

# Unit 4 Design and Fabrication

## Overview

### Purpose

The purpose of this unit is to provide students with an opportunity to build knowledge and skills in design and fabrication. An integral part of the unit is the topic on lab safety. It is intended that students will have a thorough understanding of the safety issues before they begin fabrication.

Students will use the theory of fabrication to manipulate a variety of tools and materials. They will learn how to select appropriate materials for the prototype being built. Once materials are chosen, students will learn how to select the appropriate tools and processing techniques to create the prototype. The skills learned in this unit will be used extensively when students begin the major design project in Unit 5. This unit is divided into three topics:

Topic 1: Fabrication Safety

Topic 2: Planning and Layout

Topic 3: Materials Processing

### Profile

In this unit students will be involved in:

- identifying safety hazards in a fabrication lab.
- exploring the use of personal protective equipment.
- building skills with tools in the fabrication lab.
- effective use of safety equipment.

- using industry standard sketching methods and planning tools to design prototypes.
- selecting suitable materials based on their unique properties.
- processing materials using the fundamentals of separating, forming, combining, conditioning and finishing

### **Implementation**

This unit should be completed in no more than 10 hours of class time. The outcomes associated with safety should be covered thoroughly prior to students doing any fabrication in the lab. The planning and layout topics of this unit could be covered as part of the design challenge in Unit 5

### **Evaluation**

Unit 4 is intended to introduce students to the tools and skills associated with design and fabrication. This unit should account for 10 percent of the evaluation of Robotics Systems Technology 3205.

# Evaluation

# Outcomes and Strategies

## Topic 1 - Fabrication Safety

### Specific Curriculum Outcomes

*Robotic Systems Technology 3205*

#### Students will be expected to:

4.1.1 identify potential hazards in the fabrication lab

### Suggested Teaching and Learning Strategies

#### For the Teacher

This outcome will allow students to identify potential hazards in the fabrication environment with particular emphasis on working with electronics.

#### Points to Emphasize

Teachers should make students aware of:

- general hazards around the fabrication area.
- hazards from tool use.

Specific electronics hazards including:

- potential shock and static discharge of components.
- soldering and exposure to gases and lead based solder.
- High voltage.
- Etching compounds and toxic materials.

#### For the Student

Students should be shown examples of situations (pictures, videos, etc.) of fabrication shops which have hazards and asked to identify the hazards in each situation, what dangers those hazards pose, and how to remedy the hazard. This should deal specifically with activities involving the use of electronic components.

## Topic 1 - Fabrication Safety

### Suggested Assessment and Evaluation Strategies

#### Presentation

Create a safety video on one of the following topics:

- potential hazards
- personal protective equipment
- tools/tool use
- applicable emergency equipment

#### Pencil and Paper

Given a diagram of the fabrication lab identify the location of all safety features and equipment and any potential hazards.

Given various scenarios (picture format) students are to identify and find the potential hazards depicted.

#### Journal

Write a personal entry outlining potential hazards in the fabrication lab

#### Performance

All students will be expected to wear safety glasses and follow safe shop practices at all times, in the fabrication lab.

### Resources

#### Authorized Resource:

Robot Builders Bonanza, p. 63  
– 65

#### External Link:

<http://uwworksafe.com/woodshop/default.cfm>

## Topic 1 - Fabrication Safety

### Specific Curriculum Outcomes

*Robotic Systems Technology 3205*

#### Students will be expected to:

4.1.2 demonstrate the use of personal protective equipment (PPE)

#### Delineation:

safety glasses  
earplugs  
appropriate clothing  
proper gloves  
dust masks

### Suggested Teaching and Learning Strategies

#### For the Teacher

This section on safety is expected to be completed before any activities in robotics are undertaken. Safety rules should be strictly enforced whenever students are using the equipment.

#### Points to Emphasize

- Safety glasses must be worn at all times.
- Ensure the work area is free of all obstructions.
- Earplugs should be worn when using noisy equipment such as band saws.
- Tie back any long hair.
- Appropriate clothing must be worn that minimizes the risk of injury. Remove or tie back any loose fitting clothing such as scarves or loose sleeves. No open toed shoes, high heels, hoodies, clothes with strings, etc.
- Proper gloves must be worn when handling materials such as hot items or sharp metal.
- Dust masks must be worn when sanding or other fabrication that causes dust.
- Check equipment for signs of damage.

#### For the Student

Each student will be expected to show due diligence with personal protective equipment. Safety glasses must be worn at all times. Other PPE must be worn when it is appropriate to do so.

## Topic 1 - Fabrication Safety

### Suggested Assessment and Evaluation Strategies

#### Presentation

Create a web page or electronic Presentation on one of the provided topics.

Create a safety video on one of the following topics:

- potential hazards
- personal protective equipment
- tools/tool use
- applicable emergency equipment

#### Pencil and Paper

- Identify the location of all safety features and equipment and any potential hazards.
- When given various scenarios, (picture format) students are to identify and find the potential hazards depicted.

### Resources

#### External Link:

<http://uwworksafes.com/woodshop/default.cfm>

## Topic 1 - Fabrication Safety

### Specific Curriculum Outcomes

*Robotic Systems Technology 3205*

#### Students will be expected to:

4.1.3 demonstrate the safe use of tools in a fabrication lab including tools specific to electronic/robotics fabrication.

#### Delineation:

Soldering iron

Cordless/Corded Drill

Drill Press

Band Saw

Jig saw

Bench Grinder

Compressor

Hand tools

Cutters

Wire strippers

Pliers

### Suggested Teaching and Learning Strategies

#### For the Teacher

The purpose of this outcome is to ensure that students see a demo of the proper use of each tool by the teacher. Teachers should become familiar and comfortable using each tool before demonstrating tools to students.

#### Points to Emphasize

- This should include power, hand, and soldering tools.
- Soldering is a key component and the proper method of safe use needs to be followed.
- Static charge is an inherent hazard when using tools to fabricate electronic components. Proper methods of discharging static should be employed.

#### For the Student

Each student will be expected to pass a written test on tool safety and use of each tool.



## Topic 1 - Fabrication Safety

### Suggested Assessment and Evaluation Strategies

#### Presentation

Assign each student a tool and have them create a poster on the safe use of the tool.

Create a safety video on one of the following topics:

- potential hazards
- personal protective equipment
- tools/tool use
- applicable emergency equipment

Create a web page or electronic Presentation on one of the provided topics.

#### Pencil and Paper

Complete a written test on each tool.

Given various scenarios (picture format), students are to identify the potential hazards depicted.

### Resources

#### Authorized Resource:

Robot Builders Bonanza, p. 65  
– 78

#### Department of Education

#### Skilled Trades related documents:

<http://www.ed.gov.nl.ca/edu/k12/curriculum/documents/skilledtrades/index.html>

## Topic 1 - Fabrication Safety

### Specific Curriculum Outcomes

*Robotic Systems Technology 3205*

#### Students will be expected to:

- 4.1.4 demonstrate proper use of applicable emergency equipment in a fabrication lab.

#### Delineation:

Eye wash stations  
First Aid Kits  
Fire Extinguishers  
Fire Alarms

### Suggested Teaching and Learning Strategies

#### For the Teacher

The purpose of this outcome is to have teachers identify and demonstrate emergency equipment such as eye wash stations, first aid kits, fire extinguishers and fire alarms.

#### Points to Emphasize

- Tampering with emergency equipment is an illegal offence.
- Different emergency equipment have unique roles to play in a work environment. (example: fire extinguisher designed for different types of fires)

#### For the Student

Have student teams do a presentation on the proper use of a specific piece of emergency equipment. Students could then present this to the rest of the class.

## Topic 1 - Fabrication Safety

### Suggested Assessment and Evaluation Strategies

#### Presentation

Create a web page or electronic Presentation on one of the provided topics.

Create a safety video on one of the following topics:

- potential hazards
- personal protective equipment
- tools/tool use
- applicable emergency equipment

#### Pencil and Paper

Given a diagram of the fabrication lab, identify the location of all safety features and equipment and any potential hazards.

Given various scenarios (picture format), students are to identify and find the potential hazards depicted.

### Resources

## Topic 1 - Fabrication Safety

### Specific Curriculum Outcomes

*Robotic Systems Technology 3205*

#### Students will be expected to:

4.1.5 explain WHMIS codes normally found on products in a fabrication environment

### Suggested Teaching and Learning Strategies

#### For the Teacher

The purpose of this outcome is to outline the Work Place Hazardous Information System (WHMIS) as it applies to the fabrication environment including general safety, tool safety and electrical safety. It is important that teachers identify all hazardous materials in a fabrication environment.

Material Safety Data Sheets (MSDS) should be available to the students for all materials that may pose a hazard including those specific to the robotics work environment.

#### Points to Emphasize

WHMIS governs the handling of potentially dangerous goods and became law through a series of complementary federal, provincial and territorial legislation that became effective October 31, 1988.

The main resource for safety, according to WHMIS, is the MSDS that legally must accompany every hazardous material in Canada.

Students should become familiar with:

- hazardous product symbols
- supplier labels
- workplace labels
- household product labels
- Materials Safety Data Sheets (MSDS)

#### For the Student

Students should be able to take a hazardous product MSDS and identify the product, hazards, precautions, safe handling, and personal protective equipment required.

Students will be required to match categories of hazardous products with their symbols.

## Topic 1 - Fabrication Safety

### Suggested Assessment and Evaluation Strategies

#### Pencil and Paper

Complete a worksheet on the WHMIS codes normally found in a fabrication environment.

#### Journal

Find as many items (material) as possible in the fabrication area that have WHMIS symbols. Create a table with the following headings and fill in the pertinent information on each:

- Item (material)
- Symbol
- Definition

Topic 2 and 3 could be integrated with Unit 5

### Resources

#### External Link:

Health Canada Workplace  
Hazardous Materials  
Information System

<http://www.hc-sc.gc.ca/ewh-sent/occup-travail/whmis-simdut/index-eng.php>

## Topic 2 - Planning and Layout

### Specific Curriculum Outcomes

*Robotic Systems Technology 3205*

#### Students will be expected to:

4.2.1 identify tools used in  
planning and layout

#### Delineation:

sketching techniques  
technical drawing  
measuring and drawing  
tools  
design software

### Suggested Teaching and Learning Strategies

#### For the Teacher

The purpose of this outcome is to have students explore a variety of tools that can be used to plan solutions to technological problems.

#### Points to Emphasize

- Preliminary ideas can be communicated using orthographic and pictorial sketches
- Technical drawing tools such as SolidWorks, MSVisio, Google Sketchup and Virtual Electricity Labs.

#### For the Student

Students should be able to match the appropriate tool to an element of the planning process.

## Topic 2 - Planning and Layout

### Suggested Assessment and Evaluation Strategies

#### Pencil and Paper

Given a list of tools and planning processes, match the tool to the appropriate process.

### Resources

CDLI Integrated Systems

1205 Resource:

Unit 3, Section 1, ILO 3

## Topic 2 - Planning and Layout

### Specific Curriculum Outcomes

*Robotic Systems Technology 3205*

#### Students will be expected to:

4.2.2 employ tools used in planning and layout.

##### Delineation:

planning part sizes  
allowing for material thickness  
making best use of materials  
planning the most efficient cutting pattern  
materials list  
sketching  
circuit diagrams

4.2.3 apply techniques used for layout.

##### Delineation:

prepare material  
measure  
mark  
cut  
use a cutting sequence

### Suggested Teaching and Learning Strategies

#### For the Teacher

The purpose of these outcomes is to have students use appropriate planning and layout tools and techniques for planning solutions to technological problems.

Plans developed under this outcome could potentially be useful in project planning for Unit 6.

#### Points to Emphasize

- Technical drawing techniques
- Create materials lists
- Material use planning – how to most efficiently use the materials provided so that the least amount of material is wasted.
- Create a flow chart of the steps in fabricating the solution including which tools would be required at each stage of the process. This will allow for more efficient utilization of tool resources in the fabrication lab.
- The teacher should identify and briefly describe the common metrology (measurement) tools used in fabrication, including: steel rule, steel tape, micrometers, calipers, scribe, squares and center punch.

#### For the Student

Students should identify a problem and use the appropriate planning and layout tools to plan a solution.



## Topic 2 - Planning and Layout

### Suggested Assessment and Evaluation Strategies

#### Performance

- Create a flow chart of the steps in fabricating the solution including which tools would be required at each stage of the process.
- Apply the tools and techniques for planning and layout of the Design Project.
- Complete necessary skill builders (hand sketching activities, software tutorials, etc)

#### Pencil and Paper

- Complete questions on a provided blueprint (plan).
- Prepare a materials list for the designated design project.

#### Journal

Identify the use of the following metrology (measurement) tools: steel rule, steel tape, micrometers, calipers, scribe, squares and center punch.

### Resources

CDLI Integrated Systems 1205

Resource:

Unit 3, Section 1, ILO 3

## Topic 2 - Planning and Layout

### Specific Curriculum Outcomes

*Robotic Systems Technology 3205*

#### Students will be expected to:

4.3.1 assess suitability of materials for fabricating electronic system prototypes.

Delineation:

Wood

Metals

Plastics

4.3.2 identify tools used for fabricating a variety of materials.

### Suggested Teaching and Learning Strategies

#### For the Teacher

The purpose of these outcomes is for students to identify the properties of materials, their feasibility for use in fabricating solutions and the selection of appropriate tools for this fabrication.

#### Points to Emphasize

- Different materials have different properties and therefore different uses. (examples: conductors versus insulators, strength to weight ratio as an issue when interfacing low voltage motors)
- Different materials require different tools and skill levels for fabrication. Once students have identified properties of materials they should assess the best tools for fabricating these materials.
- The teacher could demonstrate how specific tools are used to work with a variety of materials

#### For the Student

Provide students with opportunities to choose appropriate materials for a fabrication project. Have them justify their choice of materials and select the appropriate tools

## Topic 3 - Materials Processing

### Suggested Assessment and Evaluation Strategies

#### Performance

Select appropriate materials and tools for the fabrication project and state the reasons for these choices.

#### Journal

Record daily entries on progress as a part of the Design Process.

### Resources

CDLI Integrated Systems 1205

#### Resource:

Unit 3, Section 1, ILO 5

## Topic 3 - Materials Processing

### Specific Curriculum Outcomes

*Robotic Systems Technology 3205*

#### Students will be expected to:

4.3.3 employ the major processes of fabrication.

#### Delineation:

Separating

Forming

Combining

Conditioning

Finishing

### Suggested Teaching and Learning Strategies

#### For the Teacher

The purpose of the outcome is to help students understand fabrication as a process that uses a set of common methods for all materials.

#### Points to Emphasize

- Forming is used to change the size or shape of stock, usually without loss of weight or volume.
- Separating is used to remove volume.
- Combining is used to join and fasten materials together.
- Conditioning is used to change the internal or external properties of materials, often with no visible change to the material.
- Finishing is used to improve the look or protect the exterior surfaces of the material.

#### For the Student

Have students provide examples of forming, separating, combining, conditioning, and finishing as used in the development of a consumer product or in a design challenge solution.

## Topic 3 - Materials Processing

### Suggested Assessment and Evaluation Strategies

#### Performance

Employ the major processes of fabrication as required for the completion of the design project.

#### Journal

Record daily entries on progress as a part of the Design Process.

### Resources

CDLI Integrated Systems

1205 Resource:

Unit 3, Section 1, ILO 4

