California CTE

Manufacturing and Product Development

Adopted 2013

Knowledge and Performance

1 Academics 1.0

2 Communications 2.0

1 Recognize the elements of communication using a sender–receiver model. 2.1

2 Identify barriers to accurate and appropriate communication. 2.2

3 Interpret verbal and nonverbal communications and respond appropriately. 2.3

4 Demonstrate elements of written and electronic communication such as accurate spelling, grammar, and format. 2.4

5 Communicate information and ideas effectively to multiple audiences using a variety of media and formats. 2.5

6 Advocate and practice safe, legal, and responsible use of digital media information and communications technologies. 2.6

3 Career Planning and Management 3.0

1 Identify personal interests, aptitudes, information, and skills necessary for informed career decision making. 3.1

2 Evaluate personal character traits such as trust, respect, and responsibility and understand the impact they can have on career success. 3.2

3 Explore how information and communication technologies are used in career planning and decision making. 3.3

4 Research the scope of career opportunities available and the requirements for education, training, certification, and licensure. 3.4

5 Integrate changing employment trends, societal needs, and economic conditions into career planning. 3.5

6 Recognize the role and function of professional organizations, industry associations, and organized labor in a productive society. 3.6

7 Recognize the importance of small business in the California and global economies. 3.7

8 Understand how digital media are used by potential employers and postsecondary agencies to evaluate candidates. 3.8

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9 Develop a career plan that reflects career interests, pathways, and postsecondary options. 3.9

4 Technology 4.0

1 Use electronic reference materials to gather information and produce products and services. 4.1

2 Employ Web-based communications responsibly and effectively to explore complex systems and issues. 4.2

3 Use information and communication technologies to synthesize, summarize, compare, and contrast information from multiple sources. 4.3

4 Discern the quality and value of information collected using digital technologies, and recognize bias and intent of the associated sources. 4.4

5 Research past, present, and projected technological advances as they impact a particular pathway. 4.5

6 Assess the value of various information and communication technologies to interact with constituent populations as part of a search of the current literature or in relation to the information task. 4.6

5 Problem Solving and Critical Thinking 5.0

1 Identify and ask significant questions that clarify various points of view to solve problems. 5.1

2 Solve predictable and unpredictable work-related problems using various types of reasoning (inductive, deductive) as appropriate 5.2

3 Use systems thinking to analyze how various components interact with each other to produce outcomes in a complex work environment. 5.3

4 Interpret information and draw conclusions, based on the best analysis, to make informed decisions. 5.4

6 Health and Safety 6.0

1 Locate, and adhere to, Material Safety Data Sheet (MSDS) instructions. 6.1

2 Interpret policies, procedures, and regulations for the workplace environment, including employer and employee responsibilities. 6.2

3 Use health and safety practices for storing, cleaning, and maintaining tools, equipment, and supplies. 6.3

4 Set up a work area, or shop, to avoid potential health concerns and safety hazards including but not limited to ergonomics, electrical (shock), wires (tripping), fumes (lung health), noise (hearing loss), fire (burns), and so forth, incorporating ergonomics. 6.4

5 Practice personal safety when lifting, bending, or moving equipment and supplies. 6.5

6 Demonstrate how to prevent and respond to work-related accidents or injuries and emergencies. 6.6

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7 Maintain a safe and healthful working environment. 6.7

8 Be informed of laws/acts pertaining to the Occupational Safety and Health Administration (OSHA). 6.8

7 Responsibility and Flexibility 7.0

1 Recognize how financial management impacts the economy, workforce, and community. 7.1

2 Explain the importance of accountability and responsibility in fulfilling personal, community, and workplace roles. 7.2

3 Understand the need to adapt to changing and varied roles and responsibilities. 7.3

4 Practice time management and efficiency to fulfill responsibilities. 7.4

5 Apply high-quality techniques to product or presentation design and development. 7.5

6 Demonstrate knowledge and practice of responsible financial management. 7.6

7 Demonstrate the qualities and behaviors that constitute a positive and professional work demeanor, including appropriate attire for the profession. 7.7

8 Explore issues of global significance and document the impact on the Manufacturing and Product Design sector. 7.8

8 Ethics and Legal Responsibilities 8.0

1 Access, analyze, and implement quality assurance standards of practice. 8.1

2 Identify local, district, state, and federal regulatory agencies, entities, laws, and regulations related to the Manufacturing and Product Development industry sector. 8.2

3 Demonstrate ethical and legal practices consistent with Manufacturing and Product Design sector workplace standards. 8.3

4 Explain the importance of personal integrity, confidentiality, and ethical behavior in the workplace. 8.4

5 Analyze organizational culture and practices within the workplace environment. 8.5

6 Adhere to copyright and intellectual property laws and regulations, and use and appropriately cite proprietary information. 8.6

7 Conform to rules and regulations regarding sharing of confidential information, as determined by Manufacturing and Product Design sector laws and practices. 8.7

9 Leadership and Teamwork 9.0

1 Define leadership and identify the responsibilities, competencies, and behaviors of successful leaders. 9.1

Identify the characteristics of successful teams, including leadership, cooperation, collaboration, and effective decision-making skills as applied in groups, teams, and career technical student organization activities. 9.2

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3 Understand the characteristics and benefits of teamwork, leadership, and citizenship in the school, community, and workplace setting. 9.3

4 Explain how professional associations and organizations and associated leadership development and competitive career development activities enhance academic preparation, promote career choices, and contribute to employment opportunities. 9.4

5 Understand that the modern world is an international community and requires an expanded global view. 9.5

6 Respect individual and cultural differences and recognize the importance of diversity in the workplace. 9.6

7 Participate in interactive teamwork to solve real Manufacturing and Product Design sector issues and problems. 9.7

10 Technical Knowledge and Skills 10.0

1 Interpret and explain terminology and practices specific to the Manufacturing and Product Design sector. 10.1

2 Comply with the rules, regulations, and expectations of all aspects of the Manufacturing and Product Design sector. 10.2

3 Construct projects and products specific to the Manufacturing and Product Design sector requirements and expectations. 10.3

4 Collaborate with industry experts for specific technical knowledge and skills. 10.4

11 Demonstration and Application 11.0

1 Utilize work-based/workplace learning experiences to demonstrate and expand upon knowledge and skills gained during classroom instruction and laboratory practices specific to the Manufacturing and Product Design sector program of study. 11.1

2 Demonstrate proficiency in a career technical pathway that leads to certification, licensure, and/or continued learning at the postsecondary level. 11.2

3 Demonstrate entrepreneurship skills and knowledge of self-employment options and innovative ventures. 11.3

4 Employ entrepreneurial practices and behaviors appropriate to Manufacturing and Product Design sector opportunities. 11.4

5 Create a portfolio, or similar collection of work, that offers evidence through assessment and evaluation of skills and knowledge competency as contained in the anchor standards, pathway standards, and performance indicators. 11.5

Pathway Standards **A. Graphic Production Technologies**

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1. Apply the basic graphic design principles to achieve effective visual communication. A1.0
    1. Identify the relationships between space, color, image, and content. A1.1
    2. Demonstrate the graphic design principles and the utilization of the grid system in applying those principles. A1.2
    3. Create a basic layout applying images, text, and typography. A1.3
    4. Create and choose font styles. A1.4
2. Demonstrate an understanding of the psychology of color and color theory as it relates to visual communication. A2.0
    1. Understand the science of color spectrum and other aspects of color as it relates to hue, value, and chroma. A2.1
    2. Explain the differences between methods used to describe color, including cyan, magenta, yellow, black (CMYK) and red, green, blue (RGB). A2.2
    3. Produce a printed product in monotone and in multicolor. A2.3
3. Apply graphic design software and desktop publishing as a means of creating effective communication. A3.0
    1. Differentiate between and operate Macintosh (Mac) and personal computer (PC) platforms for development. A3.1
    2. Apply desktop publishing and electronic imaging software principles and processes used to prepare graphic design products. A3.2
    3. Demonstrate how to produce single and multicolor images and know how to apply them across various types of printed products. A3.3
    4. Create a visually effective layout that communicates an intention using graphic software that integrates graphics, text, photographic imagery, and color. A3.4
    5. Produce a printed product that demonstrates the application of graphic design principles and color theory using desktop publishing and electronic imaging software. A3.5
4. Demonstrate technical illustration and vector drawing skills. A4.0
    1. Create technical illustration and vector drawings. A4.1
    2. Convert and edit formats including encapsulated postscript (eps), drawing (dwg), and portable document file (pdf). A4.2
5. Adhere to the prepress process and procedures required to reproduce single-color and multicolor printing. A5.0
    1. Gain proficiency in applying the principles and processes used to prepare design work for the prepress phase of graphic design. A5.1
    2. Explain the differences in prepress for different output printing methods. A5.2
    3. Produce a printed product with the use of desktop publishing and electronic imaging software starting with the prepress phase through to reproduction. A5.3

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6 Apply the processes and procedures involved in producing image files for the reproduction of single-color and multicolor products. A6.0

1 Identify the variables that affect the image transfer process for reproduction. A6.1

2 Employ the process for creating image files that are appropriate for graphic design reproduction and specified printing requirements. A6.2

7 Develop a proficiency in applying the processes and procedures required for the reproduction of printed products and the image transfer process. A7.0

1 Explain how various processes may be used to produce multiple-imaged copies. A7.1

2 Identify the variables that affect the image transfer process. A7.2

3 Produce a single-color and multicolor quality project applying the procedures and image transfer processes with a minimum of waste. A7.3

8 Understand various binding and finishing processes. A8.0

1 Identify the variations, characteristics, and functions of binding and finishing operations in the production of printed products. A8.1

2 Produce a bound and finished product such as a notepad, brochure, or booklet. A8.2

9 Demonstrate an understanding of the screen printing process. A9.0

1 Identify the various applications of screen printing and the outcomes it produces. A9.1

2 Identify materials and operations used in the screen printing process. A9.2

3 Identify the variables that affect the image and results of the screening process. A9.3

4 Produce a screen printed product on various substrates using appropriate inks and procedures. A9.4

10 Understand the analog and digital photographic applications. A10.0

1 Employ various photographic technology, processes, and materials used in graphic design. A10.1

2 Identify the visual characteristics and differences between analog and digital outputs. A10.2

3 Apply the principles of composition and lighting used in photography. A10.3

4 Produce black-and-white and color images under natural and studio lighting conditions in both analog and digital output. A10.4

11 Apply various animation and motion graphic software to create dynamic visual communication outcomes. A11.0

1 Explore and apply animated effects to the elements of design, which include text, color, and imagery. A11.1

2 Produce a visually dynamic communication project that applies animated effects to various elements of the design. A11.2

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12 Demonstrate a proficiency in digital video production and the postproduction process. A12.0

1 Identify the functions involved in the preproduction, production, and postproduction phases of video production. A12.1

2 Apply digital video technology processes and procedures used in producing a multimedia project. A12.2

3 Produce a digital media project from a storyboard utilizing current production and postproduction technologies. A12.3

13 Understand and apply integrated graphic multimedia technologies, combining graphics, photographic imagery, motion graphics and animation, video, and special effects. A13.0

1 Apply design strategies in selecting graphic multimedia technologies to produce dynamic effective visual communication. A13.1

2 Practice the steps in producing an integrated graphic multimedia project designed to inform, teach, or sell. A13.2

3 Produce an integrated graphic multimedia project. A13.3

14 Identify the different industries that utilize graphic design and identify other potential business opportunities for graphic design applications. A14.0

1 Apply research methodologies and business and entrepreneurial principals to identify potential business opportunities to apply graphic and multimedia design. A14.1

B. Machining and Forming Technologies

1 Validate that a provided part meets specifications from its engineering drawing by comparing specifications (geometric dimensioning and tolerancing) and by demonstrating proper technique using appropriate precision measuring tools. B1.0

1 Identify and describe how the isometric and the orthographic views and the tolerance, scale, and material from an engineering drawing are used with an actual part. B1.1

2 Demonstrate the correct use of precision measuring tools such as vernier and dial calipers, height gages, and micrometers utilizing both English and Metric systems. B1.2

3 Demonstrate the correct use of a gage block (set) to check a part or to calibrate the accuracy of other precision measuring tools. B1.3

4 Explain calibration, tolerancing, and conditions that cause parts to fall out of tolerance. B1.4

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2. Describe and layout a project according to specifications or engineering drawings. Demonstrate proper technique with layout tools and work-holding devices such as three- and four-jaw chucks, collet chucks, angle plates, sine bars, parallels, and v-blocks to machine a real part. B2.0
    1. Describe and then contrast when to use work-holding fixtures, such as v-block, angle plate, toe clamp, vises, chucks, or custom fixtures. B2.1
    2. Describe and demonstrate how to indicate a vice on a milling machine to "square up" a block on a mill using a micrometer and a precision square measure to confirm that the block is square. B2.2
    3. Use a dividing head or turn table to demonstrate the proper procedure for indexing a part requiring flats, hex, or equally spaced geometry per print specifications. B2.3
    4. Use a surface plate, surface gage, height gage, prick and center punches, scriber, layout dye, and other appropriate tools to locate hole centers, radii, and locations matching the specifications provided. B2.4
    5. Describe and demonstrate the engine lathe by grinding a high speed tool bit focusing on the tool cutting geometry and tip radius, speeds and feeds for the materials being cut and using their tool bit and precision measuring tool, machine a part within specifications. B2.5
3. Research and compare the properties of two metals using two different material specifications and a process specification. B3.0
    1. Classify the difference between ferrous and nonferrous metals and contrast low-, medium-, and high-carbon steels by their common uses in industry. B3.1
    2. Describe both the alloys from their classification systems utilizing Unified Numbering System (UNS) or American Iron and Steel Institute-Society of Automotive Engineers (AISI-SAE) and explain how characteristics such as the Rockwell Hardness Test affect machining operations. B3.2
    3. Demonstrate how to calculate, then revise the calculations, for spindle speed and feed rate, for both alloy examples, for either a vertical mill or a lathe. B3.3
4. Demonstrate a cutoff saw operation(s) to produce a length of bar stock to specification. B4.0
    1. Using a length of bar stock and a process specification or drawing, cut a length of bar stock matching the cut list and demonstrate no sharp edges. B4.1
    2. Cut one steel bar and one aluminum plate determining the correct or optimal blade material (carbon steel, high speed, or bimetal), the proper sawtooth set to use for each, and explain why. B4.2

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5 Demonstrate bending, shaping, other metal forming, and fabrication techniques, including processes such as basic hand filing, knurling on a lathe, forging metal shapes or objects, green sand casting, sheet metal machines, spot welding equipment or rivets, cold form bending with cold forming machinery or homemade devices, and shapes (tooling) to achieve a specific design specification. B5.0

1 Discuss and demonstrate the wide variety of metal cutting hand files: materials, sizes, shapes, cuts, and tooth configurations. B5.1

2 Describe and demonstrate the care and use of the common file which can be used to form radii on a variety of commercially available metals or those that have been casted or forged. B5.2

3 Describe and demonstrate cold forming (i.e. knurling on a lathe). B5.3

4 Describe and demonstrate the safe use of the open forge, anvil, and tooling to custom shape hot metal. B5.4

5 Describe and demonstrate the process of making a pattern, mulling and chemistry of the green sand, the use of parting powder, and ramming the casting flasks. B5.5

6 Describe and demonstrate the safety procedures of heating and pouring the metal (aluminum, brass, or bronze) from a crucible furnace. B5.6

7 Produce a cast part and finish to specifications. B5.7

8 Describe and demonstrate the safe use of sheet metal shears, box and pan breaks, bar folders, spot welders, and riveting tools. B5.8

9 Complete a layout project using a detailed set of sequential instructions to manufacture the project to plan specifications. B5.9

6 Identify and select the right grinding wheel; perform wheel dressing; and grind the provided part/material to the size and surface finish specifications provided. B6.0

1 Set up and safely operate pedestal and surface grinders. B6.1

2 Recommend a choice of grinding wheels for a variety of conditions determining which ones are serviceable for use and selecting the right size, mounting, and dressing for grinding. B6.2

3 Complete a part in semi-finished (oversize) state; square-up and finish the block to the tolerance for size, surface finish, and squareness specified by the plan or drawing. B6.3

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7. Perform a series of routine boring operations from a set of specifications or a drawing and explain the selection of proper tools (drill, reamer, countersink, spot facer, counter bore, tap, and center drill) for each step of the process. B7.0
    1. Set up and safely operate a drill press. B7.1
    2. Square-up and lay out a block according to provided drawing and/or specifications. B7.2
    3. Drill, tap, or ream holes according to specifications. B7.3
    4. Research the proper material machinability and tooling recommendations from trade resources such as 'Machinery's Handbook'; choose the correct tool and holder; and calculate the spindle rpm and the feed rate for holes. B7.4
    5. Perform secondary operations on each hole to specification including: reaming, countersinking, counter boring, tapping, and deburring. B7.5
    6. Use a pin gage or thread gage to validate each hole or that a tapped thread meets specifications. B7.6
8. Describe and demonstrate the machining of an external and internal taper, knurled part, and threaded and bored part on an engine lathe to plan specification or drawing to produce a part and measure each end diameter within tolerance. B8.0
    1. Demonstrate proper cutting tool selection and speeds for an engine lathe. B8.1
    2. Set up and safely operate an engine lathe taper attachment or turning center. B8.2
    3. Produce a shoulder-bushing to the specification of the drawing provided. B8.3
9. Produce parts to specification using a boring head or angular cutting with a sine bar, a keyway, and pockets with a typical vertical mill. B9.0
    1. Set up and safely operate a vertical milling machine. B9.1
    2. Demonstrate proper cutting tool selection and speeds and demonstrate an efficient setup to minimize work-holding setups. B9.2
    3. Produce a part with keyway to specification demonstrating proper end mill selection, proper tool-path, and proper speeds. B9.3
    4. Mill an angular surface on a square block using a vice, sine bar, and gage blocks; measure angle to ensure it meets the specification. B9.4

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10 Produce parts to specifications or drawings provided on a computer numerical controlled (CNC) mill or lathe. Demonstrate common functions or controls through manual input and through programmed (stored) input. Introduce basic G and M Code Programming focusing on the use of the Cartesian coordinate system and machine axis. B10.0

1 Discuss and demonstrate the setup and safe operation of a CNC turning or milling center: the setup of tools in tool holders; referencing the vice or chuck to the machine's control; and referencing the cutting tool to the machine's control. B10.1

2 Demonstrate control panel commands to perform basic milling or turning commands for motion of the tool path along the coordinate axis. B10.2

3 Convert a provided three-dimensional (3-D) or computer-aided design (CAD) data set to a set of machine instructions (G code) and then run the program producing the part to specifications provided. B10.3

4 Demonstrate a tooling change and tool selection to complete a multistep process on a CNC milling or turning center. B10.4

5 Produce a part with tight-radius pocket features by demonstrating proper cutting tool selection, proper tool-path, and proper speeds on a CNC milling machine. B10.5

11 Understand and defend the purposes and processes of inspection and quality control in machining and forming processes. B11.0

1 Identify and explain machining and forming imperfections and their causes. B11.1

2 Identify and explain destructive and nondestructive examination practices. B11.2

3 Describe the reasons for inspection and quality control in the manufacturing of machined and formed parts. B11.3

4 Analyze and identify the steps to check for distortion, misalignment, and poor fit before and after and machining or forming a part. B11.4

5 Perform continuous online quality control inspections of machined and formed parts. B11.5

6 Evaluate and know how to troubleshoot performance problems of machined and formed parts. B11.6

C. Welding and Materials Joining

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1. Interpret and demonstrate the planning and layout operations used in the welding processes. C1.0
    1. Use current information technology ideation and design process systems in the manufacturing of welded parts and products. C1.1
    2. Interpret scaled welding blueprints; gather design and materials information; perform calculations; and use the detail to plan, lay out, and produce parts or finished products. C1.2
    3. Analyze welding symbols on drawings, specifications, and welding procedure specifications. C1.3
    4. Critique the design parameters across welding processes to produce a welded part or product. C1.4
2. Understand and demonstrate how materials can be processed through the use of welding tools and equipment. C2.0
    1. Introduce joint preparation methods and explain how to identify joint specifications. C2.1
    2. Use standard and new emerging welding tools and equipment, such as oxygen fuel cutting (OFC), plasma arc cutting (PAC), and carbon arc cutting (CAC) to cut materials for the purpose of completing a finished product that meets the standards of the AWS or a similar industry standard. C2.2
    3. Use welding tools and equipment such as oxy fuel welding (OFW), shielded metal arc welding (SMAW), gas metal arc welding (GMAW), flux-cored arc welding (FCAW), gas tungsten arc welding (GTAW), forge, and furnace to combine or join manufactured parts and products resulting in a finished product that meets the standards of the AWS or a similar industry standard. C2.3
    4. Compare and contrast the physical qualities of various industrial materials and how these qualities affect the ability of the materials to be processed to produce useful welded parts and products. C2.4
3. Differentiate and apply various types of welding assembly processes. C3.0
    1. Use welding tools such as OFW, SMAW, GMAW, FCAW, GTAW, forge, and furnace and the equipment and assembly processes appropriate to the design criteria of a specific product to result in a finished part or product that meets the standards of the AWS or similar industry welding standards. C3.1
    2. Produce bonded industrial materials by using adhesive such as flow, pressure, and fusion welding. C3.2
    3. Compare and contrast existing material bonding methods with future innovative bonding processes. C3.3

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4. Understand finishing processes and the differences between various types of finishing materials used in the manufacture of welded parts and products. C4.0
    1. Employ and explain the steps to be taken, and the choices to be made, in finishing welded materials. C4.1
    2. Apply the processes used for finishing welded materials. C4.2
    3. Assess how to select an appropriate finishing process to meet the design criteria of a specific welded product. C4.3
5. Understand and defend the purposes and processes of inspection and quality control in welding manufacturing processes. C5.0
    1. Identify and explain weld imperfections and their causes. C5.1
    2. Identify and explain destructive and nondestructive examination practices. C5.2
    3. Describe the reasons for inspection and quality control in the manufacturing of welded parts. C5.3
    4. Analyze and identify the steps to check for distortion, joint misalignment, and poor fit-up before and after welding. C5.4
    5. Perform continuous online quality control inspections of welded parts. C5.5
    6. Evaluate and know how to troubleshoot performance problems of welding systems. C5.6
6. Explore and understand various welding systems that require standard hand and machine tools. C6.0
    1. Select and use appropriate welding tools, equipment, and inspection devices to manufacture parts or products. C6.1
    2. Compare and contrast the various welding systems used in conventional manufacturing industries in order to select and use appropriate tools, equipment, and inspection devices. C6.2
    3. Research new and emerging welding systems and their effects on the standard hand and machine manufacturing industry. C6.3
7. Understand various automated welding systems, welding design for manufacturing, flexible manufacturing systems, and materials resource planning. C7.0
    1. Recognize materials and processes in relation to welding systems. C7.1
    2. Understand the importance of maintaining documentation for welding systems. C7.2
    3. Distinguish between welding processes involved in the following manufacturing systems: "just in time," design for manufacturing, flexible manufacturing systems, and materials resource planning. C7.3
    4. Use computers to design and produce welded products, write numerical control programs, and control robots. C7.4
    5. Compare and contrast the ways in which emerging welding systems may be integrated into current manufacturing processes. C7.5

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8 Understand various joining or combining processes, including welding processes used in manufacturing, maintenance, and repair. C8.0

1 Recognize the importance of base metal preparation and joint fit-up and alignment. C8.1

2 Analyze and be able to defend various welding processes used to complete a fabrication, an assembly, or a repair. C8.2

3 Produce a completed fabrication, an assembly, or a repair by using appropriate joining and mechanical fastening techniques and processes. C8.3

9 Understand how a manufacturing company is organized and the elements of welding production management. C9.0

1 Know how scheduling, quality control, accident prevention, and inventory control are used efficiently and appropriately in a welding production management system. C9.1

2 Understand that a welding production management system includes planning, engineering, organizing, and controlling resources and manufacturing processes. C9.2

3 Diagram corporate structures that affect welding production. C9.3

D. Product Innovation and Design

1 Understand the basic product design and development process as it relates to the design of a product, line of products, system design, or services. D1.0

1 Identify the variations in the product design and development process as it relates to the designing of a product, product line, system design, or service. D1.1

2 Apply and identify the various phases of the product design development process to an existing product, product line, system design, or service. D1.2

2 Understand and apply research methodologies as a means to identify a need, problem, or opportunity for a new product, product line, system design, or service. D2.0

1 Employ research methodologies, using primary research and electronic reference materials, to gather information relevant to the topic or area of opportunity. D2.1

2 Organize information to identify and define an area of opportunity, need, or problem that can be resolved through design. D2.2

3 Identify potential design areas (e.g., product, product line, system design, or service) that would address the need, problem, or opportunity. D2.3

4 Research and identify the user demographic for the product, product line, system design, or service (local, national, global market). D2.4

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3. Understand and apply various ideation techniques to develop ideas and concepts. D3.0
    1. Apply ideation techniques to explore and produce multiple concepts. D3.1
    2. Edit concepts and identify key idea(s) that solve the problem, fulfill a need, or address an opportunity. D3.2
    3. Assess the environmental impact of the design solution and other sustainability issues and product life cycle considerations. D3.3
    4. Synthesize information and experiment with nontraditional possibilities for innovative design solutions. D3.4
4. Apply various two-dimensional (2-D) graphic and/or three-dimensional (3-D) modeling techniques to development concept. D4.0
    1. Create a preliminary design of a product concept utilizing drawing, computer software (graphic or CAD), and/or conceptual model fabrication techniques. D4.1
    2. Identify materials, mechanisms, technologies, and other requirements (e.g., safety, manufacturing, sustainability) the concept may require. D4.2
    3. Analyze and assess the strengths and weaknesses in the design, function, ergonomics, features, and benefits and identify possible resolutions for improvement. D4.3
5. Develop the concept into a well-defined product for prototyping. D5.0
    1. Produce technical drawings and other specifications required for the prototyping or manufacturing of the product. D5.1
    2. Recognize the safety issues related to the reliability, functionality, and use of the product. D5.2
    3. Communicate and collaborate with fabricators, manufacturers, engineers, technologists, or other industry experts to review requirements and specifications and to validate the design. D5.3
6. Produce a prototype of a product. D6.0
    1. Build a looks-like, works-like prototype of the model using the appropriate fabrication, manufacturing, or reproduction techniques or technologies. D6.1
    2. Assess the outcome of the prototype product and analyze any issues that need redesigning or refining related to function, construction, or other factors. D6.2
    3. Resolve and/or redesign issues with a prototype. D6.3
7. Evaluate the prototype to determine if it meets the requirements and objectives. D7.0
    1. Create a performance criteria and a quality standard to measure and evaluate a prototype. D7.1
    2. Test the functionality and other features of the prototype against the performance criteria and quality standard and evaluate the results. D7.2
    3. Identify any redesigning or additional corrections required to improve the overall quality, look, and performance of the prototype model. D7.3

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8 Understand and apply basic business and entrepreneurial principles and identify potential markets and/or other business opportunities for distribution of the product. D8.0

1 Apply research methodologies to identify potential investors or business opportunities to market the product. D8.1

2 Create a marketing plan for the product that includes target consumer, price, product name, brand, and product positioning in the retail market. D8.2

9 Produce a package design concept for a product or line of products. D9.0

1 Understand physical packaging construction and materials used; e. g., chipboard, cardboard, PVC, plastic blisters, etc. as it relates to protecting the product, costs, and logistic requirements. D9.1

2 Understand and apply packaging graphic strategies that effectively communicate and influence the purchasing of the product. D9.2

3 Create a packaging concept utilizing drawing computer software (graphic or CAD). D9.3

4 Produce a physical package with graphics for the product. D9.4

10 Produce a presentation of the product, product line, system design, or service. D10.0

1 Create a presentation of the design solution (e.g., product, product line, system design, or service) that effectively communicates its features and benefits. D10.1

2 Integrate into the presentation a marketing plan that may include an advertisement, promotion, and packaging/retail strategy using one or more visual communication tools (e.g., graphics, multimedia). D10.2