Drafting I

8530 36 weeks / 140 hours

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Acknowledgments

The components of this instructional framework was developed by the following business panel team member:

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Course Description

Suggested Grade Level: 10 or 11

Students explore drafting careers and theory. They gain the manipulative skills necessary to produce and complete accurate manufacturing and construction drawings based on the ideas and sketches of engineers, architects, and designers. Students will focus on performing mechanical drafting and design operations, using manual drafting techniques and Computer-Aided Drafting and Design (CADD).

Task Essentials List

- Tasks/competencies designated by plus icons (⊕) in the left-hand column(s) are essential
- Tasks/competencies designated by empty-circle icons (〇) are optional
- Tasks/competencies designated by minus icons (⊖) are omitted
- Tasks marked with an asterisk (*) are sensitive.

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Dr. Tricia S. Jacobs, CTE Coordinator of Curriculum and Instruction
Office of Career, Technical, and Adult Education
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### Getting Oriented to Drafting

| 45          | ✩   | Describe various types of drawings. |
| 46          | ✩   | Care for basic drafting equipment and tools. |
| 47          |     | Use basic drafting equipment and tools. |

### Using Mathematics in Drafting

| 48          | ✩   | Perform metric to U.S. customary system conversions. |
| 49          | ✩   | Perform conversions within a measurement system. |
| 50          | ✩   | Apply basic mathematical skills to drafting operations. |
| 51          | ✩   | Apply mathematical calculations involving practical geometry and trigonometry. |

### Performing Basic Drafting Operations

| 52          | ✩   | Demonstrate techniques for scale usage. |
| 53          | ✩   | Prepare freehand sketches. |
| 54          | ✩   | Perform freehand lettering. |
| 55          | ✩   | Apply line conventions. |
| 56          | ✩   | Adjust manual drafting equipment. |
| 57          | ✩   | Apply geometric construction principles. |
| 58          | ✩   | Prepare orthographic projections. |
| 59          | ✩   | Create pictorial views from orthographic projections. |
| 60          | ✩   | Dimension mechanical drawings. |
| 61          | ✩   | Revise existing drawings. |
| 62          | ✩   | Prepare sectional views (full, half, and offset). |

### Performing Basic Computer-Aided Design and Drafting (CADD) Operations

| 63          | ✩   | Identify basic components of a CADD system. |
| 64          | ✩   | Perform fundamental computer skills. |
| 65          | ✩   | Use CADD set-up commands. |
| 66          | ✩   | Use CADD drawing commands. |
| 67          | ✩   | Use CADD modifying commands. |
| 68          | ✩   | Use CADD dimensioning commands. |
| 69          | ✩   | Use CADD 3-D modeling commands. |
| 70          | ✩   | Use CADD file commands. |
| 71          | ✩   | Prepare basic CADD drawings. |

### Performing Mechanical Drafting and Design Operations with Extensive Use of CADD

| 72          | ✩   | Use reference materials. |
| 73          | ✩   | Use basic drafting standards. |
| 74          | ✩   | Add general notes to a drawing. |
| 75          | ✩   | Select the appropriate types of projections to represent objects. |
| 76          | ✩   | Apply mechanical symbols to a drawing. |

### Preparing a Career Portfolio
Curriculum Framework

Practicing Safety

Task Number 39

Follow general safety procedures.

Definition

Following safety procedures includes

- safe handling of all tools, equipment, and furniture
- adherence to safety precautions regarding Computer-Aided Design and Drafting (CADD) electrical equipment
- adherence to classroom regulations
- familiarity with school emergency plans.

Process/Skill Questions

- How does safe handling of tools, equipment, and furniture benefit job performance?
- What potential safety hazards exist with electrical equipment?
- What are some consequences of ignoring conduct regulations in the workplace?

Task Number 40

Adjust equipment for maximum comfort and usability.

Definition
Adjustment for comfort and usability includes a routine check of equipment settings. Students should know when it is necessary to make adjustments to the

- computer monitor
- drawing table
- lights
- chair.

Process/Skill Questions

- What are some consequences of improperly adjusted equipment?
- Why is it necessary to perform routine checks of equipment settings?
- How can an improperly adjusted chair affect the work of a drafter?

Task Number 41

Describe ergonomic considerations.

Definition

Description should address comfort, fatigue, and health-related concerns, and should include classroom considerations such as

- keyboard position
- chair position
- screen position
- lighting levels
- adaptable lighting control
- body posture and position of arms, wrists, and hands when using the keyboard, mouse, and other equipment.

Process/Skill Questions

- What medical problems can result from a lack of ergonomic considerations?
- How do the ergonomic considerations of a manual drafter differ from those of a CADD operator?
- Can a setting that a person considers comfortable be harmful ergonomically? Explain.

Preparing for a Career in Drafting

Task Number 42
Describe career options for those with drafting skills.

Definition

Description may include

- architect
- drafter
- engineer
- industrial designer
- model maker
- teacher
- technical illustrator
- tool designer
- contractor
- construction manager
- surveyor
- CADD operator/drafter
- facility manager.

Many websites offer career exploration resources, including the Virginia Department of Education's Career Planning Guide and the Occupational Outlook Handbook.

Process/Skill Questions

- Why is it beneficial to learn about a variety of occupations?
- What resources are useful for exploring careers in drafting?
- What are some options for a person seeking self-employment in the drafting field?

Task Number 43

Identify educational experiences and personal traits that benefit a drafter.

Definition

Identification should include experiences and traits such as

- completion of a secondary Career and Technical Education (CTE) drafting program
- continued study in a postsecondary drafting program
- attention to details
- interest in mechanics and construction
• earning industry certification.

Process/Skill Questions

• What role does education play in preparing a person for a drafting career?
• How does an attention to details benefit a drafter?
• Why is an interest in mechanics and construction beneficial to a drafter?

Task Number 44

Describe potential barriers to career advancement and strategies for overcoming them.

Definition

Description should include potential obstacles such as

• failure to meet workplace expectations (i.e., conduct, performance)
• failure to keep current with technical knowledge and skills
• workplace discrimination based upon such factors as gender, ethnicity, age, or physical disability.

Strategies for overcoming obstacles might include

• learning state and federal employment laws and company human resource policies
• participating in professional-development programs
• participating in employee association and/or union services
• learning from constructive criticism
• earning certifications
• participating in internships.

Process/Skill Questions

• What can a nontraditional employee (e.g., a female in a male-dominated industry) do to overcome obstacles? How can colleagues and management help?
• How can a worker ensure that she or he is current with the latest technical knowledge and skills?
• What role does work ethic play in meeting workplace expectations?

Getting Oriented to Drafting
Task Number 45

Describe various types of drawings.

Definition

Description should include

- architectural
- civil
- mechanical.

Process/Skill Questions

- What are some components common to mechanical, architectural, and civil drawings?
- What are unique characteristics of a mechanical drawing? Of an architectural drawing? Of a civil drawing?
- Why must the drafter know how to make various types of drawings?

Task Number 46

Care for basic drafting equipment and tools.

Definition

Care for drafting equipment and tools should meet manufacturers’ and teacher’s specifications. Equipment and tools should be cleaned and stored securely after each use.

Process/Skill Questions

- Why should a routine be established for proper care and cleaning of equipment?
- How does a neat storage system for equipment benefit a workplace?
- What are some consequences of unclean equipment?

Task Number 47

Use basic drafting equipment and tools.

Definition
Use of basic drafting tools and equipment may include

- compass divider
- drafting tape
- drawing board
- dusting brush
- eraser
- erasing shield
- French curve
- pencil
- pencil pointer
- protractor scale
- triangle (45 degrees and 30 degrees/60 degrees)
- T-square (drafting machine, parallel bar).

Process/Skill Questions

- What are the basic tools and equipment used in drafting? What are the functions of each?
- Why should tools and equipment be used only according to workplace and manufacturer’s specifications?
- How does the mechanical arm function as part of the drafting board?

Using Mathematics in Drafting

Task Number 48

Perform metric to U.S. customary system conversions.

Definition

Performance includes converting millimeters to inches, inches to millimeters, meters to feet, and feet to meters. Students should also be able to round conversions to the nearest whole unit.

Process/Skill Questions

- In what situations are metric measurements preferred to U.S. customary measurements, and vice versa?
- Why might it be necessary to convert measurements from U.S. customary to metric or from metric to U.S. customary?
- Why are measurements often rounded to the nearest whole unit?
Task Number 49

Perform conversions within a measurement system.

Definition

Performance should include

- converting inches to feet and feet to inches
- converting millimeters to centimeters and centimeters to millimeters.

Process/Skill Questions

- Why might it be necessary to convert a measurement of one or more centimeters into millimeters?
- What are some consequences of improper conversions?

Task Number 50

Apply basic mathematical skills to drafting operations.

Definition

Application should include addition, subtraction, multiplication, and division involving

- whole numbers
- fractions
- mixed numbers
- decimals

and the conversion of fractions to decimals and decimals to fractions.

Process/Skill Questions

- What are the consequences of using incorrect mathematical operations?
- How can technology help to improve mathematical calculations skills?
- How is a mixed number converted to an improper fraction?
- When might fractions be more appropriate than decimals, and vice versa?
Task Number 51

Apply mathematical calculations involving practical geometry and trigonometry.

Definition

Application of practical geometry and trigonometry involves calculations using

- the Pythagorean theorem (3-4-5 triangle)
- the law of sines
- formulas for area and volume.

Process/Skill Questions

- How is the Pythagorean theorem applied in drafting?
- How is the law of sines applied in drafting?
- When might a drafter need to apply a formula to determine area? Volume?

Performing Basic Drafting Operations

Task Number 52

Demonstrate techniques for scale usage.

Definition

Demonstration should include making full-size, larger than full-size, and smaller than full-size measurements, using the

- architect's scale
- engineer's scale
- mechanical drafter's scale
- metric scale.

Process/Skill Questions

- What are some consequences of incorrect use of a scale?
- What are the differences between an architect’s scale, an engineer’s scale, a mechanical drafter’s scale, and a metric scale?
- In what situations might more than one type of scale be used?
Task Number 53

Prepare freehand sketches.

Definition

Preparation should include rough and finished sketches and require using

- methods of sketching lines
- methods of sketching geometric shapes
- the alphabet of lines.

Process/Skill Questions

- How is freehand sketching different from mechanical drawing?
- What role does the sketch play in the design process?
- What are the benefits of using the alphabet of lines?

Task Number 54

Perform freehand lettering.

Definition

Performance requires accurate construction of numbers and large and small uppercase letters. The American National Standards Institute (ANSI) recommends use of the single-stroke Gothic alphabet. Neat and legible lettering is ensured by the use of aids such as lettering triangles and other instruments.

Process/Skill Questions

- How does proper use and construction of letters and numbers enhance a drawing?
- What are some possible consequences of improper lettering use and construction?
- How are lettering aids used in the performance of freehand lettering?

Task Number 55
Apply line conventions.

Definition

Application of line conventions, known as the alphabet of lines include

- construction/guide lines
- object/visible lines
- hidden lines
- section lines
- center lines
- dimension lines
- extension lines
- cutting plane lines
- phantom lines
- short- and long-break lines
- leaders
- border lines.

Process/Skill Questions

- How does the alphabet of lines contribute to the clarity of a drawing?
- What is the purpose of each line type? Provide an example of each.

Task Number 56

Adjust manual drafting equipment.

Definition

Adjustments are sometimes required to improve the usability of manual drafting equipment, such as the following:

- Drafting machine
- Parallel bar
- T-square
- Drafting table
- Drafting board

Process/Skill Questions

- What factors can cause a piece of equipment to require adjustment?
• What are some consequences of improper adjustments to the drafting equipment?
• How might one determine that a drafting table requires adjustment?

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**Task Number 57**

**Apply geometric construction principles.**

**Definition**

Application should include

• bisecting lines, arcs, and angles
• dividing lines into equal parts
• constructing parallel and perpendicular lines
• constructing angles and triangles
• constructing tangent lines and arcs
• constructing polygons
• constructing ellipses.

**Process/Skill Questions**

• How are tangent lines and arcs used in drafting?
• What are some examples of basic geometric shapes used in drafting? In what situations might these shapes be used?
• Why is knowledge of basic geometric construction principles valuable to a drafter?

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**Task Number 58**

**Prepare orthographic projections.**

**Definition**

Preparation should include

• the glass box method (i.e., front, top, right-side, left-side, bottom, and rear views)
• multiview drawings
• fillets, rounds, and runouts, and the projection of each
• attention to positioning of views
• attention to line precedence.
Process/Skill Questions

- What are the benefits of providing multiple views of an object?
- What factors are considered when selecting views to be included in a multiview drawing?
- How does the positioning of views contribute to the success of the drawing?

Task Number 59

Create pictorial views from orthographic projections.

Definition

Creation of pictorial views should include

- axonometric projection (isometric, dimetric, and trimetric)
- oblique projection (general, cavalier, and cabinet)
- perspective drawings (one-point and two-point).

Process/Skill Questions

- What is the difference between a pictorial view and an orthographic projection?
- When might it be more appropriate to provide a pictorial view than an orthographic projection?
- Why might one pictorial view be chosen over another?

Task Number 60

Dimension mechanical drawings.

Definition

Dimensioning should include

- units of measurement
- dimension lines, extension lines, arrowheads, and leaders
- placement of dimensions (e.g., unidirectional, aligned)
- application of standards for applying dimensions to various geometric shapes.

Process/Skill Questions
• What are the various types of dimensioning systems?
• Why should placement of dimensions follow a standard pattern?
• What are some consequences of improper dimensioning?

Task Number 61

Revise existing drawings.

Definition

Revisions should include making edits/changes and adding a revision block to the drawing.

Process/Skill Questions

• What information is provided in the revision block?
• Why is the ability to make revisions beneficial to clients?

Task Number 62

Prepare sectional views (full, half, and offset).

Definition

Preparation should include

• selecting the type of sectional view (i.e., full, half or offset) that will best illustrate the interior feature(s) of an object
• determining the scale
• centering the views
• applying a cutting plane line
• applying section lines appropriate to the object's material
• annotating the drawing.

Process/Skill Questions

• What are the industrial uses of various sectional views?
• What factors influence a decision to use sectional views?
• What is the difference between revolved and removed section views?
Performing Basic Computer-Aided Design and Drafting (CADD) Operations

Task Number 63

Identify basic components of a CADD system.

Definition

Identification should include

- Central Processing Unit (CPU)
- monitor
- keyboard
- mouse
- plotter printer (i.e., 2-D, 3-D)
- software
- tools for online collaboration.

Process/Skill Questions

- What function does the CPU perform?
- Which devices are considered input devices? Which are output devices?
- What is the benefit of having a digitizer?

Task Number 64

Perform fundamental computer skills.

Definition

Performance should include

- booting up and shutting down the computer
- opening and closing software applications
- managing files (i.e., saving, backing up, organizing)
- performing monitor and mouse configuration and setup.

Process/Skill Questions
• Why are fundamental computer skills required before using CADD?
• What are the benefits of having strong file-management skills?
• What are some consequences of improperly exiting a software application?

Task Number 65

Use CADD set-up commands.

Definition

Use should include

• limits
• units of measurement
• text styles and size
• dimensioning variables (e.g., snap, object snap, grid)
• layers and linetypes
• scale.

Commands should be used according to the software manufacturer’s documentation.

Process/Skill Questions

• Why should all set-up tasks be performed prior to beginning a drawing?
• How does layer control enhance usability?
• How can set-up commands specific to a particular manufacturer’s CADD software (e.g., mv setup) be incorporated with other CADD systems?

Task Number 66

Use CADD drawing commands.

Definition

Use should include

• line
• circle
• arc
• polyline
• polygon
• ellipse
• rectangle
• text
• hatch.

Commands should be used according to the software manufacturer’s documentation.

Process/Skill Questions

• What are the various methods of drawing a line? Of drawing a circle?
• What are some of the shortcuts for drawing commands?

Task Number 67

Use CADD modifying commands.

Definition

Use should include

• change
• move
• copy
• mirror
• chamfer
• break
• offset
• fillet
• stretch
• scale
• rotate
• trim/extend
• erase
• text edit
• explode
• grips
• array.

Commands should be used according to the software manufacturer’s documentation.

Process/Skill Questions
Why are modifying commands used?  
Which modifying commands are used to change the size of an object?

Task Number 68

Use CADD dimensioning commands.

Definition

Use should include

- linear
- aligned
- angular
- baseline
- continue
- radius and diameter
- leaders
- associative dimensioning
- dimension styles.

Commands should be used according to the software manufacturer’s documentation.

Process/Skill Questions

- What are the CADD options for dimension placement?
- What is associative dimensioning?

Task Number 69

Use CADD 3-D modeling commands.

Definition

Use should include

- constructing solid primitives
- modifying solid primitives
- viewing and displaying 3-D models
- shading and rendering the model
• applying materials to the model
• adding lighting to the model
• setting cameras to display the model from different viewpoints.

Commands should be used according to the software manufacturer’s documentation.

**Process/Skill Questions**

• What are some of the advantages of using CADD for 3-D modeling?
• Why is knowledge of geometric shapes’ properties required to successfully create models?

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**Task Number 70**

**Use CADD file commands.**

**Definition**

Use should include

• new
• save/save as
• plot
• import/export
• open/close
• exit.

Commands should be used according to the software manufacturer’s documentation.

**Process/Skill Questions**

• How does the ability to import and export files benefit the drafter?
• What are potential consequences of neglecting to save files frequently?

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**Task Number 71**

**Prepare basic CADD drawings.**

**Definition**
Preparation should include

- scales
- linetypes and lineweights
- geometric constructions
- pictorial drawings
- orthographic projections
- dimensions
- sectional views.

Process/Skill Questions

- What advantages do CADD drawings have over manual drawings?
- What are the essential steps in preparing a basic CADD drawing?

Performing Mechanical Drafting and Design Operations with Extensive Use of CADD

Task Number 72

Use reference materials.

Definition

Use should include

- American National Standard Institute (ANSI) manuals
- International Organization for Standardization (ISO) manuals
- machinist handbooks.

Process/Skill Questions

- When might it be necessary to consult reference material?
- What are some successful methods of using reference materials?

Task Number 73

Use basic drafting standards.

Definition
Use should include

- ANSI
- ISO
- United States Department of Defense (DOD)
- military (MIL).

**Process/Skill Questions**

- Why are drafting standards necessary?
- What type of project might require that the DOD standard be followed?

---

**Task Number 74**

**Add general notes to a drawing.**

**Definition**

Additions might include

- general dimensioning notes
- general assembly notes
- general shop notes
- special material notes.

**Process/Skill Questions**

- Why might general notes be added to a drawing?
- What are some consequences of providing inaccurate or inadequate notes?

---

**Task Number 75**

**Select the appropriate types of projections to represent objects.**

**Definition**

Selection should indicate the type of projection which best communicates the design of the object. Types of projections include
• orthographic, which show multiple views of an object
• sectional, which show interior features of an object.

Process/Skill Questions

• How is it determined which projections should be selected?
• What conditions determine that an auxiliary or sectional view is needed?

Task Number 76

Apply mechanical symbols to a drawing.

Definition

Application should include symbols such as

• diameter
• radius
• counterbore
• countersink
• depth
• finish.

Process/Skill Questions

• What are the benefits of using a recognized set of symbols?
• What are some consequences of using incorrect symbols?

Preparing a Career Portfolio

Task Number 77

Plan a drafting portfolio.

Definition

Plan should consider the most favorable options for displaying the drafting work in a professional manner. A portfolio should include a variety of work that demonstrates the drafter's versatility. A portfolio could be presented in

• three-ring binder
Plan of the portfolio should include discussion of its role in the hiring process.

**Process/Skill Questions**

- What are some advantages of including a wide variety of work in the portfolio? What are some disadvantages?
- How does the portfolio represent the history of a student’s development as a drafter?
- How does planning a portfolio for submission to a prospective employer differ from planning a portfolio for submission to a teacher for a particular project?

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**Task Number 78**

**Gather material for a portfolio.**

**Definition**

Gathering of products (e.g., drawings, pictures of models) representing a variety of projects should demonstrate the range of the drafter’s talent. The portfolio may also include

- résumé
- cover letter
- references
- letters of recommendation.

**Process/Skill Questions**

- What are some strategies for writing a successful cover letter?
- How does one decide which work to include in a portfolio?
- What are some resources for résumé writing help?
- Who are good sources for letters of recommendation?

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<td>English: 10.5, 11.5</td>
</tr>
<tr>
<td>66</td>
<td>Use CADD drawing commands.</td>
<td>English: 10.5, 11.5</td>
</tr>
<tr>
<td>67</td>
<td>Use CADD modifying commands.</td>
<td>English: 10.5, 11.5</td>
</tr>
<tr>
<td>68</td>
<td>Use CADD dimensioning commands.</td>
<td>English: 10.5, 11.5</td>
</tr>
<tr>
<td>69</td>
<td>Use CADD 3-D modeling commands.</td>
<td>English: 10.5, 11.5</td>
</tr>
<tr>
<td>70</td>
<td>Use CADD file commands.</td>
<td>English: 10.5, 11.5</td>
</tr>
<tr>
<td>71</td>
<td>Prepare basic CADD drawings.</td>
<td></td>
</tr>
<tr>
<td>72</td>
<td>Use reference materials.</td>
<td>English: 10.5, 11.5</td>
</tr>
<tr>
<td>73</td>
<td>Use basic drafting standards.</td>
<td></td>
</tr>
<tr>
<td>74</td>
<td>Add general notes to a drawing.</td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>Select the appropriate types of projections to represent objects.</td>
<td></td>
</tr>
</tbody>
</table>
Apply mechanical symbols to a drawing.
Plan a drafting portfolio.
Gather material for a portfolio.

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.” Teachers can find the infusion/unit in the course listing.
Appendix: Credentials, Course Sequences, and Career Cluster Information

Industry Credentials: Only apply to 36-week courses

- Architectural Apprentice Drafter Examination
- Architectural Certified Drafter Examination
- Architectural Drafting Assessment
- Autodesk Certified Professional Examinations
- Autodesk Certified User Examinations
- CAD Assessment
- CAD-CAM Assessment
- Certified SOLIDWORKS Associate (CSWA) Examination
- College and Work Readiness Assessment (CWRA+)
- Customer Service Examination
- Customer Service Specialist (CSS) Examination
- Mechanical Apprentice Drafter Examination
- Mechanical Certified Drafter Examination
- Mechanical Drafting and Design Assessment
- National Career Readiness Certificate Assessment
- Professional Communications Certification Examination
- Technical Drafting Assessment
- Technical Drafting Examination
- 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.

- Drafting II (8531/36 weeks, 280 hours)

Career Cluster: Architecture and Construction

<table>
<thead>
<tr>
<th>Pathway</th>
<th>Occupations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design/Pre-Construction</td>
<td>Architect</td>
</tr>
<tr>
<td></td>
<td>Architectural Drafter</td>
</tr>
<tr>
<td></td>
<td>Cost Estimator</td>
</tr>
<tr>
<td></td>
<td>Landscape Architect</td>
</tr>
<tr>
<td></td>
<td>Mechanical Drafter</td>
</tr>
<tr>
<td>Pathway</td>
<td>Occupations</td>
</tr>
<tr>
<td>-------------------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>Engineering and Technology</td>
<td>Aeronautical Drafter, Architect, Electrical Drafter, Electronic Drafter, Mechanical Drafter</td>
</tr>
</tbody>
</table>