

Production Systems

8446 18 weeks

8447 36 weeks

Table of Contents

Acknowledgments.....	1
Course Description.....	2
Task Essentials Table.....	3
Curriculum Framework.....	5
Exploring the Nature of Technology	5
Examining Technology and Society	11
Analyzing Design.....	17
Practicing Safety	22
Developing Abilities for a Technological World.....	26
Examining the Designed World.....	33
Human Resources	38
SOL Correlation by Task	41
Entrepreneurship Infusion Units	44
Appendix: Credentials, Course Sequences, and Career Cluster Information	45

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Course Description

Suggested Grade Level: 9 or 10 or 11

Students assess the relationship between production and society as they compose design portfolios, construct production prototypes, incorporate computer-integrated manufacturing (CIM), and apply automation to evaluate solutions to technological problems.

As noted in [Superintendent's Memo #058-17 \(2-28-2017\)](#), this Career and Technical Education (CTE) course must maintain a maximum pupil-to-teacher ratio of 20 students to one teacher, due to safety regulations. The 2016-2018 biennial budget waiver of the teacher-to-pupil ratio staffing requirement does not apply.

Task Essentials Table

- Tasks/competencies designated by plus icons (⊕) in the left-hand column(s) are essential
- Tasks/competencies designated by empty-circle icons (○) are optional
- Tasks/competencies designated by minus icons (⊖) are omitted
- Tasks marked with an asterisk (*) are sensitive.

Task Number	8447	8446	Tasks/Competencies
Exploring the Nature of Technology			
39	⊕	⊕	Define the role of production in using technology to solve human needs and wants.
40	⊕	⊕	Describe components of the systems model as it relates to production.
41	⊕	⊕	Identify the primary processes used to obtain and produce industrial materials.
42	⊕	⊕	Describe the secondary processes used to convert stock into finished products.
43	⊕	⊕	Describe how advances in science, technology, engineering, and mathematics (STEM) fields have influenced production.
Examining Technology and Society			
44	⊕	⊕	Identify the four phases of the industrial revolution, focusing on industrial revolution 4.0.
45	⊕	⊕	Explain the relationship between production technology and the economy.
46	⊕	⊕	Appraise the environmental effects of production by-products.

47	+	+	Explain how society/culture and the development of products influence one another.
48	+	+	Describe how society's development is influenced by its ability to produce goods.
49	+	+	Describe how the social/cultural influences affect the design and quality of produced goods.
50	+	+	Describe how the economy influences the ability to produce goods.
51	+	+	Compare types of company ownership.
Analyzing Design			
52	+	+	Describe the engineering design process.
53	+	+	Employ different problem-solving techniques.
54	+	+	Communicate ideas through sketching, technical drawing, computer-aided design and drafting (CADD), or storyboarding.
Practicing Safety			
55	+	+	Discuss the importance of a safety plan.
56	+	+	Implement a safety plan.
57	+	+	Operate lab equipment according to instructor guidelines.
58	+	+	Identify job hazards.
59	+	+	Maintain safe working practices around production equipment.
60	+	+	Explain OSHA's role in production.
Developing Abilities for a Technological World			
61	+	+	Compose a design portfolio to solve a technological problem.
62	+	+	Construct models and/or prototypes.
63	+	+	Perform secondary processing operations on stock to produce products.
64	+	○	Implement a preventative maintenance program.

65	+	+	Design a production process for mass producing a product.
66	+	+	Complete a post-production evaluation of a production process.
67	+	+	Predict future trends related to production systems.
68	+	+	Evaluate the importance of market research and customer requirements throughout the design process.
Examining the Designed World			
69	+	+	Research materials to determine their mechanical, physical, and chemical properties for a designed product.
70	+	+	Select materials for use, based on their properties.
71	+	○	Differentiate among custom, intermittent, flexible, and continuous manufacturing.
72	+	○	Develop a plan for a facility to produce a specified product.
73	+	+	Explore a connected industry.
74	+	+	Create products using a combination of CADD, computer-aided manufacturing (CAM), computer numerical controlled (CNC), CIM, and flexible manufacturing systems (FMS) processes.
Human Resources			
75	+	+	Describe the management of personnel needed to produce a specific product.
76	+	○	Implement production personnel systems.
77	+	+	Research career outlook and training requirements for production employment.

Legend: + Essential ○ Non-essential ⊖ Omitted

Curriculum Framework

Exploring the Nature of Technology

Task Number 39

Define the role of production in using technology to solve human needs and wants.

Definition

Definition should include that technology is the development, production, and use of devices and processes to maintain and improve the quality of life.

Process/Skill Questions

- What are our *human needs*?
- What are *human wants*?
- How does technology impact our daily lives?
- What is *science*?

ITEEA National Standards

1. The Characteristics and Scope of Technology

TSA Competitive Events

Debating Technological Issues

Essays on Technology

Extemporaneous Speech

Future Technology Teacher

Prepared Presentation

Technology Bowl

Task Number 40

Describe components of the systems model as it relates to production.

Definition

Description should include

- **inputs**—anything used by the system (e.g., people, information, materials, tools and machines, energy, capital, time)
- **processes**—method of combining inputs to produce an action
- **outputs**—results or products of the system
- **feedback**—ongoing critical review of the process and results sent back through the system for improvement, both from internal and external customers.

Description should also include a comparison of the most common types of production systems, including

- batch system
- continuous system
- project system.

Process/Skill Questions

- What resources are needed for production systems?
- What are some examples of technological processes?
- How do the components of the systems model relate to one another?
- How is feedback used to control or change a system?
- What are two types of systems?
- How do materials, as well as capital and human costs, affect outputs?

ITEEA National Standards

2. The Core Concepts of Technology

TSA Competitive Events

Debating Technological Issues

Essays on Technology

Extemporaneous Speech

Future Technology Teacher

Prepared Presentation

Technology Bowl

Task Number 41

Identify the primary processes used to obtain and produce industrial materials.

Definition

Identification should

- contain the methods (e.g., mining, drilling, in situ, and harvesting) of obtaining material resources and how these materials are converted into standard or specialty stock
- include the concept that some materials/processes are relatively rare/difficult, influencing choices
- consider the sustainability and/or rate of depletion of natural resources.

Process/Skill Questions

- Why do manufacturers not always choose the best materials (technologically speaking)?
- What is a *raw material*?
- How are natural resources converted into raw materials?
- What are the applications of thermal, chemical, and mechanical processes in converting natural resources?
- What is *standard stock*?
- How does the cost of materials affect consumers?
- What are concerns surrounding the depletion of natural resources?

ITEEA National Standards

19. Manufacturing Technologies

2. The Core Concepts of Technology

TSA Competitive Events

Debating Technological Issues

Essays on Technology

Extemporaneous Speech

Future Technology Teacher

Prepared Presentation

Technology Bowl

Task Number 42

Describe the secondary processes used to convert stock into finished products.

Definition

Description should contain the following methods to create products from stock:

- Layout, measurement, and pattern-making
- Molding and casting
- Forming
- Separating
- Conditioning
- Assembling
- Finishing
- Additive manufacturing methods (e.g., three-dimensional [3D] printing, coating)

Process/Skill Questions

- How are raw materials converted into useable materials?
- How do tolerances in standard stock affect computer-integrated manufacturing (CIM) processes?
- What is the difference between primary and secondary processing of material?

ITEEA National Standards

19. Manufacturing Technologies

2. The Core Concepts of Technology

TSA Competitive Events

Debating Technological Issues

Essays on Technology

Extemporaneous Speech

Future Technology Teacher

Prepared Presentation

Technology Bowl

Task Number 43

Describe how advances in science, technology, engineering, and mathematics (STEM) fields have influenced production.

Definition

Description should focus on the correlation of the individual elements of STEM with the advancements of the components of a modern production system. Description should also include examples of modern production systems and how STEM made each possible.

Process/Skill Questions

- How have production systems changed?
- What are the negative and positive impacts of production systems changes?
- What are some STEM advancements that have led to change?

ITEEA National Standards

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

TSA Competitive Events

Debating Technological Issues

Essays on Technology

Extemporaneous Speech

Future Technology Teacher

Prepared Presentation

Technology Bowl

Examining Technology and Society

Task Number 44

Identify the four phases of the industrial revolution, focusing on industrial revolution 4.0.

Definition

Identification should include

- when mechanized equipment (powered by hydroelectric and steam power) was first used
- when and how mass production of goods in factories (powered by electricity) became significant
- how automation was developed and improved using programmable machinery
- how digital connection between humans and machines has developed and improved.

Process/Skill Questions

- What was the importance of the steam engine to manufacturing?
- How did the dependency on hydroelectric and steam power in phase one of the industrial revolution limit manufacturers?
- What are some examples of how electricity increased production during phase two of the industrial revolution?
- What was the first mass-produced item (on an assembly line)?
- What contributed to automation in manufacturing?
- How did the use of programmable machinery affect the workforce?
- What are some examples of humans communicating with machines?

Task Number 45

Explain the relationship between production technology and the economy.

Definition

Explanation should include some effects that technological change (i.e., invention and innovation) in production has had on global economies, and vice versa. Economic needs drive production technologies through demand. Market needs drive advances in production technology and the creation of new products and services.

Explanation should also include a discussion of the sustainability of various technological changes.

Process/Skill Questions

- Are there examples where initial change was not sustained? If so, what was the cause?
- What is *economics*?
- What is the *gross domestic product*?
- How have consumers affected manufacturing in the past and in what ways do they affect it now?
- How has the economy affected production in your local area?

ITEEA National Standards

4. The Cultural, Social, Economic, and Political Effects of Technology

6. The Role of Society in the Development and Use of Technology

TSA Competitive Events

Debating Technological Issues

Essays on Technology

Extemporaneous Speech

Future Technology Teacher

Prepared Presentation

Task Number 46

Appraise the environmental effects of production by-products.

Definition

Appraisal should identify the types of production by-products and the strategies for conservation and management of these by-products.

Process/Skill Questions

- What is the role of the Environmental Protection Agency (EPA)?
- What can be done to reduce solid waste disposal problems?
- What is *reclamation*?
- What are some impacts of manufacturing processes on the environment?
- What are some of the unwanted by-products created through manufacturing?

ITEEA National Standards

5. The Effects of Technology on the Environment

TSA Competitive Events

Debating Technological Issues

Essays on Technology

Extemporaneous Speech

Future Technology Teacher

Prepared Presentation

Task Number 47

Explain how society/culture and the development of products influence one another.

Definition

Explanation should include examples of products that were created as a response to the needs and desires of people and examples of products that have influenced society and culture. Explanation should also include how the economy of a society/culture plays a role in the design and production of products.

Process/Skill Questions

- What are the differences between consumer-led and production-led product development?
- What is the difference between *invention* and *innovation*?
- How are ideas gathered for new products?
- What are some recent cultural trends that influence product development?

ITEEA National Standards

6. The Role of Society in the Development and Use of Technology

7. The Influence of Technology on History

TSA Competitive Events

Debating Technological Issues

Essays on Technology

Extemporaneous Speech

Future Technology Teacher

Prepared Presentation

Task Number 48

Describe how society's development is influenced by its ability to produce goods.

Definition

Description should include examples of the major eras in history that have been influenced by production technology, which has impacted economic growth, and, thereby, influenced the range of capabilities, interests, and opportunities a society may be able to pursue.

Process/Skill Questions

- What was *the industrial revolution*?
- What are current examples of societies that have changed because of the ability to produce goods?
- What is meant by *industrialized society*?

ITEEA National Standards

7. The Influence of Technology on History

TSA Competitive Events

Debating Technological Issues

Essays on Technology

Extemporaneous Speech

Future Technology Teacher

Prepared Presentation

Task Number 49

Describe how the social/cultural influences affect the design and quality of produced goods.

Definition

Description of social/cultural influences should include

- values
- beliefs
- cost
- materials
- fashion
- aesthetics
- ergonomics.

Description should also include

- economic effects on the production of goods
- consumer behavior in the supply-and-demand chain
- individual and community attitudes about cost and the acceptable quality of produced goods.

Process/Skill Questions

- How do social/cultural influences affect the development and production of products?
- What are some examples of social or cultural beliefs that might cause someone to avoid purchasing a product?
- How might social/cultural influences change quickly or over long periods of time?
- How might a manufacturer or distributor influence culture?
- Why aren't all goods produced using the very best materials?
- Do consumers or manufacturers determine the level of acceptable quality? Explain.

Task Number 50

Describe how the economy influences the ability to produce goods.

Definition

Description should include

- availability of resources
- consumer spending
- taxes and tariffs
- job creation/human resource considerations.

Process/Skill Questions

- What is *capitalism* and where is it most common?
- What economic decisions lead companies to produce products in the United States?
- What economic policies result in U.S. companies producing products outside the United States?
- What is gross domestic product (GDP) used to measure?
- Why might parts of a product be produced or processed in multiple countries before being assembled and sold?
- What is the link between consumer spending and job creation?
- When manufacturers demand more raw materials, how might it affect other sectors?
- What role does the economy play on the cost of production?

Task Number 51

Compare types of company ownership.

Definition

Comparison should include

- **sole proprietorship**—a business owned by one individual
- **partnership**—an association of two or more persons or entities that conduct a business for profit as co-owners with shared liability
- **corporation**—an organization that is a legal entity bearing rights similar to those afforded individuals; a public corporation is owned by stockholders/investors who have the advantage of limited-owner liability allowing the company to exist perpetually.

Process/Skill Questions

- What are the differences between a corporation and a limited-liability corporation (LLC)?
- What is the significance of franchise ownership?
- How does a company determine its monetary needs?

ITEEA National Standards

19. Manufacturing Technologies

TSA Competitive Events

Future Technology Teacher

Technology Bowl

Analyzing Design

Task Number 52

Describe the engineering design process.

Definition

Description should include the concept that the engineering design process is a systematic, creative process for solving problems concerning real objects, products, systems, and environments. The steps of the process include

- identifying a design problem or opportunity
- identifying criteria and constraints
- creating possible designs
- choosing a design
- refining the design
- evaluating the design, including performing a cost-benefit analysis
- developing a prototype or system
- evaluating final solutions
- developing a production system with quality controls.

Process/Skill Questions

- How can design problems be identified?
- What are the types of problems that concern product developers?
- Why is it important to identify criteria and constraints?
- What techniques are used to refine a design?
- How can a design be evaluated?
- What is quality control?
- Why should final solutions be re-evaluated? How is this done?
- What are the basic requirements of design?
- What are ergonomics?
- What are functional requirements?

ITEEA National Standards

8. The Attributes of Design

TSA Competitive Events

Dragster Design

Engineering Design

Fashion Design and Technology

Flight Endurance

Future Technology Teacher

Structural Design and Engineering

System Control Technology

Technology Problem Solving

Transportation Modeling

Task Number 53

Employ different problem-solving techniques.

Definition

Employment of problem-solving techniques should include

- *trial-and-error*
- *brainstorming*
- *best guess*
- *Kaizen*
- *go-look-see*
- *Six Sigma*
- *plan-do-check-act*
- *failure mode and effects analysis*
- *accidental discovery.*

Employment of the techniques should include using the various techniques to discover a solution to the same problem and then determining the types of situations in which each method is the appropriate choice.

Process/Skill Questions

- What is *brainstorming*?
- What kinds of problems does the trial-and-error approach best solve?
- What is *accidental discovery* as it relates to problem solving?
- What type of problem-solving strategies were employed before modern production?
- In what way have advances in technology aided problem-solving strategies?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

8. The Attributes of Design

9. Engineering Design

TSA Competitive Events

Dragster Design

Engineering Design

Fashion Design and Technology

Flight Endurance

Future Technology Teacher

Music Production

On Demand Video

Structural Design and Engineering

System Control Technology

Technology Problem Solving

Transportation Modeling

Video Game Design

Task Number 54

Communicate ideas through sketching, technical drawing, computer-aided design and drafting (CADD), or storyboarding.

Definition

Communication methods should be based on identifying the following forms and their intended purposes:

- **sketching**—drawing objects by hand; typically used as a quick and easy method in the idea-generating phase

- **technical drawing**—putting ideas on paper in the form of drawings, such as in drafting, which adheres to conventional techniques, standards, and symbols; the universal language of industry
- **CADD**—using a computer to design and draft; common to the industry today, promoting both speed and accuracy of design and planning
- **storyboarding**—using visual work instructions and augmented reality.

Process/Skill Questions

- What is *proportion*? What is *scale*?
- What are the conventional technical drawing techniques?
- What are three types of pictorials?
- What sides of an object are usually seen in a working drawing?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

9. Engineering Design

TSA Competitive Events

Animatronics

Architectural Design

Biotechnology Design

Computer-Aided Design (CAD), Architecture

Computer-Aided Design (CAD), Engineering

Dragster Design

Engineering Design

Flight Endurance

Future Technology Teacher

Structural Design and Engineering

Transportation Modeling

Practicing Safety

Task Number 55

Discuss the importance of a safety plan.

Definition

Discussion should include

- hazard identification
- hazard prevention
- emergency procedures
- Occupational Safety and Health Administration (OSHA) standards
- examples of workplace safety on production lines.

Process/Skill Questions

- Why should there always be a safety plan in place?
- What types of personal protective equipment (PPE) are used in different production/manufacturing businesses?
- Why and for whom should safety be a priority?
- What are some examples of potential hazards in the work environment?
- What are some tools that can be used to assess the work environment to identify potential hazards?
- What is OSHA and how has it changed industry since its inception?
- Who is responsible for safety in a production environment?

Task Number 56

Implement a safety plan.

Definition

Implementation should include

- taking a safety proficiency test with 100% pass rate

- adhering to basic safety rules.

Process/Skill Questions

- Why is it important to pass the safety test with 100% accuracy?

ITEEA National Standards

12. Use and Maintain Technological Products and Systems

TSA Competitive Events

Future Technology Teacher

Task Number 57

Operate lab equipment according to instructor guidelines.

Definition

Operation should include

- following posted safety rules for each piece of equipment
- possessing an awareness of technical instructions/standard operating procedures
- using guards as required
- passing a proficiency demonstration with the instructor.

Process/Skill Questions

- How are the posted safety rules for any two pieces of equipment similar and different?
- Why are guards necessary?
- Why is passing a proficiency demonstration with the instructor critical?

ITEEA National Standards

12. Use and Maintain Technological Products and Systems

TSA Competitive Events

Future Technology Teacher

Task Number 58

Identify job hazards.

Definition

Identification should include

- recognizing potential hazards
- describing equipment that protects against each hazard
- wearing necessary equipment when performing hazardous tasks
- describing the purpose of various PPE for specific functions
- using required PPE.

Process/Skill Questions

- What are the names and purposes of five pieces of PPE?
- When would it be necessary to wear PPE?

ITEEA National Standards

12. Use and Maintain Technological Products and Systems

TSA Competitive Events

Future Technology Teacher

Task Number 59

Maintain safe working practices around production equipment.

Definition

Maintenance should include

- identifying potential hazards of each piece of equipment

- demonstrating safe work habits with each type of equipment.

Process/Skill Questions

- What are examples of the risks of unsafe behavior around production equipment?
- How would safety rules help prevent these risks?

ITEEA National Standards

12. Use and Maintain Technological Products and Systems

TSA Competitive Events

Future Technology Teacher

Task Number 60

Explain OSHA's role in production.

Definition

Explanation should include locating documentation for the OSHA standards to protect workers and following established procedures. Identification should also include a discussion of OSHA's Voluntary Protection Program including the business case for obtaining such a certification.

Process/Skill Questions

- What is HAZMAT?
- What information is found on a Safety Data Sheet (SDS)?
- What type of documentation does OSHA require?
- What are the repercussions of non-compliance with OSHA regulations?

ITEEA National Standards

12. Use and Maintain Technological Products and Systems

19. Manufacturing Technologies

TSA Competitive Events

Debating Technological Issues

Future Technology Teacher

Technology Bowl

Developing Abilities for a Technological World

Task Number 61

Compose a design portfolio to solve a technological problem.

Definition

Composition of a design portfolio should document the design and problem-solving process so that it can be used to reproduce a desired outcome or to review unintended outcomes of production.

Process/Skill Questions

- What is the purpose of a design portfolio?
- What is a design brief?
- What should be included in a design portfolio?
- What are the advantages and disadvantages of a design portfolio?
- How can a portfolio be useful in correcting a flawed design?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

11. Apply the Design Processes

8. The Attributes of Design

9. Engineering Design

TSA Competitive Events

Animatronics

Architectural Design

Biotechnology Design

Computer-Aided Design (CAD), Architecture

Computer-Aided Design (CAD), Engineering

Digital Video Production

Dragster Design

Engineering Design

Fashion Design and Technology

Flight Endurance

Future Technology Teacher

Music Production

On Demand Video

Photographic Technology

Structural Design and Engineering

Transportation Modeling

Video Game Design

Task Number 62

Construct models and/or prototypes.

Definition

Construction of scaled replicas, full-sized models, and/or production prototype should include some of the following elements:

- Materials with similar properties of those that are proposed for production
- Functional components
- Design standards, including form, function, and quality
- Rapid prototyping

Construction may also include the use of electronic models and virtual reality to interact with the models.

Process/Skill Questions

- What is a *prototype*?
- How does a prototype differ from a mock-up?
- What are some factors to consider when determining the type of prototype to construct?

ITEEA National Standards

11. Apply the Design Processes

19. Manufacturing Technologies

TSA Competitive Events

Animatronics

Architectural Design

Computer Integrated Manufacturing (CIM)

Dragster Design

Engineering Design

Fashion Design and Technology

Flight Endurance

Future Technology Teacher

Structural Design and Engineering

System Control Technology

Task Number 63

Perform secondary processing operations on stock to produce products.

Definition

Secondary processing includes layout and measurement, casting and molding, forming, separating, conditioning, assembling, and finishing, using a wide variety of tools and machines to create products from stock.

Process/Skill Questions

- What is the difference between value-add and non-value-add processes? Why is there a difference?
- What is the difference between casting and molding?
- What are different types of forming?
- What is the difference between machining and shearing?

ITEEA National Standards

12. Use and Maintain Technological Products and Systems

19. Manufacturing Technologies

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Dragster Design

Engineering Design

Flight Endurance

Future Technology Teacher

Structural Design and Engineering

Task Number 64

Implement a preventative maintenance program.

Definition

Implementation should include periodic maintenance processes such as cleaning and lubricating (based on the materials used) and testing the accuracy and functionality of a system and its individual components to ensure all are in good and safe working order. Implementation should also include Total Productive Maintenance (TPM) as part of lean manufacturing.

Process/Skill Questions

- How should safety guards on machines be maintained?
- What type of maintenance is required for tools powered by electricity, hydraulics, or pneumatics?
- How can maintenance affect quality control?
- Who can perform maintenance tasks in industry?

Task Number 65

Design a production process for mass producing a product.

Definition

Design should include steps of production of the product from design of product to finish of multiple products which are alike. A flow chart should be used.

Process/Skill Questions

- Why design a process for mass production?
- How does the flow chart increase the efficiency of the process?

Task Number 66

Complete a post-production evaluation of a production process.

Definition

Post-production evaluation should include a comparison of the original plans to the final product and should result in the decision to slightly alter or totally redesign the production process.

Process/Skill Questions

- What are the elements of quality control?
- What are *tolerances*?
- How can a post-production evaluation be used as feedback in a production process?
- What is *productivity*?

ITEEA National Standards

13. Assess the Impact of Products and Systems

19. Manufacturing Technologies

TSA Competitive Events

Animatronics

Dragster Design

Engineering Design

Future Technology Teacher

Transportation Modeling

Task Number 67

Predict future trends related to production systems.

Definition

Prediction of future trends should be based on history of change in technology, production methods, and materials available, and emerging trends in culture, economics, and the environment.

Process/Skill Questions

- What are the roots of automation?
- What modern devices and processes revolutionized factory automation? Explain.
- What information is needed to accurately forecast trends?
- What are some pros and cons of forecasting trends?

ITEEA National Standards

13. Assess the Impact of Products and Systems

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

4. The Cultural, Social, Economic, and Political Effects of Technology

5. The Effects of Technology on the Environment

TSA Competitive Events

Animatronics

Debating Technological Issues

Essays on Technology

Extemporaneous Speech

Future Technology Teacher

Prepared Presentation

System Control Technology

Technology Bowl

Task Number 68

Evaluate the importance of market research and customer requirements throughout the design process.

Definition

Evaluation should include

- market research and product development
- clear communication with consumers before and after product development
- consumer feedback that will continue the design process and future product development
- designs that meet consumer demands while maintaining low production costs and over-engineering
- development of processes based on design constraints rather than machine limitations.

Process/Skill Questions

- What are constraints? Why is it important to understand constraints?
- How can customer needs and wants affect the finished product?
- Are models/prototypes flexible enough to fulfill customer requirements? Explain.
- How is a customer requirement best determined? What determines if a customer requirement is successfully met?
- What are some examples of over-engineered products?
- How do manufacturers collect consumer feedback?
- How do consumers and designers communicate product requirements?
- What is the difference between engineering-driven and customer-driven requirements?

Examining the Designed World

Task Number 69

Research materials to determine their mechanical, physical, and chemical properties for a designed product.

Definition

Research should identify

- mechanical properties (e.g., compression, tension, torsion, shear)
- physical properties (e.g., thermal, electrical, magnetic, optical, acoustical)

- chemical properties (e.g., corrosion, reactivity, bonding).

Process/Skill Questions

- What are methods for preventing corrosion?
- How can mechanical properties be tested?
- What is the difference between destructive and non-destructive testing?

ITEEA National Standards

19. Manufacturing Technologies

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

TSA Competitive Events

Biotechnology Design

Engineering Design

Future Technology Teacher

Technology Bowl

Task Number 70

Select materials for use, based on their properties.

Definition

Selection of materials should be based on

- the performance demands of a product
- the properties and specifications of materials (i.e., plastics, metals, woods, ceramics, and composites)
- ease of manufacturing
- equipment needs and capabilities
- personal and environmental impacts
- the cost variables of alternative materials.

Process/Skill Questions

- What are the major types of materials?
- What is the difference between a hardwood and softwood?
- What are two major types of steels?
- What is a *composite material*?

ITEEA National Standards

19. Manufacturing Technologies

TSA Competitive Events

Biotechnology Design

Engineering Design

Fashion Design and Technology

Future Technology Teacher

Technology Bowl

Task Number 71

Differentiate among custom, intermittent, flexible, and continuous manufacturing.

Definition

Differentiation should be based on the following characteristics:

- **custom manufacturing**—one person making one product by hand or making one-of-a-kind products
- **intermittent manufacturing**—making limited quantities of a product
- **flexible manufacturing**—using complex machines that can quickly be adjusted to produce various products
- **continuous manufacturing**—making a large number of one product using mass production

Process/Skill Questions

- What types of manufacturing typically use an assembly line?

- What are examples of products that might have been produced by the different types of manufacturing?
- What levels of training are predominant in each type of manufacturing?

ITEEA National Standards

19. Manufacturing Technologies

2. The Core Concepts of Technology

TSA Competitive Events

Future Technology Teacher

Technology Bowl

Task Number 72

Develop a plan for a facility to produce a specified product.

Definition

Development of a facility plan, given a manufacturing system and product, should consist of

- investigating the regulations of the locality related to the manufacturing of the product
- selecting operations
- determining product vs. process orientation
- sequencing operations
- tooling
- designing plant layout
- creating a materials handling system (e.g., scheduling materials procurement, storing in adequate space, putting into production)
- standardizing where possible (even across different products)
- future-proofing the facility to changes in demand or product mix.

Process/Skill Questions

- How is a flow process chart used to develop a production schedule?
- What are factors to consider before "tooling up" for production?
- What factors should be considered when preparing a plant layout?
- How is the handling of scrap, waste, and re-work facilitated?
- What is the difference between a pre-material and post-material handling system?

- What is the difference between just-in-time materials procurement and a continuous system?

ITEEA National Standards

19. Manufacturing Technologies

TSA Competitive Events

Future Technology Teacher

Task Number 73

Explore a connected industry.

Definition

Exploration should include

- the definition of connected industry
- cyber-physical systems—real objects and virtual processes interlinked
- smart factories—interconnected systems
- a forecast of the future of automation.

Process/Skill Questions

- What is a connected industry?
- How are today's systems interrelated?
- What are the capabilities and trends in automation?
- What are some possibilities for automation in the future?

ITEEA National Standards

19. Manufacturing Technologies

TSA Competitive Events

Future Technology Teacher

Task Number 74

Create products using a combination of CADD, computer-aided manufacturing (CAM), computer numerical controlled (CNC), CIM, and flexible manufacturing systems (FMS) processes.

Definition

Product and process development should include

- evaluation and selection of CADD, CAM, CNC, CIM, and FMS processes used to create a product
- description of how FMS increase productivity and new product development
- creation of a viable order of operations for creating a product based on machine limitations and tolerances
- development of a portfolio.

Process/Skill Questions

- Why is a combination of CADD, CAM, CNC, CIM, and FMS necessary in modern manufacturing?
- How does FMS keep manufacturers ahead of their competition?
- Why are tolerances necessary when multiple processes and machines are used to create a product?
- What is the difference between accuracy and precision?

ITEEA National Standards

19. Manufacturing Technologies

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Future Technology Teacher

Human Resources

Task Number 75

Describe the management of personnel needed to produce a specific product.

Definition

Description should include

- **services of a human resources management system**—recruits, hires, trains, retrain, advances, addresses labor relations, and establishes division of labor
- **management structures**—top-down, bottom-up, and teams
- **roles of supervisors**—scheduling, conflict resolution, labor relations.

Process/Skill Questions

- What are the pros/cons of the different approaches to the management of personnel (e.g., encouraging creativity vs. encouraging compliance to the process)?
- What is a labor union?
- With whom does a union negotiate a contract?
- How can schools be used by employers to recruit employees?
- What is the difference between salary and wage?
- What are some examples of employee benefits?

ITEEA National Standards

19. Manufacturing Technologies

TSA Competitive Events

Chapter Team

Future Technology Teacher

System Control Technology

Technology Bowl

Task Number 76

Implement production personnel systems.

Definition

Implementation should include

- selecting appropriate personnel system
- orienting new personnel
- training
- communicating
- establishing division of labor
- resolving conflict
- monitoring performance to ensure that the desired results occur
- planning for skill-development
- participating in continuous improvement
- cross-training and flexibility.

Process/Skill Questions

- What are the functions of management?
- How is worker productivity calculated?
- What is the concept of *continuous improvement*?
- What is the difference between a work cell and an assembly line?
- What are the differences among different personnel systems (e.g., department, committee, task force, team)?

ITEEA National Standards

19. Manufacturing Technologies

TSA Competitive Events

Chapter Team

Future Technology Teacher

Technology Bowl

Task Number 77

Research career outlook and training requirements for production employment.

Definition

The study of careers should include

- career paths related to production systems
- education/training requirements for entry and advancement in chosen occupations (e.g., Many companies recognize years-of-experience in lieu of a degree, or fund education to get an employee to a required standard [even for engineering positions].)
- perceived advantages and disadvantages of selected occupations
- projected employment outlook for occupations of interest
- advances in production technology and their impact on products and employees.

Additionally, research should include exploring best practices in résumé writing and interviewing.

Process/Skill Questions

- How is on-the-job training accomplished?
- What resources should be used to learn about career outlook and training requirements?
- How can a worker prepare for changes in the production systems field?

ITEEA National Standards

19. Manufacturing Technologies

TSA Competitive Events

Essays on Technology

Future Technology Teacher

SOL Correlation by Task

39	Define the role of production in using technology to solve human needs and wants.	English: 9.3, 10.3, 11.3 History and Social Science: VUS.13, WG.2, WG.4, WG.14, WG.17
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40	Describe components of the systems model as it relates to production.	English: 9.5, 10.5, 11.5
41	Identify the primary processes used to obtain and produce industrial materials.	English: 9.5, 10.5, 11.5 History and Social Science: GOVT.9, GOVT.15, VUS.8, VUS.10, VUS.13, VUS.14, WG.1, WG.2, WG.3
42	Describe the secondary processes used to convert stock into finished products.	English: 9.5, 10.5, 11.5
43	Describe how advances in science, technology, engineering, and mathematics (STEM) fields have influenced production.	English: 9.5, 10.5, 11.5 History and Social Science: VUS.13
44	Identify the four phases of the industrial revolution, focusing on industrial revolution 4.0.	English: 9.5, 10.5, 11.5 History and Social Science: VUS.8, VUS.13, WHIL.1, WHIL.8, WHIL.14
45	Explain the relationship between production technology and the economy.	English: 9.5, 10.5, 11.5 History and Social Science: GOVT.9, GOVT.15, VUS.8, WHI.1, WHI.8
46	Appraise the environmental effects of production by-products.	English: 9.5, 10.5, 11.5 History and Social Science: WG.2, WG.4, WG.16, WG.17, WG.18
47	Explain how society/culture and the development of products influence one another.	English: 9.5, 10.5, 11.5 History and Social Science: VUS.13, WG.2, WG.4, WG.16, WG.17, WG.18, WHIL.8
48	Describe how society's development is influenced by its ability to produce goods.	English: 9.5, 10.5, 11.5 History and Social Science: GOVT.9, GOVT.15, WG.2, WG.4, WG.16, WG.17, WG.18
49	Describe how the social/cultural influences affect the design and quality of produced goods.	English: 9.5, 10.5, 11.5
50	Describe how the economy influences the ability to produce goods.	English: 9.5, 10.5, 11.5 History and Social Science: VUS.1, WG.1, WHI.1, WHIL.1, WHIL.14

51	Compare types of company ownership.	English: 9.5, 10.5, 11.5 History and Social Science: VUS.8, WG.5
52	Describe the engineering design process.	English: 9.5, 10.5, 11.5 Mathematics: COM.3
53	Employ different problem-solving techniques.	English: 9.5, 10.5, 11.5 Science: PH.3
54	Communicate ideas through sketching, technical drawing, computer-aided design and drafting (CADD), or storyboarding.	English: 9.5, 10.5, 11.5 Mathematics: G.3, G.14, COM.1
55	Discuss the importance of a safety plan.	English: 9.5, 9.8, 10.5, 10.8, 11.5, 11.8
56	Implement a safety plan.	English: 9.5, 10.5, 11.5
57	Operate lab equipment according to instructor guidelines.	English: 9.5, 10.5, 11.5 Science: PH.1
58	Identify job hazards.	English: 9.5, 10.5, 11.5
59	Maintain safe working practices around production equipment.	English: 9.5, 10.5, 11.5
60	Explain OSHA's role in production.	English: 9.5, 9.8, 10.5, 10.8, 11.5, 11.8
61	Compose a design portfolio to solve a technological problem.	English: 9.5, 10.5, 11.5
62	Construct models and/or prototypes.	Mathematics: G.3, G.13, G.14
63	Perform secondary processing operations on stock to produce products.	
64	Implement a preventative maintenance program.	English: 9.5, 10.5, 11.5
65	Design a production process for mass producing a product.	English: 9.5, 10.5, 11.5
66	Complete a post-production evaluation of a production process.	English: 9.5, 10.5, 11.5
67	Predict future trends related to production systems.	English: 9.5, 10.5, 11.5
68	Evaluate the importance of market research and customer requirements throughout the design process.	English: 9.5, 10.5, 11.5
69	Research materials to determine their mechanical, physical, and chemical properties for a designed product.	English: 9.8, 10.8, 11.8 Science: CH.2, PH.3, PH.4
70	Select materials for use, based on their properties.	Science: CH.2
71	Differentiate among custom, intermittent, flexible, and continuous manufacturing.	English: 9.5, 10.5, 11.5
72	Develop a plan for a facility to produce a specified product.	English: 9.5, 10.5, 11.5

		History and Social Science: GOVT.1, GOVT.15
73	Explore a connected industry.	English: 9.3, 9.5, 10.3, 10.5, 11.3, 11.5
74	Create products using a combination of CADD, computer-aided manufacturing (CAM), computer numerical controlled (CNC), CIM, and flexible manufacturing systems (FMS) processes.	English: 9.5, 9.8, 10.5, 10.8, 11.5, 11.8 Mathematics: COM.1, COM.17
75	Describe the management of personnel needed to produce a specific product.	English: 9.5, 10.5, 11.5
76	Implement production personnel systems.	English: 9.5, 10.5, 11.5 History and Social Science: GOVT.1, GOVT.16
77	Research career outlook and training requirements for production employment.	English: 9.5, 9.8, 10.5, 10.8, 11.5, 11.8

Entrepreneurship Infusion Units

Entrepreneurship Infusion Units may be used to help students achieve additional, focused competencies and enhance the validated tasks/competencies related to identifying and starting a new business venture. Because the unit is a complement to certain designated courses and is not mandatory, all tasks/competencies are marked “optional.”

Appendix: Credentials, Course Sequences, and Career Cluster Information

Industry Credentials: Only apply to 36-week courses

- College and Work Readiness Assessment (CWRA+)
- National Career Readiness Certificate Assessment
- Workplace Readiness Skills for the Commonwealth Examination

Concentration sequences: *A combination of this course and those below, equivalent to two 36-week courses, is a concentration sequence. Students wishing to complete a specialization may take additional courses based on their career pathways. A program completer is a student who has met the requirements for a CTE concentration sequence and all other requirements for high school graduation or an approved alternative education program.*

- Construction Technology (8431/36 weeks)
- Construction Technology (8432/18 weeks)
- Manufacturing Systems I (8425/36 weeks)
- Manufacturing Systems I (8426/18 weeks)
- Materials and Processes Technology (8433/36 weeks)
- Materials and Processes Technology (8478/18 weeks)

Career Cluster: Manufacturing	
Pathway	Occupations
Logistics and Inventory Control	Logistician
Manufacturing Production Process Development	Industrial Engineer Industrial Engineering Technician Manufacturing Systems Engineer Precision Inspector, Tester, or Grader Production Manager
Production	Assembler Automated Manufacturing Technician
Quality Assurance	Quality Control Technician