

Technical Drawing and Design

8434 18 weeks

8435 36 weeks

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Course Description

Suggested Grade Level: 9 or 10 or 11

In this foundation course, students learn the basic language of technical drawing and design, and they design, sketch, and make technical drawings, models, or prototypes of real design problems. The course is especially recommended for future engineering and architecture students.

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	8435	8434	Tasks/Competencies
Introducing the Design Process			
39	+	+	Describe the design process.
40	+	+	Apply the design process.
41	+	+	Analyze design solutions.
42	+	+	Refine the design solution.
Exploring Technical Drawing Foundations			
43	+	+	Define <i>technical drawing</i> .
44	+	+	Compare architectural and civil engineering drawings.
45	+	○	Describe the history of drawing and design.
46	+	+	Maintain a reference library of technical data.
47	+	+	Maintain drawing equipment.
48	+	○	Select drawing-related media and materials to effectively communicate a solution for a design problem.
49	+	○	Apply geometric construction principles.
50	+	+	Apply mathematical calculations to technical drawings.
51	+	+	Apply English and metric measuring devices and systems to technical drawings.
52	+	+	Interpret technical documentation.
53	+	+	Apply principles of dimensioning, annotation, and lettering.
54	+	+	Create a title block.
Producing Technical Drawings			
55	+	+	Apply technical drawing and design standards.
56	+	○	Develop 2-D patterns from 3-D objects.
57	+	+	Prepare technical sketches.

58	+	○	Revise drawings.
59	+	+	Prepare multiview drawings, using orthographic projections.
60	+	+	Prepare sectional view drawings.
61	+	+	Prepare pictorial drawings.
62	+	○	Prepare a set of architectural drawings.
63	+	+	Create solutions, using computer-aided drafting and design (CADD).
Producing Prototypes			
64	+	+	Construct a prototype.
65	+	○	Produce a prototype, using a 3-D printer.

Legend: + Essential ○ Non-essential ⊖ Omitted

Curriculum Framework

Introducing the Design Process

Task Number 39

Describe the design process.

Definition

Description should include that the design process is a systematic, creative process for turning ideas into real objects, products, systems, and environments.

Process/Skill Questions

- How do you determine problems or flaws in any design?
- What are the criteria and constraints of a design?
- Why is it important to identify criteria and constraints, such as deadlines and budget?
- What techniques are used to refine a design?

- How can a design be evaluated?
- What is quality control?
- Why should final solutions be reevaluated? How is this done?
- Why is it important to document every step of the design process?
- What is *iteration*, and how is related to the design process?

ITEEA National Standards

Apply Design Processes

TSA Competitive Events

Architectural Design

Dragster Design

Engineering Design

Fashion Design and Technology

Flight Endurance

Scientific Visualization (SciVis)

Structural Design and Engineering

System Control Technology

Technology Problem Solving

Task Number 40

Apply the design process.

Definition

Application of the design process should include

- establishing a system of documentation for monitoring workflow
- identifying a design problem
- identifying criteria and constraints
- brainstorming and identifying a potential solution

- creating a plan/outline for achieving the design
- developing sketches
- evaluating the initial design solution
- developing a prototype or model of a product or system
- re-evaluating solutions refining the design, as needed.

Process/Skill Questions

- Why is it important to follow a systematic design process?
- How might you determine possible solutions for a design problem? How are solutions tested?
- Why is it important to repeat the steps of the design process?
- When is it necessary to refine the design?
- What are some products and designs that have been refined over the last five years?
- How can documentation of previous problems aid in the development of new technologies?

ITEEA National Standards

Apply Design Processes

TSA Competitive Events

Animatronics

Architectural Design

Computer-Aided Design (CAD), Architecture

Computer-Aided Design (CAD), Engineering

Engineering Design

Fashion Design and Technology

Scientific Visualization (SciVis)

Structural Design and Engineering

System Control Technology

Technology Problem Solving

Transportation Modeling

Task Number 41

Analyze design solutions.

Definition

Analysis should include

- specifications and criteria
- function(s)
- quality control(s)
- critiques (made by client, self, jury, community, superior, or instructor)
- aesthetic quality
- spatial plan
- improvements for future revisions.

Process/Skill Questions

- What are some of the criteria used to evaluate successful design?
- How can you present the design solution clearly?
- What guidelines should be followed to evaluate the design success?
- How is the design solution accepted or disapproved?
- How can this design solution be implemented, or merit further study?
- How can you develop a rating system to determine the best solution?
- What are the principles of design?
- What are the elements of design?

ITEEA National Standards

Apply Design Processes

Assess the Impact of Products and Systems

Engineering Design

The Attributes of Design

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

TSA Competitive Events

Architectural Design

Computer-Aided Design (CAD), Architecture

Computer-Aided Design (CAD), Engineering

Engineering Design

Fashion Design and Technology

Scientific Visualization (SciVis)

Structural Design and Engineering

System Control Technology

Technology Problem Solving

Transportation Modeling

Video Game Design

Task Number 42

Refine the design solution.

Definition

Refinement should include

- analysis of initial design
- specifications for the refined design
- improved functionality
- quality control
- improved aesthetic quality
- recommendations/revisions for additional design improvements
- technical drawings of the proposed design refinements.

Process/Skill Questions

- Why might you need to perform a revision to your design?

- What are the benefits and drawbacks to refining your design?
- Why is it important to document your design decisions and steps?
- Why is it important to document and rate each of the refinement areas discussed in this competency?

ITEEA National Standards

Assess the Impact of Products and Systems

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

Use and Maintain Technological Products and Systems

TSA Competitive Events

Architectural Design

Computer-Aided Design (CAD), Architecture

Computer-Aided Design (CAD), Engineering

Engineering Design

Technology Problem Solving

Exploring Technical Drawing Foundations

Task Number 43

Define *technical drawing*.

Definition

Definition should include technical drawing as the graphic representation of an object or a concept, using a universal language consisting of graphic symbols.

Process/Skill Questions

- What is graphic communication?
- What is technical drawing?
- Why is it important to be able to define technical drawing?
- What are common uses of technical drawing?
- What is the role of technical drawing in society today?

ITEEA National Standards

Relationships Among Technologies and the Connections Between Technology and Other Fields

The Characteristics and Scope of Technology

The Core Concepts of Technology

TSA Competitive Events

Architectural Design

Structural Design and Engineering

Technology Bowl

Task Number 44

Compare architectural and civil engineering drawings.

Definition

Comparison should include the following ideas:

- Architects use a more creative approach to designing buildings and other structures. The aesthetics of the building are a priority.
- Civil engineers use a more scientific, practical, and systematic approach to structural design. Often, an architect's blueprints are the foundation of the civil engineer's work, and their job is to make the vision happen, using sound scientific and mathematical principles.
- Architects and civil engineers work collaboratively to create aesthetically pleasing and safe structures.

Process/Skill Questions

- In what ways do architects and civil engineers work together on structural solutions?
- What is unique about an architect's perspective in designing structures?
- What does a civil engineer typically do?

ITEEA National Standards

Apply Design Processes

Engineering Design

TSA Competitive Events

Architectural Design

Engineering Design

Structural Design and Engineering

Task Number 45

Describe the history of drawing and design.

Definition

Description should include

- the evolution of technical drawing and design from the Renaissance through the Information Age
- the effects of technical drawing and design on the development of technology
- the use of perspective drawing in the development of technical drawing and design
- earlier uses of orthographic projection in great inventions (e.g., the Wright Flyer)
- the development of tools in technical drawing and design (i.e., from manual drafting equipment through computer software)
- the adoption of American National Standards Institute (ANSI) and International Organization for Standardization (ISO) standards in technical drawing and design tools and methodology.

Process/Skill Questions

- What is the impact of computer aided design (CAD)/computer aided design and drafting (CADD) systems on the design process?
- How has technical drawing evolved?
- How has the computer improved the drafting process?
- What are the contributions of Leonardo da Vinci, Thomas Jefferson, George Washington, and Michael Graves?
- What is the earliest evidence of technology?

ITEEA National Standards

The Characteristics and Scope of Technology

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

The Influence of Technology on History

TSA Competitive Events

Computer-Aided Design (CAD), Architecture

Computer-Aided Design (CAD), Engineering

Task Number 46

Maintain a reference library of technical data.

Definition

Maintenance should include the practical organization of relevant drawing files, symbols, spreadsheets, and other technical data.

Process/Skill Questions

- What may be included in a reference library?
- What is technical data?
- How are drawing files copied, moved, and deleted?
- How are folders created and deleted?

ITEEA National Standards

Information and Communication Technologies

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

Use and Maintain Technological Products and Systems

TSA Competitive Events

Computer-Aided Design (CAD), Architecture

Computer-Aided Design (CAD), Engineering

Essays on Technology

Geospatial Technology (Virginia only)

Scientific Visualization (SciVis)

System Control Technology

Task Number 47

Maintain drawing equipment.

Definition

Maintenance should include examining, cleaning, properly using, and storing equipment, including

- manual tools (e.g., triangles, scales, compasses, T-squares)
- computer hardware, including printers
- computer software.

Designers who use and rely on computer software should pay special attention to product updates, glitches/bugs, and troubleshooting and adhere to standard online operating procedures.

Process/Skill Questions

- What are the two parts of the T-square?
- What are the angles that can be drawn with a set of drafting triangles?
- What is the purpose of dividers?
- What are the hardware parts of a CADD system?

ITEEA National Standards

Construction Technologies

Information and Communication Technologies

The Core Concepts of Technology

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

The Effects of Technology on the Environment

Use and Maintain Technological Products and Systems

TSA Competitive Events

Architectural Design

Computer-Aided Design (CAD), Architecture

Computer-Aided Design (CAD), Engineering

Dragster Design

Flight Endurance

Task Number 48

Select drawing-related media and materials to effectively communicate a solution for a design problem.

Definition

Given a specific technical drawing and design problem, designers should select the appropriate drawing media. The design problem should be clearly communicated through the appropriate use of software, paper sizes, scales, drafting tools, and presentation tools.

Process/Skill Questions

- What are the sizes of paper that ANSI standards refer to as A, B, C, and D?
- What are different drawing media?

- What software products are available to help create technical drawings?

ITEEA National Standards

Apply Design Processes

Assess the Impact of Products and Systems

Information and Communication Technologies

Relationships Among Technologies and the Connections Between Technology and Other Fields

The Core Concepts of Technology

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

The Effects of Technology on the Environment

The Role of Society in the Development and Use of Technology

Use and Maintain Technological Products and Systems

TSA Competitive Events

Architectural Design

Computer-Aided Design (CAD), Architecture

Computer-Aided Design (CAD), Engineering

Dragster Design

Flight Endurance

Task Number 49

Apply geometric construction principles.

Definition

Application of basic geometric construction principles should include

- bisecting a line
- bisecting an angle
- drawing an arc or circle (radius) through three points
- drawing a line parallel to a straight or curved line at a given distance
- drawing a line perpendicular to another line or from a point not on the line
- dividing a line into equal parts or into proportional parts
- transferring an angle, an odd shape, or a complex shape
- proportionally enlarging or reducing a shape
- drawing polygons (triangle, square, pentagon, hexagon)
- locating the center of a circle
- constructing an arc tangent to a right angle, acute angle, obtuse angle, straight line, curve, or two radii or diameters
- drawing an ogee curve
- drawing ellipses
- locating the major and minor axes of an ellipse.

Process/Skill Questions

- Why is it important to learn how to do these processes by hand as well as with tools such as AutoCAD and Revit?
- How are geometric construction principles used in drawing plans for a house, a bridge, or a strip mall?
- How are geometric construction principles used in drawing plans for the roof of a skyscraper?

ITEEA National Standards

Apply Design Processes

Engineering Design

Information and Communication Technologies

Relationships Among Technologies and the Connections Between Technology and Other Fields

The Attributes of Design

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

TSA Competitive Events

Architectural Design

Dragster Design

Flight Endurance

Structural Design and Engineering

Technology Problem Solving

Transportation Modeling

Task Number 50

Apply mathematical calculations to technical drawings.

Definition

Mathematical calculations involving practical geometry may include

- scaling drawings
- converting unit systems
- proportioning and ratios
- solving for area
- solving for circumference.

Process/Skill Questions

- How is the radius of a circle different from the diameter?
- When would you need to know the perimeter of an object?
- What characteristic of a circle is the spoke of a wheel?
- How is the true length of an inclined plane in an orthographic projection determined?
- What functions and commands can be used in CADD software to simplify geometric formulas?
- Where can one locate the information needed to perform the calculations?

ITEEA National Standards

Apply Design Processes

Engineering Design

Information and Communication Technologies

Relationships Among Technologies and the Connections Between Technology and Other Fields

The Attributes of Design

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

TSA Competitive Events

Architectural Design

Engineering Design

Flight Endurance

Task Number 51

Apply English and metric measuring devices and systems to technical drawings.

Definition

Application should include selecting and adjusting the following measuring devices to reflect the intended system:

- Engineer's scale
- Architect's scale
- Metric scale
- Dual-dimensioning system
- Decimal inch scale
- Surveyor's scale
- Fractional inch scale

Process/Skill Questions

- What measurement system is used in Europe?
- What are some common scales found in an engineer's drawing?
- What are some common scales found in architectural drawings?
- When should the dual-dimensioning system be used?

ITEEA National Standards

Apply Design Processes

Relationships Among Technologies and the Connections Between Technology and Other Fields

The Core Concepts of Technology

The Role of Society in the Development and Use of Technology

TSA Competitive Events

Architectural Design

Dragster Design

Engineering Design

Flight Endurance

Structural Design and Engineering

Transportation Modeling

Task Number 52

Interpret technical documentation.

Definition

Interpretation should include demonstrating

- knowledge of common symbols and standards used in architectural and engineering drawings (i.e., symbol and lettering literacy)
- the ability to read a technical drawing and apply the information to a new drawing.

Process/Skill Questions

- What is the most common lettering style used on drawings?
- What do hidden lines represent in an orthographic projection?
- What is the function of center lines?

- What do object lines show?
- How are dimensions placed?
- How is lettering manipulated using a CAD program?

ITEEA National Standards

Apply Design Processes

Information and Communication Technologies

Relationships Among Technologies and the Connections Between Technology and Other Fields

The Characteristics and Scope of Technology

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

The Influence of Technology on History

Use and Maintain Technological Products and Systems

TSA Competitive Events

Architectural Design

Dragster Design

Engineering Design

Task Number 53

Apply principles of dimensioning, annotation, and lettering.

Definition

Application should include following the general rules of dimensioning and providing information about sizes and locations, including

- overall width, height, and depth of the object
- angles other than 90 degrees
- size and location of drilled holes, chamfers, fillets, and other features
- datums.

Process/Skill Questions

- What basic information is given by dimensions?
- What is a size dimension?
- What is a location dimension?
- What does *datum* mean?
- What are the general rules of dimensioning?

ITEEA National Standards

Apply Design Processes

Engineering Design

Information and Communication Technologies

Relationships Among Technologies and the Connections Between Technology and Other Fields

The Attributes of Design

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

Use and Maintain Technological Products and Systems

TSA Competitive Events

Architectural Design

Computer-Aided Design (CAD), Architecture

Computer-Aided Design (CAD), Engineering

Dragster Design

Essays on Technology

Flight Endurance

Structural Design and Engineering

Transportation Modeling

Task Number 54

Create a title block.

Definition

Completion should include the following components:

- Contributor (student) name
- Organization (school) name
- Scale of drawing
- Paper/sheet size
- Sheet number and sheet total
- Title of drawing
- Border line
- Date and/or revision number and date of revision
- Any additional information relevant to the drafting specialization or company

Process/Skill Questions

- Where should the title block ordinarily be located?
- What key information is included in a title block?
- What additional information might be included in a title block? Why is this information important?
- What is the function of the title block?
- What are field attributes, and how can they be used in title block creation?

ITEEA National Standards

Use and Maintain Technological Products and Systems

TSA Competitive Events

Architectural Design

Computer-Aided Design (CAD), Architecture

Computer-Aided Design (CAD), Engineering

Dragster Design

Engineering Design

Structural Design and Engineering

Producing Technical Drawings

Task Number 55

Apply technical drawing and design standards.

Definition

Application of technical drawing and design standards may include

- American National Standards Institute (ANSI)
- International Organization for Standardization (ISO)
- Society of Automotive Engineers (SAE)
- American Society of Tests and Measurements (ASTM)
- intercompany standards
- classroom standards.

Process/Skill Questions

- Why are standards important in technical drawing and design?
- What does ANSI (ISO, SAE, ASTM) stand for?
- Why is it important for an employee to comply with company standards?

ITEEA National Standards

Engineering Design

The Attributes of Design

The Core Concepts of Technology

TSA Competitive Events

Architectural Design

Computer-Aided Design (CAD), Architecture

Computer-Aided Design (CAD), Engineering

Dragster Design

Engineering Design

Flight Endurance

Photographic Technology

Structural Design and Engineering

System Control Technology

Technology Problem Solving

Transportation Modeling

Task Number 56

Develop 2-D patterns from 3-D objects.

Definition

Development should include

- reverse engineering boxes or packages
- replicating a 2-D pattern from a 3-D object
- demonstrating 3-D object functionality from a 2-D pattern.

Process/Skill Questions

- What is a stretch-out pattern?
- What are examples of everyday products created from patterns?
- What are transition pieces?
- How does geometry play a role in developing patterns?

ITEEA National Standards

Apply Design Processes

Engineering Design

The Attributes of Design

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

Use and Maintain Technological Products and Systems

TSA Competitive Events

Dragster Design

Fashion Design and Technology

Flight Endurance

Task Number 57

Prepare technical sketches.

Definition

Preparation should enable quick documentation of preliminary ideas for a given design problem and may include single views, multiviews, and isometrics, as well as surface developments and patterns.

Process/Skill Questions

- What are the types of pictorial drawings?
- How is the pattern for a rectangular prism developed?
- What are non-isometric lines?
- What is the purpose of sketching multiview drawings?
- At what stage(s) of the design process are technical sketches typically used?
- For what types of drawings are sketches frequently prepared?

ITEEA National Standards

Apply Design Processes

Engineering Design

Information and Communication Technologies

The Attributes of Design

TSA Competitive Events

Architectural Design

Dragster Design

Engineering Design

Flight Endurance

Structural Design and Engineering

Technology Problem Solving

Transportation Modeling

Task Number 58

Revise drawings.

Definition

Revision should include documenting the reevaluation and refinement stages of the design process.

Process/Skill Questions

- What is the logical procedure in making corrections?
- Who is responsible for checking drawings in the design process?
- What is the procedure for modifying drawings?

ITEEA National Standards

Apply Design Processes

Assess the Impact of Products and Systems

Information and Communication Technologies

The Attributes of Design

Use and Maintain Technological Products and Systems

TSA Competitive Events

Architectural Design

Dragster Design

Engineering Design

Flight Endurance

Transportation Modeling

Task Number 59

Prepare multiview drawings, using orthographic projections.

Definition

Preparation should include providing a series of 2-D drawings that would allow a person to visualize a 3-D object, to include some of the following views of an object:

- Top
- Front
- Bottom
- Left side
- Right side
- Back

Process/Skill Questions

- What are the three primary views used in multi-view drawings?
- What is orthographic projection?
- Why is it important to identify the front view of an object?
- How is the front view of an object identified?

ITEEA National Standards

Apply Design Processes

Engineering Design

Information and Communication Technologies

The Attributes of Design

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

Use and Maintain Technological Products and Systems

TSA Competitive Events

Architectural Design

Dragster Design

Engineering Design

Flight Endurance

Structural Design and Engineering

Transportation Modeling

Task Number 60

Prepare sectional view drawings.

Definition

Preparation should show internal details of an object not readily available from a single view, and might include the following views:

- Full
- Half
- Broken-out
- Revolved
- Removed
- Offset

Process/Skill Questions

- Which type of sectional view should be used to shorten long objects to fit in a drawing?
- At what angle are section linings usually drawn?
- When should you use a sectional view?
- Which view should you choose to show as a sectional view?

ITEEA National Standards

Apply Design Processes

Engineering Design

Information and Communication Technologies

The Attributes of Design

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

Use and Maintain Technological Products and Systems

TSA Competitive Events

Architectural Design

Engineering Design

Task Number 61

Prepare pictorial drawings.

Definition

Preparation of pictorial drawings should provide visual understanding of an idea and might include

- axonometric projection (isometric)
- oblique projection (cavalier, cabinet)
- perspectives (parallel, two point, three point)
- exploded view
- isometric circles.

Process/Skill Questions

- Why are pictorial drawings used?
- What are four types of pictorial drawings?
- What is the isometric axis, and why is it important?
- What are non-isometric lines? Provide examples.
- What are the steps in drawing a pictorial view from a multiview drawing?

ITEEA National Standards

Apply Design Processes

Engineering Design

Information and Communication Technologies

The Attributes of Design

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

Use and Maintain Technological Products and Systems

TSA Competitive Events

Architectural Design

Computer-Aided Design (CAD), Architecture

Computer-Aided Design (CAD), Engineering

Dragster Design

Engineering Design

Transportation Modeling

Task Number 62

Prepare a set of architectural drawings.

Definition

Preparation should include a selection of the following:

- Standard architectural symbols, linetypes, and lettering
- Simple floor plan
- Two-point and one-point perspective sketch of exterior/interior
- Elevations
- Sections
- Details
- Renderings
- Specifications
- House perspectives
- Foundation cross-section
- Scale for plotting/printing

Process/Skill Questions

- What is *architecture*?
- How does architectural lettering differ from engineering lettering?
- How are architectural drawings dimensioned?
- What is required in a floor plan?
- What are the standard symbols used in an architectural drawing?
- When should you use architectural symbols?
- What types of drawing are used in architecture?
- What are the line types and scales used in architectural drawings?
- What is the importance of a set of house plans?

ITEEA National Standards

Apply Design Processes

Construction Technologies

The Attributes of Design

TSA Competitive Events

Architectural Design

Engineering Design

Prepared Presentation

Scientific Visualization (SciVis)

Structural Design and Engineering

Task Number 63

Create solutions, using computer-aided drafting and design (CADD).

Definition

Solutions should demonstrate CADD literacy, including the ability to

- set drawing limits
- set units
- edit and manipulate layers
- design, edit, and manipulate templates
- use drawing commands
- modify commands
- analyze and manipulate dimensioning
- print or plot a drawing.

Process/Skill Questions

- What are the advantages of using CADD over the hands-on or manual drafting process?
- What are some free and proprietary CADD software programs used by professional and student designers today?

ITEEA National Standards

Apply Design Processes

Assess the Impact of Products and Systems

Engineering Design

Information and Communication Technologies

Manufacturing Technologies

The Attributes of Design

The Role of Society in the Development and Use of Technology

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

Use and Maintain Technological Products and Systems

TSA Competitive Events

Architectural Design

Computer-Aided Design (CAD), Architecture

Computer-Aided Design (CAD), Engineering

Dragster Design

Engineering Design

Transportation Modeling

Producing Prototypes

Task Number 64

Construct a prototype.

Definition

Construction of scaled replicas or full-sized prototypes 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

Process/Skill Questions

- How are problems with the prototype determined?
- What are the advantages and disadvantages of constructing prototypes?
- What are some factors to consider when determining the type of prototype to construct?
- How might improving the prototype also improve the design and final product?
- How does a static model differ from a working model?

ITEEA National Standards

Assess the Impact of Products and Systems

Engineering Design

Manufacturing Technologies

The Attributes of Design

TSA Competitive Events

Architectural Design

Computer-Aided Design (CAD), Architecture

Computer-Aided Design (CAD), Engineering

Engineering Design

Task Number 65

Produce a prototype, using a 3-D printer.

Definition

Production should include

- Scanning existing 3-D objects
- Designing new objects and entering their data into a computer application.

Process/Skill Questions

- What are the benefits of 3-D printing?
- What are some challenges with using 3-D printers?
- How are 3-D printers used in today's industries?

- What 3-D printers are available?
- From what materials can prototypes be made?
- What sizes of prototypes can be made on 3-D printers?
- How can the use of 3-D modeling and 3-D printing aid in the prototype process?

ITEEA National Standards

Assess the Impact of Products and Systems

Engineering Design

Manufacturing Technologies

The Attributes of Design

The Influence of Technology on History

TSA Competitive Events

Architectural Design

Computer-Aided Design (CAD), Architecture

Computer-Aided Design (CAD), Engineering

Engineering Design

SOL Correlation by Task

39	Describe the design process.	English: 9.5, 10.5, 11.5, 12.5
40	Apply the design process.	
41	Analyze design solutions.	
42	Refine the design solution.	
43	Define <i>technical drawing</i> .	English: 9.3, 10.3, 11.3, 12.3
44	Compare architectural and civil engineering drawings.	
45	Describe the history of drawing and design.	English: 9.5, 10.5, 11.5, 12.5 History and Social Science: VUS.2, VUS.6, VUS.8, WHI.15, WHII.4, WHII.9
46	Maintain a reference library of technical data.	

47	Maintain drawing equipment.	
48	Select drawing-related media and materials to effectively communicate a solution for a design problem.	
49	Apply geometric construction principles.	Mathematics: G.8, G.11, G.14
50	Apply mathematical calculations to technical drawings.	Mathematics: G.14
51	Apply English and metric measuring devices and systems to technical drawings.	Science: PH.1
52	Interpret technical documentation.	
53	Apply principles of dimensioning, annotation, and lettering.	
54	Create a title block.	Mathematics: G.14
55	Apply technical drawing and design standards.	English: 9.5, 10.5, 11.5, 12.5
56	Develop 2-D patterns from 3-D objects.	Mathematics: G.10, G.11, G.14
57	Prepare technical sketches.	Mathematics: G.2, G.5, G.8 Science: PH.2
58	Revise drawings.	Mathematics: G.2, G.3, G.14
59	Prepare multiview drawings, using orthographic projections.	Mathematics: G.3, G.14
60	Prepare sectional view drawings.	Mathematics: G.14
61	Prepare pictorial drawings.	Mathematics: G.14
62	Prepare a set of architectural drawings.	Mathematics: G.14
62	Create solutions, using computer-aided drafting and design (CADD).	Mathematics: G.2, G.3, G.11, G.14
64	Construct a prototype.	
65	Produce a prototype, using a 3-D printer.	

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

- Autodesk Certified Professional Examinations
- Autodesk Certified User Examinations
- Certified SOLIDWORKS Associate (CSWA) Examination
- College and Work Readiness Assessment (CWRA+)
- Mechanical Apprentice Drafter Examination
- Mechanical Drafting and Design Assessment
- 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.*

- Architectural Drawing and Design (8437/36 weeks)
- Architectural Drawing and Design (8492/18 weeks)
- Civil Engineering and Architecture (PLTW) (8430/36 weeks)
- Digital Electronics (PLTW) (8440/36 weeks)
- Digital Visualization (8459/36 weeks)
- Engineering Drawing and Design (8436/36 weeks)
- Engineering Drawing and Design (8493/18 weeks)
- Technology Foundations (8403/36 weeks)

Career Cluster: Science, Technology, Engineering and Mathematics	
Pathway	Occupations
Engineering and Technology	Aerospace Engineer Aerospace Engineering Technician Agricultural Engineer Architect Assembler Biomedical Engineer Chemical Engineer Civil Engineer Civil Engineering Technician Commercial and Industrial Designer Computer Hardware Engineer Electrical Engineering Technician Electro-Mechanical Technician Electronics Engineering Technician Engineer

Career Cluster: Science, Technology, Engineering and Mathematics	
Pathway	Occupations
	Engineering Manager Engineering Technician Human Factors Engineer Industrial Engineer Industrial Engineering Technician Machine Setter, Operator Manufacturing Systems Engineer Marine Engineer Materials Engineer Mechanical Drafter Mechanical Engineer Mechanical Engineering Technician Power Systems Engineer