

Introduction to Drafting and Design

Level: 1

Career Cluster: Advanced Manufacturing

Program: Engineering

Pathway(s): Engineering

Course Catalog Description

This course introduces students to technical drawing and design through sketching, geometric construction, multiview drawing, computer-aided design (CAD), and the engineering design process. Students also explore engineering careers, apply drafting skills to a range of design applications, and develop professional communication and portfolio skills.

Summary

This course introduces students to engineering career pathways, professionalism, ethics, and postsecondary opportunities while building foundational knowledge and skills in technical drawing and design. Students learn to use drafting tools, apply industry standards, and communicate ideas through freehand sketching, geometric construction, orthographic projection, multiview drawing, and computer-aided design (CAD). Through the engineering design process, students develop and refine technical drawings and models, analyze design solutions, and apply their learning to a variety of engineering and design contexts. The course also emphasizes collaboration, presentation, technical documentation, and portfolio development to prepare students for future education and careers in engineering and design.

Notes

This updated version reflects a clearer and more modern approach to introductory engineering coursework. While the earlier course introduced general drafting and design concepts, the revised course places a stronger emphasis on technical drawing, engineering graphics, geometric construction, orthographic projection, multiview drawing, computer-aided design (CAD), and the engineering design process as core instructional areas. The content is also organized into a more intentional sequence of student learning outcomes, making the progression of knowledge and skills more explicit from career exploration and foundational drafting concepts through technical application, digital modeling, and design problem-solving. In addition, the updated course strengthens professional communication, portfolio development, and career readiness by including more direct connections to workplace expectations and postsecondary opportunities. New components for a final assessment project, leadership, and work-based learning further expand the course beyond basic drafting concepts and align it more closely with current CTE priorities, employability skills, and authentic preparation for future study and careers in engineering and design.

Student Learning Outcomes

1. Career Exploration and Postsecondary Opportunities

Objective: *Students will analyze career pathways in engineering by exploring industry roles, workplace expectations, required education, certifications, professional organizations, and postsecondary opportunities available in Colorado in order to make informed academic and career decisions.*

- 1) Identify employment opportunities in various fields with a focus in the area of engineering
 - a. Recognize the work typically performed, tools and technology used, and nature of work environments
 - b. Identify potential certifications within the careers
 - c. Find membership organizations associated with the careers
 - d. Understand the necessary education associated within the careers
- 2) Define professionalism within the context of engineering
 - a. Criticism and evaluation
 - b. Presentation
 - c. Assessment
- 3) Recognize laws, regulations, and ethics significant to the fields of engineering
- 4) Identify postsecondary opportunities offered in the state of Colorado
 - a. Technical college, community college, 4-year institutions
 - b. Certificates, associates, bachelor, and advanced degree opportunities

2. Foundations of Technical Drawing and Engineering Graphics

Objective: *Students will understand the role of technical drawing as a universal language used to communicate engineering ideas and solutions.*

- 5) Define technical drawing and explain its role in engineering and design.
- 6) Identify tools, materials, and software used in drafting and design.
- 7) Describe how technical graphics communicate ideas visually.
- 8) Differentiate between freehand, mechanical, and computer-aided drawing methods.
- 9) Explain the importance of accuracy, precision, and standards in technical drawings.
- 10) Classify drawing types (sketches, working drawings, models, digital renderings).
- 11) Analyze how technical drawings are used across engineering and design industries.
- 12) Evaluate the effectiveness of drawings as communication tools.

3. Drafting Tools, Standards, and Professional Practices

Objective: *Students will demonstrate proper use of drafting tools and apply industry standards in technical drawings.*

- 13) Identify components and functions of traditional drafting tools and CAD systems.
- 14) Demonstrate correct handling and setup of drafting equipment and materials.
- 15) Apply standard line types, lettering conventions, and dimensioning practices.
- 16) Interpret technical drawing standards (scale, layout, symbols, annotations).
- 17) Construct drawings that follow established conventions and formatting requirements.
- 18) Analyze drawings for accuracy, completeness, and adherence to standards.

19) Evaluate the quality of drafting work based on professional criteria.

4. Freehand Sketching and Visualization

Objective: *Students will develop visualization and sketching skills to represent ideas quickly and accurately.*

- 20) Sketch basic shapes, geometric forms, and objects using freehand techniques.
- 21) Illustrate objects from multiple viewpoints (2D and 3D).
- 22) Interpret spatial relationships between objects and views.
- 23) Apply proportion, scale, and alignment in sketches.
- 24) Visualize three-dimensional objects from two-dimensional representations.
- 25) Construct isometric and oblique sketches.
- 26) Analyze sketches for clarity and accuracy of visual communication.
- 27) Evaluate sketching techniques for effectiveness in ideation.

5. Geometric Construction and Precision Drawing

Objective: *Students will apply geometric principles to create precise technical drawings and constructions.*

- 28) Construct basic geometric shapes using drafting tools or CAD.
- 29) Develop bisectors, perpendiculars, tangents, and geometric relationships.
- 30) Apply geometric concepts to solve design and layout problems.
- 31) Analyze relationships between shapes, angles, and dimensions.
- 32) Interpret geometric structures in real-world engineering designs.
- 33) Evaluate accuracy of geometric constructions and make corrections.

6. Orthographic Projection and Multiview Drawings

Objective: *Students will create and interpret multiview drawings to accurately represent three-dimensional objects.*

- 34) Explain the purpose and importance of orthographic projection.
- 35) Identify front, top, and side views of an object.
- 36) Construct multiview drawings using first-angle or third-angle projection.
- 37) Interpret multiview drawings to visualize objects in three dimensions.
- 38) Analyze relationships between views and identify missing information.
- 39) Evaluate drawings for accuracy, dimensioning, and completeness.

7. Computer-Aided Design (CAD) and Digital Modeling

Objective: *Students will develop foundational CAD skills to create digital technical drawings and models.*

- 40) Navigate CAD software interfaces and tools.
- 41) Create 2D technical drawings using CAD software.
- 42) Apply dimensioning, layers, and annotation tools in CAD environments.
- 43) Develop basic 3D models of components or structures.
- 44) Modify and refine designs using digital tools.

- 45) Analyze differences between hand-drawn and CAD-generated drawings.
- 46) Evaluate design accuracy and efficiency using CAD workflows.

8. Engineering Design Process in Drafting

Objective: *Students will apply the engineering design process to create and refine technical drawings and design solutions.*

- 47) Describe the steps of the engineering design process.
- 48) Define a design problem with criteria and constraints.
- 49) Generate design solutions through sketching and modeling.
- 50) Select appropriate solutions based on performance and feasibility.
- 51) Construct technical drawings that represent design solutions.
- 52) Test and analyze designs for functionality and efficiency.
- 53) Revise designs based on feedback and data.
- 54) Evaluate final designs against established criteria.

9. Design Applications and Systems Visualization

Objective: *Students will apply technical drawing and CAD skills to represent and analyze components, assemblies, and systems used in engineering and design contexts.*

- 55) Identify major components and systems represented in engineering drawings.
- 56) Sketch components and assemblies using appropriate views.
- 57) Create technical drawings of parts and assemblies using drafting standards.
- 58) Develop CAD models of components or system layouts.
- 59) Analyze how individual components integrate within a larger system.
- 60) Compare different design solutions based on structure and function.
- 61) Evaluate design modifications to improve performance, efficiency, or usability.
- 62) Apply technical drawing to solve problems in engineering and design applications.

10. Professional Communication and Portfolio Development

Objective: *Students will communicate technical ideas effectively and develop artifacts that demonstrate readiness for engineering and design.*

- 63) Create a portfolio of sketches, drawings, and CAD projects.
- 64) Prepare professional-quality technical documentation.
- 65) Present design ideas using appropriate technical language.
- 66) Evaluate personal strengths and interests related to career pathways.
- 67) Demonstrate collaboration and communication skills in project work.

11. Final Assessment Project

Objective: *Students will apply course knowledge and technical skills to complete a culminating drafting and design project that demonstrates problem-solving, accuracy, creativity, and professional presentation.*

- 68) Complete a final drafting and design project that incorporates technical drawing, problem-solving, and design process skills.

- 69) Develop and present a polished product that demonstrates technical accuracy, creativity, and professional communication.
- 70) Evaluate project outcomes using established criteria, feedback, and self-reflection.

12. Leadership

Objective: *Students will demonstrate leadership skills by applying responsibility, teamwork, initiative, ethical decision-making, and effective communication in classroom, project, and CTSO-related experiences.*

- 71) Demonstrate leadership skills through teamwork, responsibility, and initiative in classroom and project settings.
- 72) Practice effective communication, collaboration, and problem-solving while working with peers and instructors.
- 73) Apply ethical behavior, accountability, and professionalism in leadership-related experiences.

13. Work-Based Learning

Objective: *Students will connect classroom learning to workplace expectations by exploring careers, practicing employability skills, and engaging in authentic work-based learning experiences related to engineering and design.*

- 74) Identify workplace expectations, employability skills, and professional behaviors relevant to engineering and design careers.
- 75) Demonstrate readiness for work-based learning through communication, time management, and task completion.
- 76) Reflect on work-based learning experiences to evaluate career interests, strengths, and areas for growth.

14. Career and Technical Student Organizations

Objective: *Using the CTSO Resource Document, chapter activities will provide some of the best opportunities CTSO members will have to learn by doing. A successful program of work creates a positive learning atmosphere in the classroom. CTSO members learn how to accept responsibility, work as a team, manage a budget, and handle success and failure. Per the CTE Admin Handbook, CTSOs are embedded into curriculum.*

Professional Development

Prepare each member for entry into the workforce and provide a foundation for success in a career. Becoming a professional does not stop with acquiring a skill, but involves an increased awareness of the meaning of good citizenship and the importance of labor and management in the world of work.

Community Service

Promote and improve goodwill and understanding among all segments of the community through services donated by CTSO chapters, and to instill in its members a lifetime commitment to community service.

Business and Industry Connections

Increase awareness of quality job practices and attitudes, and increase the opportunities for employer engagement and eventual employment.

Financial Leadership

Plan and participate in activities to allow all members to carry out the chapter's projects. Educate members on their own personal finance for current and future success.

Public Relations

Make the general public aware of the good work that students in career and technical education are doing to better themselves and their community, state, nation, and world.

Social Activities

To increase cooperation in the school and community through activities that allow CTSO members to get to know each other in something other than a business or classroom setting.

Academic Standards Alignment

Colorado CTE courses are required to integrate academic and essential skills into course content. The following academic standards have been identified as aligned to this course and should be integrated throughout instruction.

[CO CTE Academic Standards Resources](#) (Rubrics, integration strategies, etc)
[CDE Colorado Academic Standards Online](#) (Online standards lookup tool)

Note: Mathematics and Science standards will be added in the future. Visit the [Colorado Academic Standards](#) page for the most current version.

Reading, Writing and Communicating Crosswalk

Course: Introduction to Drafting and Design

Colorado Academic Standards – Reading, Writing, and Communicating

Standard	Prepared Graduate Competency	Description	Course Evidence / Alignment
Standard 1: Oral Expression and Listening	Prepared Graduate 1 – Collaboration	Collaborate effectively as group members or leaders.	Students work in design teams, collaborate with peers on projects, and participate in group problem-solving and critiques.
Standard 1: Oral Expression and Listening	Prepared Graduate 2 – Oral Presentations	Deliver effective oral presentations for varied audiences.	Students present design concepts and solutions and explain drawings, models, or prototypes.
Standard 2: Reading for All Purposes	Prepared Graduate 4 – Informational Texts	Read a wide range of informational texts.	Students read drafting instructions, technical diagrams, and design briefs/specifications.
Standard 2: Reading for All Purposes	Prepared Graduate 5 – Language in Context	Understand how language functions in different contexts.	Students use technical drafting vocabulary and discipline-specific language in written and oral explanations.
Standard 3: Writing and Composition	Prepared Graduate 7 – Informational Writing	Craft informational/explanatory texts.	Students produce design explanations, technical documentation, and

			written project descriptions.
Standard 3: Writing and Composition	Prepared Graduate 9 – Writing Process	Demonstrate mastery of their own writing process.	Students draft, revise, and finalize technical work, including polished drawings and written explanations.
Standard 4: Research Inquiry and Design	Prepared Graduate 10 – Research and Ethics	Gather information from a variety of sources.	Students research design constraints and applications and use reference materials and examples to inform their work.

Free Resource Links

1. Career Exploration and Postsecondary Opportunities

- Engineering Career Explorer O NET Online (engineering careers job outlook skills pathways)
<https://www.onetonline.org>
- Explore STEM Careers NASA STEM (STEM careers engineering workforce pathways)
<https://www.nasa.gov/stem>
- Career Planning Tools CareerOneStop (career planning certifications education pathways)
<https://www.careeronestop.org>
- Engineering Career Resources TryEngineering (engineering careers student exploration professional pathways)
<https://tryengineering.org>

2. Foundations of Technical Drawing and Engineering Graphics

- Introduction to Technical Drawing Engineering Graphics (technical drawing basics engineering graphics communication)
<https://engineeringgraphics.files.wordpress.com/2007/03/01intro.pdf>
- Technical Drawing Basics Engineering Toolbox (engineering graphics drawing fundamentals communication)
<https://www.engineeringtoolbox.com>
- Engineering Graphics Resources MIT OpenCourseWare (engineering graphics visualization drawing fundamentals)
<https://ocw.mit.edu>
- Technical Drawing Tutorials YouTube Learn Engineering (technical drawing fundamentals visual communication concepts)
<https://www.youtube.com/c/LearnEngineering>

3. Drafting Tools, Standards, and Professional Practices

- Drafting Standards Basics ANSI Overview (drawing standards line types dimensioning conventions)
https://www.engineeringtoolbox.com/ansi-standards-d_1522.html
- CAD and Drafting Fundamentals Autodesk Education (CAD tools drafting software industry practices)
<https://www.autodesk.com/education>
- Drafting Equipment Guide WikiHow Drafting Tools (drafting tools setup professional practices basics)
<https://www.wikihow.com/Use-Drafting-Tools>
- Technical Lettering Guide Engineering Drawing Basics (lettering conventions drawing standards formatting)
https://www.engineeringtoolbox.com/engineering-drawing-d_127.html

4. Freehand Sketching and Visualization

- Sketching for Engineering Design SkillsYouNeed (freehand sketching visualization communication skills)
<https://www.skillsyouneed.com>
- Engineering Sketching Tutorials YouTube Product Design Online (sketching techniques drawing visualization ideation)
<https://www.youtube.com/c/ProductDesignOnline>
- Isometric Drawing Practice Math Is Fun (isometric drawing visualization 3D sketching basics)
<https://www.mathsisfun.com/geometry/isometric-drawing.html>
- Visualization Skills Exercises Improve Drawing (spatial reasoning visualization sketching exercises)
<https://drawabox.com>

5. Geometric Construction and Precision Drawing

- Geometry and Constructions Khan Academy (geometry constructions angles measurement precision drawing)
<https://www.khanacademy.org/math/geometry>
- Geometric Constructions Math Open Reference (construction techniques compass straightedge geometry)
<https://www.mathopenref.com>
- Engineering Geometry Basics Engineering Toolbox (geometric relationships construction applications engineering)
<https://www.engineeringtoolbox.com>
- Construction Practice Tools GeoGebra (geometric construction digital tools visualization math)
<https://www.geogebra.org>

6. Orthographic Projection and Multiview Drawings

- Orthographic Projection Tutorials Science Buddies (multiview drawings projection concepts engineering graphics)
<https://www.sciencebuddies.org>
- Engineering Drawing Projections YouTube Learn Engineering (orthographic projection multiview visualization explanation)
<https://www.youtube.com/c/LearnEngineering>
- Multiview Drawing Practice Worksheets Tower of Engineering (multiview drawing exercises projection interpretation skills)
<https://www.towerofengineering.com>
- Projection Basics Engineering Graphics LibreTexts (orthographic multiview projection engineering visualization)
<https://eng.libretexts.org>

7. Computer Aided Design CAD and Digital Modeling

- Tinkercad 3D Design Platform Autodesk (CAD modeling 3D design beginner tools)
<https://www.tinkercad.com>

- Fusion 360 Student Resources Autodesk (CAD modeling parametric design engineering tools)
<https://www.autodesk.com/products/fusion-360/education>
- CAD Tutorials FreeCAD Documentation (CAD modeling digital design open source tools)
<https://wiki.freecad.org>
- SketchUp for Schools Trimble (3D modeling CAD design visualization tools)
<https://edu.sketchup.com>

8. Engineering Design Process in Drafting

- Engineering Design Process NASA STEM (engineering design steps problem solving iteration)
<https://www.nasa.gov/stem/engineering-design-process>
- Design Thinking Toolkit IDEO Design Kit (design thinking problem solving ideation prototyping)
<https://www.designkit.org>
- TeachEngineering Design Lessons (engineering design process classroom activities projects)
<https://www.teachengineering.org>
- Engineering Design Overview Science Buddies (design process steps testing iteration prototypes)
<https://www.sciencebuddies.org>

9. Design Applications and Systems Visualization

- Engineering Design Applications NASA STEM (engineering systems design applications problem solving)
<https://www.nasa.gov/stem>
- Design Process and Systems Thinking TeachEngineering (systems thinking design applications engineering projects)
<https://www.teachengineering.org>
- Engineering Graphics and Visualization MIT OpenCourseWare (technical visualization systems engineering design)
<https://ocw.mit.edu>
- CAD Design Projects Autodesk Education (CAD design applications modeling systems)
<https://www.autodesk.com/education>

10. Professional Communication and Portfolio Development

- Engineering Portfolio Guide Science Buddies (engineering portfolio documentation project artifacts reflection)
<https://www.sciencebuddies.org>
- Technical Writing Resources Purdue OWL (technical writing reports communication documentation)
<https://owl.purdue.edu>

- Presentation Skills Resources Toastmasters (public speaking presentation delivery communication skills)
<https://www.toastmasters.org/resources>
- Design Portfolio Examples Canva Design School (portfolio design visual communication presentation examples)
<https://www.canva.com/learn>

11. Final Assessment Project

- Engineering Design Process Rubric STEM in the Middle (final project rubric engineering design process assessment)
<https://steminthemiddle.net/engineering-design-process-rubric/>
- Engineering Design Process Portfolio Scoring Rubric Cal Poly Pomona (project portfolio scoring reflection presentation evaluation)
https://academic.cpp.edu/senate/docs/GE009167ref_7.pdf
- 12 Step Engineering Design Process Assessment Rubric University of North Texas (design process prototype testing communication rubric)
https://engineering.unt.edu/ee/sites/default/files/12_step_engineering_design_process_assessment_rubric_-_varanasi.pdf
- Purdue OWL Presentation and Technical Writing Resources (presentation skills technical writing project communication)
<https://owl.purdue.edu>

12. Leadership

- Lead4Change Student Leadership Program (student leadership teamwork communication service learning)
<https://lead4change.org/>
- Student Leadership Activities and Lessons TEEN TRUTH (leadership lessons communication teamwork decision making)
<https://teentruth.net/student-leadership-activities/>
- Leadership Skills Activities for Students Worksheet Zone (leadership activities collaboration responsibility problem solving)
<https://worksheetzone.org/blog/leadership-skills-activities-for-students>
- Team Building Activities for Students Top Hat (teamwork classroom collaboration communication activities)
<https://tophat.com/blog/team-building-activities-for-students/>

13. Work-Based Learning

- IBM SkillsBuild Job Readiness Courses (job readiness employability workplace skills career preparation)
<https://skillsbuild.org/students/course-catalog/job-readiness>
- IBM SkillsBuild Career Readiness Teacher Toolkit (career readiness lessons resume interview workplace skills)
<https://skillsbuild.org/career-readiness-teacher-toolkit.pdf>



Technology Student Association – National Competitive Events

Computer-Aided Design (CAD), Engineering

Objective: *Students will use CAD tools and technical design practices to solve an engineering design problem and produce accurate three-dimensional representations of an engineering subject.*

- Develop a CAD-based solution to an engineering design problem within a defined work period.
- Create three-dimensional representations of engineering subjects such as a machine part, tool, device, or manufactured product.
- Apply appropriate CAD tools, processes, dimensions, annotations, and technical drawing conventions.
- Work independently to produce an original design solution without outside assistance.
- Save, manage, and submit digital CAD files according to competition procedures.
- Explain the design solution, technical decisions, and CAD process during a brief interview.
- Evaluate the final design using TSA criteria for accuracy, completeness, technical quality, and communication.

Resources

- Technology Student Association – Computer-Aided Design (CAD), Engineering competition guidelines
<https://tsaweb.org/competitions-programs/tsa/themes-problems>
- Autodesk Education – AutoCAD and CAD software access
<https://www.autodesk.com/education/edu-software/overview>
- SOLIDWORKS Education
<https://www.solidworks.com/solution/education>
- Onshape Education
<https://www.onshape.com/en/education/>



Technology Student Association – National Competitive Events

Computer-Aided Design (CAD), Architecture

Objective: *Students will use CAD tools and architectural design practices to solve an architectural design problem and produce accurate computer-generated drawings and representations.*

- Develop a CAD-based solution to an architectural design problem within a defined work period.
- Create architectural drawings or representations that communicate structure, space, layout, and design intent.
- Apply appropriate architectural drafting conventions, dimensions, labels, views, and annotations.
- Use CAD software to produce an original solution independently during the competition work session.
- Save, manage, and submit digital design files according to competition procedures.
- Explain the architectural design solution and drafting decisions during a brief interview.
- Evaluate the final design using TSA criteria for accuracy, technical communication, completeness, and design quality.

Resources

- Technology Student Association – Computer-Aided Design (CAD), Architecture competition guidelines
<https://tsaweb.org/competitions-programs/tsa/themes-problems>
- Autodesk Education – Revit, AutoCAD, and architecture design tools
<https://www.autodesk.com/education/edu-software/overview>
- SketchUp for Schools
<https://www.sketchup.com/en/plans-and-pricing/sketchup-for-schools>
- Onshape Education
<https://www.onshape.com/en/education/>



Technology Student Association – National Competitive Events

Manufacturing Prototype

Objective: *Students will design, document, fabricate, and present a manufactured prototype that meets TSA requirements for technical drawings, CNC/CIM processes, documentation, and product communication.*

- Design an original promotional product or manufactured prototype that meets the annual TSA challenge requirements.
- Create working drawings, detail drawings, and a parts list that clearly document the manufactured components.
- Fabricate a prototype using at least two CNC or CIM processes, such as 3D printing, laser engraving, CNC machining, or CNC vinyl cutting.
- Document construction, testing, improvements, strengths, weaknesses, materials, and production decisions in a portfolio.
- Prepare a bill of materials and work log that communicate the design and manufacturing process.
- Present a two-minute sales pitch explaining the product, materials, production cost, and pricing considerations.
- Evaluate the prototype using TSA criteria for component quality, documentation, manufacturability, and presentation.
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Resources

- Technology Student Association – Manufacturing Prototype competition guidelines
<https://tsaweb.org/competitions-programs/tsa/themes-problems>
- Autodesk Fusion – CAD/CAM design and manufacturing tools
<https://www.autodesk.com/products/fusion-360/education>
- Onshape Education
<https://www.onshape.com/en/education/>
- Xometry – Manufacturing and prototyping process resources
<https://www.xometry.com/resources/>