day-to-day performance of WSH activities • Ensure that work is carried out safely, in accordance with organisational procedures and legislative requirements • Identify and manage workplace hazards • Ensure compliance to workplace procedures for risk control measures • Manage and supervise programmes to ensure emergency equipment is identified, available and maintained • Oversee incident reporting, in accordance with organisational procedures and legislative requirements		
Innovation and Value Creation *It refers to the ability to generate purposive ideas to*	The ability to: • Propose improvements to organisational WSH procedures to enhance the organisation's ability to comply with regulatory requirements		

improve work performance and/or enhance business values that are aligned to organisational	
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Communicate WSH procedures and risk control measures to the production teams
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Identify appropriate training for production teams, in accordance with organisational and regulatory requirements • Keep abreast of changes to WSH regulations and other regulatory requirements through legislative forum sharing
Range of Application (where applicable) *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	Industry Codes of Practice (CP) and Singapore Standards (SS) must include: • CP for safety in welding and cutting (and other operations involving the use of heat) • CP for selection, use and maintenance of respiratory protective devices • CP for selection, use, care and maintenance of hearing protectors • SS 217, Specification for industrial safety signs • SS 473, Specification for personal eye-protectors – Part 1: General requirements • SS 473, Specification for personal eye-protectors – Part 2: Selection, use and maintenance • CP 98, Material Safety Data Sheet (Safety Data Sheet) Rules and regulations must include:

	• Workplace Safety and Health Act • Environmental Management Act • ISO 14000

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Skill Code	PRE-NPD-6001-1	**Skill Category**	New Product Development
		Skill Sub-Category *(where applicable)*	N/A
Skill	Create Engineering Designs		
Skill Description	This skill describes the ability to create engineering designs in accordance with approved procedures. It also includes gathering information from design briefs and creating designs to meet the design brief objectives.		
Knowledge and Analysis *It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.*	The ability to understand: • Components of design briefs and specifications • Engineering or manufacturing principles and concepts required to produce fit for purpose designs • Methods for presenting designs to clients • Potential risks to designs and their mitigating measures • Functionality of designs and inter-relationships with other components, products, systems and technologies • Workplace Safety and Health regulations		
Application and Adaptation *It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.*	The ability to: • Create designs, as specified in design briefs, for engineering products and processes and in accordance with clients' requirements • Apply approved engineering concepts, processes and principles to achieve the design briefs • Create suitable range of designs for clients to consider • Ensure that the designs comply with all relevant regulations, standard directives and codes of practice • Ensure that designs are protected, in accordance with organisational procedures		
Innovation and Value Creation *It refers to the ability to generate purposive ideas to improve work performance and/or enhance business values that are aligned to*	The ability to: • Identify areas of improvement for design briefs to add value to clients' requirements		

organisational goals.	
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Seek guidance and advice to assist in design work • Present designs in suitable formats, and with sufficient information, to allow clients to assess them
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	N/A
Range of Application *(where applicable)* *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	Resources required for engineering designs must include: • Financial resources • Time scales • Manpower • Plant and equipment • Materials

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

<table>
<tr><td rowspan="2">Skill Code</td><td rowspan="2">PRE-NPD-6002-1</td><td>Skill Category</td><td>New Product Development</td></tr>
<tr><td>Skill Sub-Category
(where applicable)</td><td>N/A</td></tr>
<tr><td>Skill</td><td colspan="3">Identify Engineering Design Requirements of Clients</td></tr>
<tr><td>Skill Description</td><td colspan="3">This skill describes the ability to establish design requirements for clients. It also includes consulting with clients to obtain details of their requirements and to present the consultation results to relevant stakeholders.</td></tr>
<tr><td>Knowledge and Analysis

It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.</td><td colspan="3">The ability to understand:

• Types of information required for establishing design objectives
• Types of design features to be considered unique and/or specific
• Factors that affect the feasibility of achieving clients' requirements
• Components of briefs confirming clients' requirements
• Methods to present briefs to clients
• Organisational processes or procedures for recording design requirements
• Workplace Safety and Health regulations</td></tr>
<tr><td>Application and Adaptation

It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.</td><td colspan="3">The ability to:

• Confirm clients' objectives for engineering products or processes
• Identify unique and/or specific features that require specific attention
• Determine the feasibility of achieving clients' requirements</td></tr>
<tr><td>Innovation and Value Creation

It refers to the ability to generate purposive ideas to improve work performance and/or enhance business values that are aligned to</td><td colspan="3">The ability to:

• Analyse client requirements to determine feasibility of enhancing requirements to add value</td></tr>
</table>

organisational goals.	
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Present briefs to clients to seek endorsement on engineering design requirements
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Research relevant emerging trends through research networks to ascertain emerging technologies, which may be incorporated into the engineering design requirements
Range of Application *(where applicable)* *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	Information required to establish design objectives must include: • Functions • Life cycles • Technologies • Resources • Budget • Performance and capability • Monitoring, servicing and maintenance frequency • Delivery schedules • Volume • Aesthetics • Usability • Timing • Materials • Interfacing • Environmental and sustainability consideratrions • Branding • Safety Components of briefs to confirm requirements must include:

	• Confirmation of objectives • Draft design concepts • Supporting calculations and data • High level functionality • Feasibility of achieving requirements • Description of proposed implementation, including any special features • Details of specific issues for customer consideration,e.g. product safety, health and safety, impending regulation changes, emerging technologies • Project review process • Product life cycle requirements • Client on-going support

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Skill Code	PRE-BAN-6005-1	**Skill Category**	Business Analytics
		Skill Sub-Category *(where applicable)*	N/A
Skill	Analyse Data and Identify Business Insights		
Skill Description	This skill describes the ability to analyse the different types of data to address the hypothesis and working with the stakeholders to identify business insights**.**		
Knowledge and Analysis *It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.*	The ability to understand: • Statistical modelling techniques • Programming language and tools for big data analytics and how they integrate with big data technologies • Current and emerging trends in the business domain • Concepts of computing used in big data analytics • Understanding the meaning of the data in different data sources		
Application and Adaptation *It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.*	The ability to: • Review the hypothesis to address problem statement for the analytics project • Explore the data in the analytics platform or organisation to familiarise with the data available for analysis • Perform analysis on the data to prove or disprove the hypothesis and obtain business insights using the relevant programming language or tools for big data analytics tools • Develop a report of the business insights for the relevant parties		
Innovation and Value Creation *It refers to the ability to generate purposive ideas to improve work performance and/or*	The ability to: • Review financial analysis ratios to measure profitability, viability and resource utilisation of the business unit		

enhance business values that are aligned to organisational	
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	N/A
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Keep abreast of current and emerging trends in the business domain through diverse learning platforms to continually revise one's assumptions in analysing data
Range of Application (where applicable) *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	Tools for big data analytics may include: • Analytical tools (e.g. SAS, Google Analytics, IBM Netezza) • Statistical packages (e.g. SAS, SPSS) • Business intelligence (BI) reporting or analytical tools • R-based tools (e.g. RevoScaleR)

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Skill Code	BM-BN-502E-1	**Skill Category**	Business Negotiation
		Skill Sub-Category *(where applicable)*	N/A
Skill	Manage Dispute Mediation		
Skill Description	This skill describes the ability to manage dispute mediation to achieve mediation objectives. It also includes developing mediation guidelines, preparing and participating in mediation and evaluating mediation outcomes.		
Knowledge and Analysis *It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.*	The ability to understand: • Mediation purpose and outcomes • Types of disputes • Means of managing relevant stakeholders in mediation process • Dispute resolution processes		
Application and Adaptation *It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.*	The ability to: • Develop and review mediation guidelines in consultation with relevant stakeholders to manage mediation process • Prepare for mediation in accordance with mediation guidelines to achieve desired mediation outcomes • Set objectives for resolution to guide mediation process • Use a range of communication techniques to mediate dispute successfully		

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Innovation and Value Creation *It refers to the ability to generate purposive ideas to improve work performance and/or enhance business values that are aligned to organisational goals.*	The ability to: • Evaluate mediation outcomes to determine achievement against objectives and identify potential areas for improvement for future mediations
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Demonstrate empathy and openness to embrace different perspectives during the mediation process to achieve desired mediation outcomes
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Research on history of disputes and dispute resolution within the organisation to apply to current and future situations
Range of Application *(where applicable)* *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	N/A

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Skill Code	BM-CM-501E-1	**Skill Category**	Business Continuity Management
		Skill Sub-Category *(where applicable)*	N/A
Skill	Direct End-to-End Change Management		
Skill Description	This skill describes the ability to develop and implement a change management strategy. This includes reviewing the organisational systems and processes and creating an environment for change management.		
Knowledge and Analysis *It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.*	The ability to understand: • Enablers of change • Components of organisational readiness assessment • Components and objectives of change management implementation plans • Components of change management programme plans and change management process • Communication strategies to promote change • Individual role in contributing to change management as a strategic business partner		
Application and Adaptation *It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.*	The ability to: • Develop change management strategy and change management programmes in consultation with management • Implement change management strategy in accordance with implementation plans		
Innovation and Value Creation *It refers to the ability to generate purposive ideas to improve work performance and/or*	The ability to: • Review organisational systems, processes and policies to identify areas of improvement for appropriate change management programmes and initiatives • Create an environment conducive for change management • Monitor, evaluate and refine change management strategy and programmes in accordance with desired organisational outcomes		

enhance business values that are aligned to organisational	
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Sponsor change management programmes and initiatives to gain buy-in from relevant stakeholders
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Critically appraise one's role in the change management process to improve one's performance in directing and managing the change management process
Range of Application (where applicable) *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	N/A

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Skill Code	BM-COM-505E-1	**Skill Category**	Communication
		Skill Sub-Category *(where applicable)*	N/A
Skill	Resolve Conflicts with Stakeholders		
Skill Description	This skill describes the ability to resolve conflicts with stakeholders to reach mutually agreed outcomes. It includes identifying and assessing conflict situations, selecting, evaluating and implementing conflict resolution approaches and evaluating outcomes to determine learning points.		
Knowledge and Analysis *It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.*	The ability to understand: • Signs of conflict • Stages of conflicts • Causes of conflict • Communication techniques • Conflict resolution techniques • Legal, regulatory, ethical and socio-cultural constraints related to conflict resolution		
Application and Adaptation *It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.*	The ability to: • Identify and assess potential conflict situations in accordance with organisational policies and procedures to determine nature of conflict • Select and evaluate conflict resolution approaches in accordance with organisational policies and procedures to support desired outcomes		
Innovation and Value Creation *It refers to the ability to generate purposive ideas to*	The ability to: • Implement conflict resolution approaches to reach mutual agreed outcomes		

improve work performance and/or enhance business values that are aligned to organisational	
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Demonstrate openness and willingness to embrace different perspectives during conflict resolution to maintain relationships and achieve desired outcomes
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Evaluate outcomes to determine learning points for future conflict situations
Range of Application (where applicable) *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	Legal, regulatory, ethical and socio-cultural constraints related to conflict resolution must include: • Relevant legislation • Codes of practice • Business ethics • Policies and guidelines • Social responsibilities • Cultural and societal expectations and influences

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

<table>
<tr><td rowspan="2">Skill Code</td><td rowspan="2">PRE-DTH-6002-1</td><td>Skill Category</td><td>Design Thinking</td></tr>
<tr><td>Skill Sub-Category
(where applicable)</td><td>N/A</td></tr>
<tr><td>Skill</td><td colspan="3">Apply a Holistic User-centric Approach for Strategic Design Thinking</td></tr>
<tr><td>Skill Description</td><td colspan="3">This skill describes the ability to apply a holistic approach to conduct strategic design thinking to achieve new user experiences, product and service innovations, and organisation change and business growth. It also includes using the People, Objects, Environment, Message/Media Services (POEMS) framework to identify business intents and assess the design, business and/or organisation to identify opportunities.</td></tr>
<tr><td>Knowledge and Analysis

It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.</td><td colspan="3">The ability to understand:

• Business research techniques to assess existing design, business and/or organisation
• Types of innovation
• Associated dimensions of innovation
• People, Objects, Environment, Message/Media Services (POEMS) framework and associated tools
• Characteristics of user journey mapping</td></tr>
<tr><td>Application and Adaptation

It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.</td><td colspan="3">The ability to:

• Identify the strategic intents of the organisation’s business
• Understand the core values of the organisation’s business through its mission and vision statements
• Conduct assessments of the organisation’s existing design, business and organisation
• Undertake the user journey mapping process to identify user touch points in sequence</td></tr>
<tr><td>Innovation and Value Creation

It refers to the ability to generate</td><td colspan="3">The ability to:

• Apply POEMS framework to identify opportunities to create new user experiences, based on the five categories</td></tr>
</table>

purposive ideas to improve work performance and/or enhance business values that are aligned to organisational	
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	N/A
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	N/A
Range of Application (where applicable) *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	Methods to assess the organisation's existing design, business, and organisation must include: • Identifying the risk appetite of the organisation • Identifying the strengths and weaknesses in business and design capabilities • Identifying the strengths and weaknesses of the business model • Assessing the organisation's innovation risk tolerance • Assessing the organisation in the context of competition and prevailing factors affecting the industry People, Objects, Environment, Message/Media, Services (POEMS) framework to identify opportunities for creating new user experiences, based on the five categories must include:

	• People – individuals involved in the activity • Objects – things people interact with while doing the activity • Environment – the space, settings or location where the activity takes place • Message/Media – information that is transferred during the activity • Services – person or system offering services to enable the activity

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Skill Code	PRE-HRM-6006-1	**Skill Category**	Human Resource Management
		Skill Sub-Category *(where applicable)*	N/A
Skill	Conduct Interviews and Make Hiring Decisions		
Skill Description	This skill describes the ability to conduct interview and make hiring decisions for the business unit. It also includes an awareness of fair employment practices, market trends and developments in relation to interview processes and techniques.		
Knowledge and Analysis *It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.*	The ability to understand: • Fair employment practices, tripartite guidelines for fair employment relating to recruitment and selection • Legal and ethical considerations relating to recruitment and selection data and processes • Organisational policies and procedures • Models and methods for evaluating and shortlisting applicants • Communication and negotiation techniques • Market trends and developments in relation to interview processes and techniques		
Application and Adaptation *It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.*	The ability to: • Evaluate all applications to shortlist candidates for the interview • Evaluate data gathered from the interview session to select preferred candidate		
Innovation and Value Creation *It refers to the ability to generate purposive ideas to*	N/A		

improve work performance and/or enhance business values that are aligned to organisational	
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Adhere to privacy and confidentiality considerations that govern all human resource transactions • Conduct the selection interview using appropriate interview techniques to review applicants' suitability
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Critically appraise one's performance in the interview process for future interview sessions
Range of Application (where applicable) *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	N/A

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Skill Code	PRE-ICT-5002-1	**Skill Category**	Info-Communication Technologies
		Skill Sub-Category *(where applicable)*	N/A
Skill	Produce Advanced Spreadsheet Outputs using Spreadsheet Applications		
Skill Description	This skill describes the ability to use spreadsheet applications to produce advanced spreadsheet outputs for management reports. It also includes in-depth knowledge of MS Excel, including its features.		
Knowledge and Analysis *It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.*	The ability to understand: • Formatting of cells and worksheets • Functions and formulas • Charts • Analyses with tables, sorting and filtering		
Application and Adaptation *It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.*	The ability to: • Apply advanced formatting options in handling worksheets • Use functions associated with logical, statistical, financial and mathematical operations • Create charts and apply advanced chart formatting features • Work with tables and lists to analyse, filter and sort data • Use linking, embedding and importing features to integrate data		
Innovation and Value Creation *It refers to the ability to generate purposive ideas to improve work*	The ability to: • Enhance productivity by working with named cell ranges, macros and templates		

performance and/or enhance business values that are aligned to organisational	
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Validate and audit spreadsheet data • Collaborate on and review spreadsheets with key stakeholders
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	N/A
Range of Application (where applicable) *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	N/A

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Skill Code	PRE-IPR-5001-1	**Skill Category**	Intellectual Property
		Skill Sub-Category *(where applicable)*	N/A
Skill	Apply Basic Knowledge of Intellectual Property (IP) to support IP-related Organisational Procedures		
Skill Description	This skill describes the ability to analyse the various types of Intellectual Property (IP) supporting organisational procedures and applying IP knowledge to support implementation of IP registration procedures Singapore.		
Knowledge and Analysis *It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.*	The ability to understand: • Definition of Intellectual Property (IP) • Types of IP • Sources from which information about IP can be obtained • Registration procedures of various types of IP in Singapore		
Application and Adaptation *It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.*	The ability to: • Analyse various types of IP in accordance with organisational procedures • Collate necessary IP-related materials for IP applications • Support organisational procedures, in collaboration with appropriate IP experts • Apply IP knowledge to support implementation of IP registration procedures in Singapore		
Innovation and Value Creation *It refers to the ability to generate purposive ideas to improve work*	The ability to: • Implement organisational IP-review processes		

performance and/or enhance business values that are aligned to organisational	
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	N/A
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	N/A
Range of Application (where applicable) *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	Types of IP must include: • Copyrights • Registered and unregistered trade marks (including certification marks, and a consideration of domain names and company/business names) • Patents, which may include software • Trade secrets and confidential information • Registered designs • Plant varieties • Geographical indications • Layout-design of integrated circuits

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

<table>
<tr><td rowspan="2">Skill Code</td><td rowspan="2">LPM-PER-501C-0</td><td>Skill Category</td><td>Personal Management and Development</td></tr>
<tr><td>Skill Sub-Category
(where applicable)</td><td>N/A</td></tr>
<tr><td>Skill</td><td colspan="3">Develop Self to Maintain Professional Competence at Senior Management Level</td></tr>
<tr><td>Skill Description</td><td colspan="3">This skill describes the ability to improve organisational communications and influence decision-making as a senior member of a business unit or division. It also includes developing own leadership style and capability.</td></tr>
<tr><td>Knowledge and Analysis

It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.</td><td colspan="3">The ability to understand:

• Legal and ethical considerations relating to organisational communications, decision-making and personal conduct at the workplace
• Organisational policies and procedures relating to organisational communications and development of professional competence
• Implications and impact of organisational communication processes on stakeholders
• Implications and impact of own leadership style and capability on employees and the organisation
• The relationship between high level organisational strategy and the development and implementation of business plans and processes at business unit or divisional level
• Underlying issues and trends that may affect decision-making by stakeholders</td></tr>
<tr><td>Application and Adaptation

It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.</td><td colspan="3">The ability to:

• Use appropriate methods of communication to promote the organisation
• Encourage and display effective communication techniques and behaviours to demonstrate the organisation’s values and ethics
• Work with the leadership team to develop plans to achieve strategic priorities and directions of the organisation</td></tr>
</table>

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Innovation and Value Creation *It refers to the ability to generate purposive ideas to improve work performance and/or enhance business values that are aligned to organisational goals.*	The ability to: • Collaborate with stakeholders to develop communication channels and enhance organisational communications
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Influence stakeholders to pursue actions which support the achievement of the organisation's strategic priorities and directions • Maintain integrity of self throughout the decision-making process to meet requirements on organisational code of conduct decision-making • Apply emotional intelligence to guide own thinking and actions when interacting with stakeholders • Demonstrate alignment between personal ethics and values and those of the organisation to develop own leadership style
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Use opportunities to self-reflect on own work performance and leadership style to identify areas for improvement • Maintain awareness and understanding of the skills and knowledge of colleagues and competitors to identify professional development opportunities for self
Range of Application *(where applicable)* *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	N/A

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

<table>
<tr><td rowspan="2">Skill Code</td><td rowspan="2">LPM-RLT-501C-0</td><td>Skill Category</td><td>People and Relationship Management</td></tr>
<tr><td>Skill Sub-Category
(where applicable)</td><td>N/A</td></tr>
<tr><td>Skill</td><td colspan="3">Foster Business Relationships and Organisational Diversity</td></tr>
<tr><td>Skill Description</td><td colspan="3">This skill describes the ability to develop effective working relationships and networks to provide strategic value to the organisation. It also includes developing and maintaining business and professional networks and encouraging workforce diversity and cooperation through strategies and conflict management.</td></tr>
<tr><td>Knowledge and Analysis

It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.</td><td colspan="3">The ability to understand:

• Legal and ethical considerations relating to organisational participation in networking and opportunities for collaboration, workplace diversity and conflict management
• Organisational policies and procedures relating to business networking, organisational diversity and conflict management
• Relevant professional or industry codes of practice and standards for managing organisational diversity and business networking
• Relevant professional or industry codes of practice and standards relating to business networking
• Relevant local, regional and international networks
• Common barriers to developing a diverse and cooperative workplace</td></tr>
<tr><td>Application and Adaptation

It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.</td><td colspan="3">The ability to:

• Identify and prioritise networks which may provide strategic value to the organisation or the individuals to facilitate networking decisions
• Identify and review the constraints that may affect participation in networks to develop appropriate responses
• Pursue collaborative opportunities to support mutually beneficial outcomes
• Develop strategies to support diversity and cooperation at all levels of the organisation
• Identify sources of conflict and negotiate issues to reach acceptable outcomes</td></tr>
</table>

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Innovation and Value Creation *It refers to the ability to generate purposive ideas to improve work performance and/or enhance business values that are aligned to organisational goals.*	The ability to: • Review the effectiveness of conflict management strategies and take action to prevent recurrence of conflict
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Manage relationships to achieve cross-cultural cooperation and positive outcomes for individuals, teams and the organisation • Support individuals to attain respect and address instances of unfairness or discrimination to promote a positive working environment • Adjust interpersonal style and respond appropriately to emotional cues when interacting with others to meet the requirements of the social and cultural business context
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Keep abreast of organisational diversity management strategies by subscribing to diverse learning channels and participating in peer discussion platforms to enhance own knowledge for workplace application
Range of Application *(where applicable)* *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	N/A

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Skill Code	BM-PM-505E-1	**Skills Category**	Project Management
		Skills Sub-Category *(where applicable)*	N/A
Skill	Lead Programme and Project After-Action Review		
Skill Description	This skill describes the ability to lead a programme and project after action review (AAR). It includes setting programme and project AAR policies and guidelines, directing AAR discussions, as well as evaluating and following up on the implications of the AAR findings to establish improvements		
Knowledge and Analysis *It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.*	The ability to understand: • Objectives of an after action review (AAR) • Potential programme and project management issues		
Application and Adaptation *It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.*	The ability to: • Set programme and project AAR policies and guidelines in order to encourage continuous improvement and learning • Direct discussion to assess programme and project management outcomes • Evaluate implications of AAR findings and discussion topics on project management functions, organisational processes and procedures to determine follow-up actions		
Innovation and Value Creation *It refers to the ability to generate purposive ideas to improve work*	The ability to: • Establish improvements to project management functions and organisational processes and procedures based on AAR findings to enhance organisational performance		

performance and/or enhance business values that are aligned to organisational	
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Demonstrate openness to feedback to set an open atmosphere to encourage active participation in AAR discussions
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Improve own capability in leading AAR by subscribing to diverse learning channels and discussion platforms to enhance workplace performance
Range of Application (where applicable) *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	N/A

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Skill Code	BM-SPI-509E-1	**Skill Category**	Strategy Planning and Implementation
		Skill Sub-Category *(where applicable)*	N/A
Skill	Establish Strategies for the Business Function		
Skill Description	This skill describes the ability to develop business strategies for a business function. It also includes evaluating impact of critical business functions and internal and external factors, conducting situational analysis, as well as formulating and presenting business function strategies for management's approval and reviewing and refining them on a regular basis.		
Knowledge and Analysis *It refers to gathering, cognitive processing, integration and inspection of facts and information required to perform the work tasks and activities.*	The ability to understand: • Objectives of functional strategies • Own role in conduct of situational analysis • Critical business functions		
Application and Adaptation *It refers to the ability to perform the work tasks and activities required of the occupation, and the ability to react to and manage the changes at work.*	The ability to: • Evaluate impact of critical business functions on organisational performance to identify implications for strategy formulation • Conduct situational analysis to identify factors affecting the organisation • Analyse impact of internal and external influencing factors on business function strategies to facilitate strategy formulation • Formulate business function strategies to align to organisational strategies, goals and objectives • Present business function strategies to management to seek endorsement		
Innovation and Value Creation	The ability to: • Review and refine business function strategies on a regular basis to		

It refers to the ability to generate purposive ideas to improve work performance and/or enhance business values that are aligned to organisational	align with organisational strategies, goals and objectives
Social Intelligence and Ethics *It refers to the ability to use affective factors in leadership, relationship and diversity management guided by professional codes of ethics.*	The ability to: • Apply emotional intelligence to guide one's thinking and actions when seeking management endorsement on business function strategies to ensure individual concerns are acknowledged and addressed
Learning to Learn *It refers to the ability to develop and improve one's self within and outside of one's area of work.*	The ability to: • Improve own capability in developing business unit strategies by subscribing to diverse learning channels to enhance workplace performance
Range of Application (where applicable) *It refers to the critical circumstances and contexts that the skill may be demonstrated.*	N/A

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Version Control

Version	Date	Changes Made	Edited by
1.0	12 October 2016	Initial Version	SSG and EDB

SKILLS FRAMEWORK FOR PRECISION ENGINEERING
SKILLS STANDARDS FOR
SENIOR ENGINEER

Definitions of the Five (5) Domains

Domain	Definition
Knowledge and Analysis	Knowledge includes the gathering of facts and information through traditional and digital forms. Analysis involves the cognitive processing, integration and inspection of single or multiple sources of facts and information required to perform work tasks and activities and takes into consideration, the work contexts in which the tasks and activities are carried out. The result of knowledge and analysis produce judgements on work tasks/activities/issues/areas, and the conceptualisation of solutions to solve problems at work.
Application and Adaptation	Application involves the ability to perform work tasks and activities defined by the requirements of the occupation. Adaptation involves the ability to react to and manage the changes in the work contexts. The result of application and adaptation leads to the production of psycho-motor actions and behavioural reactions to the work tasks/activities/issues/areas, and the execution of the planned solutions to solve problems at work.
Innovation and Value Creation	Innovation includes the ability to generate purposive ideas to improve work performance and/or enhance business values that are aligned to the organisational goals. As a result of innovation, the organisation is able to reap the values from individual or team contributors to achieve organisational growth.
Social Intelligence and Ethics	Social intelligence includes the ability to appreciate and use affective factors in leadership, relationship and diversity management guided by professional codes of ethics as effective individuals or team contributors.
Learning to Learn	Learning-to-learn includes the ability to improve on self-development within and outside of one's area of work. It involves the continual inspection of one's knowledge, analytical, application, adaptive, innovative and social skills that are needed to perform the work optimally and/or solve problems effectively.