



Manufacturing and Product Development Industry Sector

Career Pathways

- ◆ Graphic Arts Technology
- ◆ Integrated Graphics Technology
- ◆ Machine and Forming Technology
- ◆ Welding Technology



Manufacturing and Product Development Industry Sector

The Manufacturing and Product Development sector provides a foundation in manufacturing processes and systems, including machine tool, welding, graphic communications, and graphic design, for secondary students in California. Students engage in an instructional program that integrates academic and technical preparation and focuses on career awareness, career exploration, and skill preparation in four pathways. The pathways emphasize real-world, occupationally relevant experiences of significant scope and depth in manufacturing and in graphic communication. The knowledge and skills are acquired within a sequential, standards-based pathway program that integrates hands-on, project-based, and work-based instruction as well as internship, community classroom, work experience, apprenticeship, and cooperative career technical education. Standards included in the Manufacturing and Product Development sector are designed to prepare students for technical training, postsecondary education, and entry to a career.

FOUNDATION STANDARDS

1.0 Academics

Students understand the academic content required for entry into postsecondary education and employment in the Manufacturing and Product Development sector.

(The standards listed below retain in parentheses the numbering as specified in the mathematics, science, history–social science, and visual and performing arts content standards adopted by the State Board of Education.)

1.1 Mathematics

Specific applications of Number Sense standards (grade seven):

- (1.1) Read, write, and compare rational numbers in scientific notation (positive and negative powers of 10) with approximate numbers using scientific notation.

- (1.2) Add, subtract, multiply, and divide rational numbers (integers, fractions, and terminating decimals) and take positive rational numbers to whole-number powers.
- (1.3) Convert fractions to decimals and percents and use these representations in estimations, computations, and applications.
- (1.4) Differentiate between rational and irrational numbers.
- (1.5) Know that every rational number is either a terminating or a repeating decimal and be able to convert terminating decimals into reduced fractions.
- (1.6) Calculate the percentage of increases and decreases of a quantity.
- (1.7) Solve problems that involve discounts, markups, commissions, and profit and compute simple and compound interest.

Specific applications of Measurement and Geometry standards (grade seven):

- (2.4) Relate the changes in measurement with a change of scale to the units used (e.g., square inches, cubic feet) and to conversions between units (1 square foot = 144 square inches or $[1 \text{ ft}^2] = [144 \text{ in}^2]$, 1 cubic inch is approximately 16.38 cubic centimeters or $[1 \text{ in}^3] = [16.38 \text{ cm}^3]$).

Specific applications of Statistics, Data Analysis, and Probability standards (grade seven):

- (1.3) Understand the meaning of, and be able to compute, the minimum, the lower quartile, the median, the upper quartile, and the maximum of a data set.

Specific applications of Mathematical Reasoning standards (grade seven):

- (2.1) Use estimation to verify the reasonableness of calculated results.
- (2.2) Apply strategies and results from simpler problems to more complex problems.
- (2.3) Estimate unknown quantities graphically and solve for them by using logical reasoning and arithmetic and algebraic techniques.
- (2.4) Make and test conjectures by using both inductive and deductive reasoning.
- (2.5) Use a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, and models, to explain mathematical reasoning.
- (2.6) Express the solution clearly and logically by using the appropriate mathematical notation and terms and clear language; support solutions with evidence in both verbal and symbolic work.
- (2.7) Indicate the relative advantages of exact and approximate solutions to problems and give answers to a specified degree of accuracy.
- (2.8) Make precise calculations and check the validity of the results from the context of the problem.
- (3.1) Evaluate the reasonableness of the solution in the context of the original situation.
- (3.2) Note the method of deriving the solution and demonstrate a conceptual understanding of the derivation by solving similar problems.
- (3.3) Develop generalizations of the results obtained and the strategies used and apply them to new problem situations.

Specific applications of Algebra I standards (grades eight through twelve):

- (1.1) Students use properties of numbers to demonstrate whether assertions are true or false.
- (5.0) Students solve multistep problems, including word problems, involving linear equations and linear inequalities in one variable and provide justification for each step.
- (6.0) Students graph a linear equation and compute the x - and y - intercepts (e.g., graph $2x + 6y = 4$). They are also able to sketch the region defined by linear inequality (e.g., they sketch the region defined by $2x + 6y < 4$).
- (8.0) Students understand the concepts of parallel lines and perpendicular lines and how those slopes are related. Students are able to find the equation of a line perpendicular to a given line that passes through a given point.
- (10.0) Students add, subtract, multiply, and divide monomials and polynomials. Students solve multistep problems, including word problems, by using these techniques.
- (12.0) Students simplify fractions with polynomials in the numerator and denominator by factoring both and reducing them to the lowest terms.
- (15.0) Students apply algebraic techniques to solve rate problems, work problems, and percent mixture problems.

Specific applications of Geometry standards (grades eight through twelve):

- (8.0) Students know, derive, and solve problems involving the perimeter, circumference, area, volume, lateral area, and surface area of common geometric figures.
- (16.0) Students perform basic constructions with a straightedge and compass, such as angle bisectors, perpendicular bisectors, and the line parallel to a given line through a point off the line.
- (19.0) Students use trigonometric functions to solve for an unknown length of a side of a right triangle, given an angle and a length of a side.

1.2 Science

Specific applications of Physics standards (grades nine through twelve):

- (3.a) Students know heat flow and work are two forms of energy transfer between systems.
- (3.f) Students know the statement “Entropy tends to increase” is a law of statistical probability that governs all closed systems (second law of thermodynamics).
- (3.g) Students know how to solve problems involving heat flow, work, and efficiency in a heat engine and know that all real engines lose some heat to their surroundings.
- (5.a) Students know how to predict the voltage or current in simple direct current (DC) electric circuits constructed from batteries, wires, resistors, and capacitors.
- (5.b) Students know how to solve problems involving Ohm’s law.

Specific applications of Investigation and Experimentation standards (grades nine through twelve):

- (1.a) Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.
- (1.d) Formulate explanations by using logic and evidence.

1.3 *History–Social Science*

Specific applications of United States History and Geography: Continuity and Change in the Twentieth Century standards (grade eleven):

- (11.5) Students analyze the major political, social, economic, technological, and cultural developments of the 1920s.
- (11.5.7) Discuss the rise of mass production techniques, the growth of cities, the impact of new technologies (e.g., the automobile, electricity), and the resulting prosperity and effect on the American landscape.
- (11.7) Students analyze America’s participation in World War II.
- (11.7.6) Describe major developments in aviation, weaponry, communication, and medicine and the war’s impact on the location of American industry and use of resources.
- (11.8) Students analyze the economic boom and social transformation of post-World War II America.
- (11.8.7) Describe the effects on society and the economy of technological developments since 1945, including the computer revolution, changes in communication, advances in medicine, and improvements in agricultural technology.
- (11.11) Students analyze the major social problems and domestic policy issues in contemporary American society.
- (11.11.3) Describe the changing roles of women in society as reflected in the entry of more women into the labor force and the changing family structure.

1.4 *Visual and Performing Arts*

Specific applications of Visual Arts standards at the proficient level (grades nine through twelve):

- (2.3) Develop and refine skill in the manipulation of digital imagery (either still or video).

Specific applications of Visual Arts standards at the advanced level (grades nine through twelve):

- (5.3) Prepare portfolios of their original works of art for a variety of purposes (e.g., review for postsecondary application, exhibition, job application, and personal collection).

2.0 Communications

Students understand the principles of effective oral, written, and multimedia communication in a variety of formats and contexts.

(The standards listed below retain in parentheses the numbering as specified in the English–language arts content standards adopted by the State Board of Education.)

2.1 Reading

Specific applications of Reading Comprehension standards (grades nine and ten):

- (2.1) Analyze the structure and format of functional workplace documents, including the graphics and headers, and explain how authors use the features to achieve their purposes.
- (2.2) Prepare a bibliography of reference materials for a report using a variety of consumer, workplace, and public documents.
- (2.6) Demonstrate use of sophisticated learning tools by following technical directions (e.g., those found with graphic calculators and specialized software programs and in access guides to World Wide Web sites on the Internet).

Specific applications of Reading Comprehension standards (grades eleven and twelve):

- (2.3) Verify and clarify facts presented in other types of expository texts by using a variety of consumer, workplace, and public documents.
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2.2 Writing

Specific applications of Writing Strategies standards (grade eight):

- (1.4) Plan and conduct multiple-step information searches by using computer networks and modems.
- (1.5) Achieve an effective balance between researched information and original ideas.
- (1.6) Revise writing for word choice; appropriate organization; consistent point of view; and transitions between paragraphs, passages, and ideas.

Specific applications of Writing Strategies and Applications standards (grades nine and ten):

- (1.3) Use clear research questions and suitable research methods (e.g., library, electronic media, personal interview) to elicit and present evidence from primary and secondary sources.
- (1.4) Develop the main ideas within the body of the composition through supporting evidence (e.g., scenarios, commonly held beliefs, hypotheses, definitions).
- (1.5) Synthesize information from multiple sources and identify complexities and discrepancies in the information and the different perspectives found in each medium (e.g., almanacs, microfiche, news sources, in-depth field studies, speeches, journals, technical documents).
- (1.6) Integrate quotations and citations into a written text while maintaining the flow of ideas.

- (1.7) Use appropriate conventions for documentation in the text, notes, and bibliographies by adhering to those in style manuals (e.g., *Modern Language Association Handbook*, *The Chicago Manual of Style*).
- (1.8) Design and publish documents by using advanced publishing software and graphic programs.
- (2.3) Write expository compositions, including analytical essays and research reports:
 - a. Marshal evidence in support of a thesis and related claims, including information on all relevant perspectives.
 - b. Convey information and ideas from primary and secondary sources accurately and coherently.
 - c. Make distinctions between the relative value and significance of specific data, facts, and ideas.
 - d. Include visual aids by employing appropriate technology to organize and record information on charts, maps, and graphs.
 - e. Anticipate and address readers' potential misunderstandings, biases, and expectations.
 - f. Use technical terms and notations accurately.
- (2.6) Write technical documents (e.g., a manual on rules of behavior for conflict resolution, procedures for conducting a meeting, minutes of a meeting):
 - a. Report information and convey ideas logically and correctly.
 - b. Offer detailed and accurate specifications.
 - c. Include scenarios, definitions, and examples to aid comprehension (e.g., troubleshooting guide).
 - d. Anticipate readers' problems, mistakes, and misunderstandings.

Specific applications of Writing Strategies and Applications standards (grades eleven and twelve):

- (1.6) Develop presentations by using clear research questions and creative and critical research strategies (e.g., field studies, oral histories, interviews, experiments, electronic sources).
- (1.7) Use systematic strategies to organize and record information (e.g., anecdotal scripting, annotated bibliographies).
- (1.8) Integrate databases, graphics, and spreadsheets into word-processed documents.
- (2.5) Write job applications and résumés:
 - a. Provide clear and purposeful information and address the intended audience appropriately.
 - b. Use varied levels, patterns, and types of language to achieve intended effects and aid comprehension.
 - c. Modify the tone to fit the purpose and audience.
 - d. Follow the conventional style for that type of document (e.g., résumé, memorandum) and use page formats, fonts, and spacing that contribute to the readability and impact of the document.

- (2.6) Deliver multimedia presentations:
- a. Combine text, images, and sound and draw information from many sources (e.g., television broadcasts, videos, films, newspapers, magazines, CD-ROMs, the Internet, electronic media-generated images).
 - b. Select an appropriate medium for each element of the presentation.
 - c. Use the selected media skillfully, editing appropriately and monitoring for quality.
 - d. Test the audience's response and revise the presentation accordingly.

2.3 *Written and Oral English Language Conventions*

Specific applications of English Language Conventions standards (grade eight):

- (1.4) Edit written manuscripts to ensure that correct grammar is used.
- (1.5) Use correct punctuation and capitalization.
- (1.6) Use correct spelling conventions.

Specific applications of English Language Conventions standards (grades eleven and twelve):

- (1.2) Produce legible work that shows accurate spelling and correct punctuation and capitalization.

2.4 *Listening and Speaking*

Specific applications of Listening and Speaking Strategies and Applications standards (grade eight):

- (1.1) Analyze oral interpretations of literature, including language choice and delivery, and the effect of the interpretations on the listener.
- (1.2) Paraphrase a speaker's purpose and point of view and ask relevant questions concerning the speaker's content, delivery, and purpose.
- (1.3) Organize information to achieve particular purposes by matching the message, vocabulary, voice modulation, expression, and tone to the audience and purpose.
- (1.4) Prepare a speech outline based upon a chosen pattern of organization, which generally includes an introduction; transitions, previews, and summaries; a logically developed body; and an effective conclusion.
- (1.5) Use precise language, action verbs, sensory details, appropriate and colorful modifiers, and the active rather than the passive voice in ways that enliven oral presentations.
- (1.6) Use appropriate grammar, word choice, enunciation, and pace during formal presentations.
- (1.7) Use audience feedback (e.g., verbal and nonverbal cues):
 - a. Reconsider and modify the organizational structure or plan.
 - b. Rearrange words and sentences to clarify the meaning.
- (1.8) Evaluate the credibility of a speaker (e.g., hidden agendas, slanted or biased material).

- (1.9) Interpret and evaluate the various ways in which visual image makers (e.g., graphic artists, illustrators, news photographers) communicate information and affect impressions and opinions.
- (2.1) Deliver narrative presentations (e.g., biographical, autobiographical):
 - a. Relate a clear, coherent incident, event, or situation by using well-chosen details.
 - b. Reveal the significance of, and the subject's attitude about, the incident, event, or situation.
 - c. Employ narrative and descriptive strategies (e.g., relevant dialogue, specific action, physical description, background description, comparison or contrast of characters).
- (2.2) Deliver oral responses to literature:
 - a. Interpret a reading and provide insight.
 - b. Connect the students' own responses to the writer's techniques and to specific textual references.
 - c. Draw supported inferences about the effects of a literary work on its audience.
 - d. Support judgments through references to the text, other works, other authors, or personal knowledge.
- (2.3) Deliver research presentations:
 - a. Define a thesis.
 - b. Record important ideas, concepts, and direct quotations from significant information sources and paraphrase and summarize all relevant perspectives on the topic, as appropriate.
 - c. Use a variety of primary and secondary sources and distinguish the nature and value of each.
 - d. Organize and record information on charts, maps, and graphs.
- (2.4) Deliver persuasive presentations:
 - a. Include a well-defined thesis (i.e., one that makes a clear and knowledgeable judgment).
 - b. Differentiate fact from opinion and support arguments with detailed evidence, examples, and reasoning.
 - c. Anticipate and answer listener concerns and counterarguments effectively through the inclusion and arrangement of details, reasons, examples, and other elements.
 - d. Maintain a reasonable tone.
- (2.5) Recite poems (of four to six stanzas), sections of speeches, or dramatic soliloquies, using voice modulation, tone, and gestures expressively to enhance the meaning.

Specific applications of Speaking Applications standards (grades nine and ten):

- (2.2) Deliver expository presentations:
 - a. Marshal evidence in support of a thesis and related claims, including information on all relevant perspectives.
 - b. Convey information and ideas from primary and secondary sources accurately and coherently.
 - c. Make distinctions between the relative value and significance of specific data, facts, and ideas.
 - d. Include visual aids by employing appropriate technology to organize and display information on charts, maps, and graphs.
 - e. Anticipate and address the listener’s potential misunderstandings, biases, and expectations.
 - f. Use technical terms and notations accurately.
- (2.5) Deliver persuasive arguments (including evaluation and analysis of problems and solutions and causes and effects):
 - a. Structure ideas and arguments in a coherent, logical fashion.
 - b. Use rhetorical devices to support assertions (e.g., by appeal to logic through reasoning; by appeal to emotion or ethical belief; by use of personal anecdote, case study, or analogy).
 - c. Clarify and defend positions with precise and relevant evidence, including facts, expert opinions, quotations, expressions of commonly accepted beliefs, and logical reasoning.
 - d. Anticipate and address the listener’s concerns and counterarguments.

Specific applications of Listening and Speaking Strategies and Applications standards (grades eleven and twelve):

- (1.8) Use effective and interesting language, including:
 - a. Informal expressions for effect
 - b. Standard American English for clarity
 - c. Technical language for specificity
- (2.2) Deliver oral reports on historical investigations:
 - a. Use exposition, narration, description, persuasion, or some combination of those to support the thesis.
 - b. Analyze several historical records of a single event, examining critical relationships between elements of the research topic.
 - c. Explain the perceived reason or reasons for the similarities and differences by using information derived from primary and secondary sources to support or enhance the presentation.
 - d. Include information on all relevant perspectives and consider the validity and reliability of sources.

- (2.4) Deliver multimedia presentations:
- a. Combine text, images, and sound by incorporating information from a wide range of media, including films, newspapers, magazines, CD-ROMs, online information, television, videos, and electronic media-generated images.
 - b. Select an appropriate medium for each element of the presentation.
 - c. Use the selected media skillfully, editing appropriately and monitoring for quality.
 - d. Test the audience's response and revise the presentation accordingly.

2.5 *Multimedia:*

Understand the importance of technical and computer-aided design, drawing, and graphic technologies essential to the language of the industry; read, interpret, and create drawings, sketches, and schematics by using manufacturing and product development industry conventions and standards; interpret and understand detailed information provided from technical documents, both print and electronic, and experienced people; and use computers, calculators, multimedia equipment, and other devices in a variety of applications.

3.0 Career Planning and Management

Students understand how to make effective decisions, use career information, and manage personal career plans:

- 3.1 Know the personal qualifications, interests, aptitudes, knowledge, and skills necessary to succeed in careers.
- 3.2 Understand the scope of career opportunities and know the requirements for education, training, and licensure.
- 3.3 Develop a career plan that is designed to reflect career interests, pathways, and postsecondary options.
- 3.4 Understand the role and function of professional organizations, industry associations, and organized labor in a productive society.
- 3.5 Understand the past, present, and future trends that affect careers, such as technological developments and societal trends, and the resulting need for lifelong learning.
- 3.6 Know important strategies for self-promotion in the hiring process, such as job applications, résumé writing, interviewing skills, and preparation of a portfolio.

4.0 Technology

Students know how to use contemporary and emerging technological resources in diverse and changing personal, community, and workplace environments:

- 4.1 Understand past, present, and future technological advances as they relate to a chosen pathway.
- 4.2 Understand the use of technological resources to gain access to, manipulate, and produce information, products, and services.

- 4.3 Understand the influence of current and emerging technology on selected segments of the economy.
- 4.4 Understand how the stability of a technological system is influenced by all of the components in the system.
- 4.5 Understand manufacturing-related concepts and the applications of technological (systems) literacy and technical (craft) skill.

5.0 Problem Solving and Critical Thinking

Students understand how to create alternative solutions by using critical and creative thinking skills, such as logical reasoning, analytical thinking, and problem-solving techniques:

- 5.1 Apply appropriate problem-solving strategies and critical thinking skills to work-related issues and tasks.
- 5.2 Understand the systematic problem-solving models that incorporate input, process, outcome, and feedback components.
- 5.3 Use critical thinking skills to make informed decisions and solve problems.

6.0 Health and Safety

Students understand health and safety policies, procedures, regulations, and practices, including the use of equipment and handling of hazardous materials:

- 6.1 Know the policies, procedures, and regulations regarding health and safety in the workplace, including employers' and employees' responsibilities.
- 6.2 Understand critical elements for health and safety practices related to storing, cleaning, and maintaining tools, equipment, and supplies.
- 6.3 Know how to safely and appropriately handle, store, transport, transform, and dispose of hazardous and nonhazardous materials and chemicals in the school manufacturing facility.
- 6.4 Understand the safe and appropriate use of tools and equipment in the school manufacturing facility.
- 6.5 Understand important rules and responsibilities of various governmental safety agencies and their relationship to manufacturing industries.
- 6.6 Know the health and safety precautions and rules essential to a person's health and well-being.

7.0 Responsibility and Flexibility

Students know the behaviors associated with the demonstration of responsibility and flexibility in personal, workplace, and community settings:

- 7.1 Understand the qualities and behaviors that constitute a positive and professional work demeanor.
- 7.2 Understand the importance of accountability and responsibility in fulfilling personal, community, and workplace roles.

- 7.3 Understand the need to adapt to varied roles and responsibilities.
- 7.4 Understand that individual actions can affect the larger community.

8.0 Ethics and Legal Responsibilities

Students understand professional, ethical, and legal behavior consistent with applicable laws, regulations, and organizational norms:

- 8.1 Know the major local, district, state, and federal regulatory agencies and entities that affect the industry and how they enforce laws and regulations.
- 8.2 Understand the concept and application of ethical and legal behavior consistent with workplace standards.
- 8.3 Understand the role of personal integrity and ethical behavior in the workplace.
- 8.4 Practice ethical and legal behavior consistent with workplace standards.

9.0 Leadership and Teamwork

Students understand effective leadership styles, key concepts of group dynamics, team and individual decision making, the benefits of workforce diversity, and conflict resolution:

- 9.1 Understand the characteristics and benefits of teamwork, leadership, and citizenship in the school, community, and workplace settings.
- 9.2 Understand the ways in which preprofessional associations, such as SkillsUSA, and competitive career development activities enhance academic skills, promote career choices, and contribute to employability.
- 9.3 Understand how to organize and structure work individually and in teams for effective performance and the attainment of goals.
- 9.4 Know multiple approaches to conflict resolution and their appropriateness for a variety of situations in the workplace.
- 9.5 Understand how to interact with others in ways that demonstrate respect for individual and cultural differences and for the attitudes and feelings of others.

10.0 Technical Knowledge and Skills

Students understand the essential knowledge and skills common to all pathways in the Manufacturing and Product Development sector:

- 10.1 Use and maintain tools, equipment, systems, and products common to the school manufacturing facility.
- 10.2 Know the processes for acquiring and storing industrial materials as well as for allocating time and space efficiently.
- 10.3 Understand that quality control is a planned process to ensure that a product, service, or system meets established criteria.
- 10.4 Understand the role of manufacturing sector industries in the California economy.
- 10.5 Complete a comprehensive working sketch and drawing of a product to be produced.

- 10.6 Apply the design process in the development, evaluation, and refinement of a manufacturing product prototype.
- 10.7 Understand how graphic arts processes produce visual images to inform, educate, and serve manufacturing and personal needs.
- 10.8 Understand how manufacturing systems and processes transform and add value to industrial materials.
- 10.9 Understand the characteristics of various nonprint media, using current technologies available to school manufacturing facilities.
- 10.10 Understand the need to participate in sector-related professional improvement activities, SkillsUSA, other career technical education leadership and skill associations, and related career pathway specializations.
- 10.11 Understand the need to obtain and maintain industry-standard, technical certifications significant to an industry sector.

11.0 Demonstration and Application

Students demonstrate and apply the concepts contained in the foundation and pathway standards.

PATHWAY STANDARDS

A. Graphic Arts Technology Pathway

The Graphic Arts Technology Pathway provides students with an understanding of manufacturing processes and systems common to careers in graphic arts and printing technology. Representative topics include the printing enterprise, art and copy preparation, graphic design, image generation and assembly, reproduction photography, graphic reproduction operations, binding and finishing related to digital imaging, lithography, and screen printing.

A1.0 Students understand the application of basic graphic art design principles to achieve specific goals:

- A1.1 Produce sketches, rough layouts, and comprehensive layouts for a printed product by using design principles to guide the process.
 - A1.2 Evaluate graphic arts copies, designs, and layouts for proper grammar, punctuation, and adherence to specifications.
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A2.0 Students understand graphic arts functions and copy preparation, including applications of desktop publishing and electronic imaging software:

- A2.1 Know variables related to graphic art and copy preparation.
 - A2.2 Know how to produce single and multicolor images used for reproducing printed products.
 - A2.3 Know desktop publishing and electronic imaging software principles and processes used to prepare graphic arts products.
 - A2.4 Produce a printed product with the use of desktop publishing and electronic imaging software.
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A3.0 Students understand image generation processes and procedures required to reproduce single-color and multicolor printing:

- A3.1 Know the principles and processes used to prepare artwork for graphic art reproduction.
 - A3.2 Produce line, halftone, and special-effect images required for graphic art reproduction products.
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A4.0 Students understand the processes and procedures involved in producing image carriers for the reproduction of single-color and multicolor products:

- A4.1 Understand the process for creating image carriers for graphic art reproduction and printing.
- A4.2 Produce image carriers for single-color and multicolor products.

A5.0 Students understand the functions, processes, and procedures required for the reproduction of printed products and the factors affecting the image transfer process:

- A5.1 Know how various processes may be used to produce multiple-imaged copies.
- A5.2 Understand the variables that affect the image transfer process.
- A5.3 Produce single-color and multicolor products with a minimum of waste.

A6.0 Students understand the binding and finishing processes:

- A6.1 Know the functions and importance of binding and finishing operations in the production of printed products.
- A6.2 Bind and finish notepads, brochures, booklets, business cards, and other printed products.

A7.0 Students understand the screen-printing process:

- A7.1 Know the materials and operations used in screen printing.
- A7.2 Know various applications of screen printing.
- A7.3 Print products on various substrates by using appropriate inks and procedures.

A8.0 Students understand contemporary photography and its applications:

- A8.1 Understand current photographic technologies, processes, and materials used in the graphic arts.
- A8.2 Produce black-and-white and color images under natural and studio lighting conditions.

A9.0 Students understand the proper health and safety procedures and guidelines for the graphic arts environment, including the storage and recycling of raw materials and waste products:

- A9.1 Understand the health and safety precautions required in graphic communications laboratories.
- A9.2 Know the Occupational Safety and Health Administration rules and procedures for storing and using graphic arts materials and chemicals, the classification of recorded graphic arts environment fires, and fire-fighting treatments for those classifications.
- A9.3 Know the rules and responsibilities of the various governmental safety agencies that regulate and influence the graphics arts manufacturing industry.

B. Integrated Graphics Technology Pathway

The Integrated Graphics Technology Pathway provides students with an understanding of the manufacturing processes and systems common to careers in integrated graphics technology. Representative topics include integrated text, graphic, audio, video, and animation enterprises; composition and imaging; on-demand publishing; desktop publishing; integrated graphic design; digital imaging; color separation theory; communication techniques; electronic prepress; electronic image assembly; analog and digital video; integrated graphic media distribution; and integrated graphic media protection and storage.

B1.0 Students understand the application of basic integrated graphic design principles to achieve specific goals:

- B1.1 Produce sketches, rough layouts, and comprehensive layouts for an integrated graphic product, using design principles to guide the process.
- B1.2 Evaluate integrated graphic multimedia designs and layouts for proper grammar, punctuation, and adherence to specifications.

B2.0 Students understand integrated graphic multimedia functions and applications of electronic imaging software:

- B2.1 Know electronic imaging software principles and processes used to prepare integrated graphic multimedia products.
- B2.2 Produce an integrated graphic multimedia product by using electronic imaging software.

B3.0 Students understand contemporary photography and its applications in integrated graphic multimedia processes and systems:

- B3.1 Understand current photographic technologies, processes, and materials used in the integrated graphic multimedia industry.
- B3.2 Produce black-and-white and color images under natural and studio lighting conditions.

B4.0 Students understand contemporary video production:

- B4.1 Know current video technologies, processes, and procedures used in producing videos.
- B4.2 Understand the process for producing a comprehensive script and storyboard.

B5.0 Students understand integrated graphic multimedia technologies:

- B5.1 Understand current integrated graphic multimedia technologies, characteristics, processes, procedures, and systems.
- B5.2 Know the steps in producing an integrated graphic multimedia project designed to inform, teach, or sell.
- B5.3 Know strategies for disseminating integrated graphic multimedia projects.
- B5.4 Know strategies for distributing an integrated graphic multimedia project using one or more media.

C. Machine and Forming Technology Pathway

The Machine and Forming Technology Pathway provides students with an understanding of manufacturing processes and systems common to careers in machine tool and materials forming industries. Representative topics include the interpretation and layout of machined and formed-part prints; the cutting, shaping, fastening, and finishing of machine tools; and casting, forging, molding, cold forming, and shearing processes.

C1.0 Students understand the planning and layout operations used in machine tool and materials forming processes:

- C1.1 Interpret scaled machine tool and materials forming prints; gather design and materials information; perform calculations; and use the detail to plan, lay out, and produce parts or finished products that meet the standards of the National Institute for Metalworking Skills, the Manufacturing Skill Standards Council, or similar standards.
- C1.2 Understand the design parameters across machine tool and materials-forming organizational levels.
- C1.3 Use current information technology ideation and design process systems in the manufacturing of machined and formed parts and products.

C2.0 Students understand how materials can be processed through the use of machine tools, such as milling, drilling, turning, and shaping machines, and forming equipment, such as dies, presses, and rolls:

- C2.1 Understand the qualities of various raw and industrial materials and how these qualities affect the ability of the materials to be processed in the manufacturing of machined and formed parts and products.
- C2.2 Use machine tools, such as machine lathes, milling machines, drilling machines, power hacksaws, and band saws, and forming equipment, such as presses, brakes, ironworkers, and stake benches, to cut, shape, combine, and form manufactured parts or products that meet the standards of the National Institute for Metalworking Skills, the Manufacturing Skill Standards Council, or similar standards.

C3.0 Students understand various types of machine and forming assembly processes, such as flow, pressure, cold, and adhesive bonding, and mechanical fasteners:

- C3.1 Use various methods for the assembly of machined and formed parts and products in manufacturing, such as thread cutting and bonding agents.
- C3.2 Select and use the tools, such as taps and dies, wrenches, and spot welders, and the assembly process appropriate to the design criteria of a specific machined and formed product.

C4.0 *Students understand finishing processes and the differences between various types of finishing materials used in the manufacturing of machined and formed parts and products:*

- C4.1 Understand and use processes such as pickling, dipping, plating, spraying, and flow coating to finish machined and formed materials.
- C4.2 Select and use appropriate machined- and formed-part finishing processes, such as coating, plating, and anodizing, to meet specific product design criteria.

C5.0 *Students understand the purposes and processes of inspection and quality control in machining and forming manufacturing processes:*

- C5.1 Know the reasons for inspection and quality control in the manufacture of machined and formed parts.
- C5.2 Know how to perform a continuous online quality control inspection of machined and formed parts.
- C5.3 Know how to troubleshoot performance problems of machining and forming systems.

C6.0 *Students understand various machining and forming manufacturing systems that require standard hand and machine tools:*

- C6.1 Understand the characteristics of various machining and forming systems used in conventional manufacturing industries, such as open dies, smith forging, blow molding, stamping, drawing, shearing, chip removal, milling, turning, and electrical discharge systems.
- C6.2 Select and use appropriate machining and forming tools, equipment, and inspection devices to manufacture parts or products.

C7.0 *Students understand various machining and forming automated manufacturing systems, tool design, design for manufacturing, flexible manufacturing systems, and materials resource planning:*

- C7.1 Understand materials and processes in relation to machining and forming manufacturing systems.
- C7.2 Understand the processes involved in the following machining and forming manufacturing systems: “just in time,” tool design, design for manufacturing, flexible manufacturing systems, and materials resource planning.
- C7.3 Use computers to design and produce machined and formed products, write numerical control programs, and control robots.

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- C8.0 *Students understand the development of emerging machining and forming technology systems:*
- C8.1 Manufacture parts or products from industrial materials by using machining and forming systems, such as electrical discharge, laser cutting, chemical machining, and chemical bonding processes.
 - C8.2 Understand the importance of maintaining documentation for machining and forming systems.
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- C9.0 *Students understand the operation and functions of machine tools in production and prototype work:*
- C9.1 Use various machine tools, such as lathes, mills, drills, and saws, to produce parts and products.
 - C9.2 Select appropriate machining processes and equipment to produce prototypes or production parts or products.
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- C10.0 *Students understand industrial forming processes and their application to specific types of materials:*
- C10.1 Use various forming tools and equipment, such as rolls, brakes, dies, and presses, to manufacture parts and products.
 - C10.2 Select appropriate tools, processes, and equipment to successfully produce formed parts or products.
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- C11.0 *Students understand how a manufacturing company is organized and the elements of a machining and forming production management system:*
- C11.1 Understand corporate structures that affect machining and forming production.
 - C11.2 Understand that a machining and forming production management system includes planning, engineering, organizing, and controlling resources and manufacturing processes.
 - C11.3 Know how scheduling, quality control, accident prevention, and inventory control are used efficiently and appropriately in a machining and forming production management system.

D. Welding Technology Pathway

The Welding Technology Pathway provides students with an understanding of manufacturing processes and systems common to careers in welding and related industries. Representative topics include the interpretation and layout of welded and assembled-part prints, mechanical bonding, joining, cohesive bonding, adhesive bonding, and mechanical fastening.

D1.0 Students understand the planning and layout operations used in welding processes:

- D1.1 Interpret scaled welding prints; gather design and materials information; perform calculations; and use the detail to plan, lay out, and produce parts or finished products.
 - D1.2 Understand the design parameters across welding-process organizational levels.
 - D1.3 Use current information technology ideation and design process systems in the manufacturing of welded parts and products.
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D2.0 Students understand how materials can be processed through the use of welding tools and equipment:

- D2.1 Understand the qualities of various raw and industrial materials and how these qualities affect the ability of the materials to be processed to produce useful and value-added welded parts and products.
 - D2.2 Use welding tools and equipment, such as MIG, TIG, arc, forge and furnace, to combine or join manufactured parts and products, resulting in a finished product that meets the standards of the American Welding Society or a similar industry.
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D3.0 Students understand various types of welding assembly processes:

- D3.1 Bond industrial materials by using adhesive and cohesive processes, such as flow, pressure, cold, and fusion bonding.
 - D3.2 Understand the processes used for finishing welded materials.
 - D3.3 Use welding tools, such as MIG, TIG, arc, forge, and furnace, and the equipment and assembly processes appropriate to the design criteria of a specific product to result in a finished product that meets the standards of the American Welding Society or similar welding standards.
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D4.0 Students understand finishing processes and the differences between various types of finishing materials used in the manufacture of welded parts and products:

- D4.1 Know the steps to be taken and the choices to be made in finishing welded materials.
- D4.2 Understand how to select an appropriate finishing process to meet the design criteria of a specific welded product.

D5.0 Students understand the purposes and processes of inspection and quality control in welding manufacturing processes:

- D5.1 Know the reasons for inspection and quality control in the manufacturing of welded parts.
- D5.2 Perform continuous online quality control inspections of welded parts.
- D5.3 Know how to troubleshoot performance problems of welding systems.

D6.0 Students understand various welding systems that require standard hand and machine tools:

- D6.1 Understand the various welding systems used in conventional manufacturing industries in order to select and use appropriate tools, equipment, and inspection devices.
- D6.2 Select and use appropriate welding tools, equipment, and inspection devices to manufacture parts or products.

D7.0 Students understand various automated welding systems, welding design for manufacturing, flexible manufacturing systems, and materials resource planning:

- D7.1 Understand materials and processes in relation to welding systems.
- D7.2 Understand welding processes involved in the following manufacturing systems: “just in time,” design for manufacturing, flexible manufacturing systems, and materials resource planning.
- D7.3 Use computers to design and produce welded products, write numerical control programs, and control robots.
- D7.4 Understand the ways in which emerging welding systems may be integrated into current manufacturing processes.
- D7.5 Understand the importance of maintaining documentation for welding systems.

D8.0 Students understand various joining or combining processes, including welding processes used in manufacturing, maintenance, and repair:

- D8.1 Know various welding processes used to complete a fabrication, an assembly, or a repair.
- D8.2 Complete a fabrication, an assembly, or a repair by using appropriate techniques and processes.

D9.0 Students understand how a manufacturing company is organized and the elements of welding production management:

- D9.1 Understand corporate structures that affect welding production.
- D9.2 Understand that a welding production management system includes planning, engineering, organizing, and controlling resources and manufacturing processes.
- D9.3 Know how scheduling, quality control, accident prevention, and inventory control are used efficiently and appropriately in a welding production management system.