

# 10

## Technology and Livelihood Education Information and Communication Technology Learner's Material

### Technical Drafting

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## Personal Entrepreneurial Competencies (PECs)

Content Standards	Performance Standards
The learner demonstrates understanding of one's PECs in Technical Drafting.	The learner independently creates a plan of action that strengthens and/or further develops his/her PECs in Technical Drafting.

**Quarter I**

**Time Allotment:** 4 hours

### Module 1

## Personal Entrepreneurial Competencies

### Introduction

In this module, you will learn more about entrepreneurship and the entrepreneurial competencies related to Technical Drafting. You will have a first-hand experience in educational activities leading to assessment of your personal entrepreneurial competencies (PECs) and the entrepreneurial competencies of a successful draftsman and/or CAD operator within your province. You will also have several activities that will align your competencies with those of successful practitioners. Moreover, this module will encourage you to think about entrepreneurship and its role in the business community as well as in the economic and social development of an individual.

To start with this module, let us first understand entrepreneurs and entrepreneurship.

Entrepreneurs are those with the skills and capabilities to see and evaluate business opportunities. They are individuals who can strategically identify products or services needed by the community, and have the capacity to deliver them at the right time and at the right place.

Entrepreneurs are agents of economic change; they organize, manage, and assume risks of a business. Some of the good qualities of entrepreneurs are: opportunity-seeker, risk-taker, goal-setter, excellent planner, confident problem-solver, hardworking, persistent, and committed.

Entrepreneurship, on the other hand, is not just a simple business activity but a strategic process of innovation and new product creation. Basically, entrepreneurship is both an art and science of converting business ideas into marketable products or services to improve the quality of living.

Now that you have background knowledge about entrepreneurs and entrepreneurship, you can now walk through in assessing your PECs. Always remember that successful entrepreneurs continuously develop and improve their PECs.

To begin, let us find out the competencies you will have gained upon completion of this module.

### Objectives

At the end of this module, you are expected to:

- identify areas for improvement, development, and growth,
- align your PECs according to your business or career choice, and
- create a plan of action that ensures success in your business or career choice.

Now try to take the first challenge in this module, the pre assessment.

### Pre-assessment

As part of your initial activity, try to assess your prior knowledge and experience related to personal entrepreneurial competencies. Answer Task 1.

### Task 1: Matching Type

**Directions:** Match the entrepreneurial competencies in column **A** with their meaning in column **B**. Write the letter of the correct answer on the space provided before each number.

<b>A</b>	<b>B</b>
____1. Creative	A. makes wise decisions towards the set objectives
____2. Profit-oriented	B. strategic thinking and setting of goals
____3. Disciplined	C. trusting in one's ability

- |                                |  |
|--------------------------------|--|
| ___4. Sound decision maker     | D. adoptable to change   |
| ___5. Possess people skills    | E. innovates to have an edge over other competitors                        |
| ___6. Excellent Planner        | F. solid dedication  |
| ___7. Confident                | G. skillful in record keeping  |
| ___8. Hardworking              | H. always sticks to the plan   |
| ___9. Ability to accept change | I. work diligently   |
| ___10. Committed               | J. effective and efficient communication skills and relates well to people |
|                                | K. always looking for an opportunity to have/earn income.                  |

## Task 2: Guide Questions

**Directions:** The following are guide questions which covers the entire module. Write your answers on your assignment notebook. Discuss / share these to the class.

- A. Explain why entrepreneurial activities are important to social development and economy progress.
- B. What entrepreneurial activities related to Technical Drafting do you know and are capable of doing?
- C. If you were given the opportunity to own a business that relates to Technical Drafting, do you think you will be confident to manage it? Explain your answer.
- D. What do you think are the most important competencies one must possess in order to be successful in running a chosen business?
- E. Name successful entrepreneurs from your province whose businesses are related to Technical Drafting. Make sure you will be able to share with the class the PECs that made them successful.

After all the guide questions are answered, share these with your classmates. You may also compare your insights, personal knowledge, and relevant experiences on the topic to make the sharing more exciting and engaging.

### Learning Goals and Targets

After understanding the objectives of this module, having gone through pre-assessment, and answering the guide questions, you will be asked to set your own personal goals and targets. These goals and targets will urge you to further achieve the ultimate objective of this module. In the end, these ultimate goals will motivate you to learn more about PECs.



Figure 1: Strategic process to achieve the objectives of this module

### Reading Resources and Instructional Activities

After setting your own personal goals and targets in achieving the objectives of this module, check your inherent knowledge of PECs. Answer the following guide questions with the help of your classmates.

#### Task 3: Group Activity

**Directions:** Answer the following guide questions on a separate sheet of paper. Share your answers with the class.

1. Explain the importance of assessing one's PECs before engaging in a particular entrepreneurial activity.

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2. Are there other strategies or approaches where you can assess your PECs? Explain how these strategies will become more useful in selecting a viable business venture.

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3. What are the desirable personal characteristics, attributes, lifestyles, skills, and traits of a prospective entrepreneur? Why are these important?

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4. Why is there a need to assess one's PECs in terms of characteristics, attributes, lifestyles, skills, and traits before starting a particular business?

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5. What is the significance of evaluating PECs of a successful entrepreneur? What helpful insights can you draw from this activity?

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How was your experience in answering the guide questions with your classmates? Were you able to benefit from them? What were the insights you have realized?

This time you're going to study the different topics that will enrich your knowledge of PECs. Read all the important details about the succeeding topic carefully.



## Assessment of Personal Entrepreneurial Competencies (PECs) and Skills vis-à-vis a Practicing Entrepreneur in a Province

Entrepreneurial competencies refer to the important characteristics that should be possessed by an individual in order to perform entrepreneurial functions effectively. In this module, you will learn some of the most important characteristics, attributes, lifestyle, skills and traits of a successful entrepreneur or an employee to be successful in a chosen career.

Below are few important characteristics / traits / attributes of a good entrepreneur:

- **Hardworking:** One of the important characteristics of a good entrepreneur is hardworking. This means working diligently and being consistent about it. Hardworking people keep improving their performance to produce good products and/or provide good services.
- **Confident:** Entrepreneurs have self-reliance in one's ability and judgment. They exhibit self-confidence to cope with the risks of operating their own business.
- **Disciplined:** Successful entrepreneurs always stick to the plan and fight the temptation to do what is unimportant.
- **Committed:** Good entrepreneurs assume full responsibility over their business. They give full commitment and solid dedication to make the business successful.
- **Ability to accept change:** Nothing is permanent but change. Change occurs frequently. When you own a business, you should cope with and thrive on changes. Capitalize on positive changes to make your business grow.
- **Creative:** An entrepreneur should be creative and innovative to stay in the business and in order to have an edge over the other competitors.



- **Has the initiative:** An entrepreneur takes the initiative. You must put yourself in a position where you are responsible for the failure or success of your business.
- **Profit-oriented:** An entrepreneur enters the world of business to generate profit or additional income. The business shall become your bread and butter. Therefore, you must see to it that the business can generate income.

Listed below are the important skills of a successful entrepreneur:

- **Excellent planner:** Planning involves strategic thinking and goal setting to achieve objectives by carefully maximizing all the available resources. A good entrepreneur develops and follows the steps in the plans diligently to realize goals. A good entrepreneur knows that planning is an effective skill only when combined with action.
- **Possesses people skills:** This is a very important skill needed to be successful in any kind of business. People skills refer to effective and efficient communication and establishing good relationship to the people working in and out of your business. In day-to-day business transactions, you need to deal with people. A well-developed interpersonal skill can make a huge difference between success and failure of the business.
- **Sound decision maker:** Successful entrepreneurs have the ability to think quickly and to make wise decisions towards a pre-determined set of objectives. No one can deny that the ability to make wise decisions is an important skill that an entrepreneur should possess. Sound decisions should be based on given facts and information and lead towards the pre-determined objectives.



To firm up what you have learned and have a better appreciation of the different entrepreneurial competencies, read the PECs checklist below, then answer the same.

#### Task 4: PECs Checklist

**Directions:** Using the PECs checklist, assess yourself by putting a check (✓) mark in either strengths or development areas column. Interpret the results by counting the total number of check marks in each of the columns. After accomplishing the checklist, form a group and share your insights on the result of the personal assessment.

Table 1: PECs Checklist

Personal Entrepreneurial Competencies (PECs) of an Entrepreneur	Personal Assessment in terms of:	
	Strengths	Development Areas
Hardworking - Works diligently		
Confident - Self-reliance in one's ability		
Disciplined - Always stick to the plan		
Committed - Solid dedication		
Ability to accept changes - Adaptable		
Creative - Innovative to have edge over other competitors		
Profit-oriented - Always looking for an opportunity to have/earn income		
Excellent planner - Strategic thinking and setting of goals		

Possess people skill - Effective and efficient communication skills and relates well to people		
Sound decision maker - Makes wise decisions towards the set objectives		
TOTAL		

Interpretation or Insight:

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### *Reflect and Understand*

How was your experience in discovering the strengths and the areas you need to develop? Did you gain a valuable experience in exchanging insights with your classmates? To learn more and deepen your understanding of PECs, do task 5 below.

#### **Task 5: Interview**

**Directions:** In your province, interview a successful draftsman, CAD operator and/or entrepreneur whose type of business is related with Technical Drafting. Focus your questions on PECs and other business-related attributes that helped them become successful. Analyze the results of the interview and reflect on the similarities and/or differences. Write your answer on a separate sheet of paper.

## Sample Interview Guide

Name of Proprietor/Practitioner: \_\_\_\_\_

Age: \_\_\_\_\_ Number of Years in Business: \_\_\_\_\_

Business Name: \_\_\_\_\_

Business Address: \_\_\_\_\_

1. What preparations did you make before you engaged in this type of business or job?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_.

2. What special skills and characteristics do you have that are related with your business or job?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_.

3. How did you solve business-related problems during the early years of your business operation?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_.

4. Did you follow the tips from a successful businessman or practitioner before you engaged in your business?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_.

5. What best business practices can you share with aspiring entrepreneurs?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_.

6. What do you think are the salient characteristics, attributes, lifestyle, skills and traits that made you successful in your business or job?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_.

**Directions:** Copy the tables below in your notebook or in a separate sheet of paper. Gather the needed information from the interview to supply answer/s to row 1 in the table below, after which, fill out the second row with your PECs.

Personal Entrepreneurial Competencies	Characteristics	Attributes	Lifestyles	Skills	Traits
Successful Entrepreneur in the province					
My PECs					

Using the information on the table above, analyze and reflect on the similarities and differences in your answers. Put your reflection on the table you copied in your notebook or in a separate sheet of paper. Write your conclusion on the space provided.

Personal Entrepreneurial Competencies	Similarities	Differences
Characteristics		
Attributes		
Lifestyles		
Skills		
Traits		

Conclusion:

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## Transfer

After performing the activities on the importance of PECs, let's determine how much you have learned. Perform task 6 to determine how well you have understood the lesson.

### Task 6: Preparation of a Plan of Action

**Directions:** Use in a separate sheet of paper/in your notebook the information generated from task 5 (Interview) and prepare an action plan that indicates alignment of your PECs to the PECs of a successful entrepreneur in Technical Drafting in your province.

Objective	Area	Activities	Strategies	Time Frame	Expected Outcome
To align my PECs with the PECs of a successful entrepreneur in Technical Drafting	Characteristics				
	Skills				
	Attribute				
	Traits				

## Task 7: Essential Questions

**Directions:** Read and study the following questions below. You may use a separate sheet of paper or your notebook to write your answers.

1. Why is there a need to compare and align one's PECs with the PECs of a successful entrepreneur?

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2. How does your action plan help sustain your strong PECs and/or address your development areas?

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3. What plan of action will you utilize to address your development areas?

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## ENVIRONMENT AND MARKET (EM)

Content Standards	Performance Standards
The learner demonstrates understanding of environment and market in Technical Drafting in one's province.	The learner independently creates a business vicinity map reflective of potential market in Technical Drafting in a province.

**Quarter I**

**Time Allotment:** 4 hours

### **Module 2 Environment and Market**

#### **Introduction**

Aspiring entrepreneur need to explore the economic, cultural, and social conditions prevailing in an area. Needs and wants of the people in a certain area that are not met may be considered business opportunities. Identifying the needs of the community, its resources, available raw materials, skills, and appropriate technology can help a new entrepreneur seize business opportunities.

To be successful in any kind of business venture, potential entrepreneurs should look closely at the environment and market. They should always be watchful of existing opportunities and constraints, and to take calculated risks. The opportunities in the business environment are factors that provide possibilities for a business to expand and make more profit. Constraints, on the other hand, are factors that limit business growth, hence reduce the chance of generating profit. One of the best ways to evaluate opportunities and constraints is to conduct a Strengths, Weaknesses, Opportunities and Threats (SWOT) Analysis.

SWOT Analysis is a managerial tool used to assess the environment. It is used to gather important information which is then used in strategic planning. Strengths and weaknesses are internal in an organization. They relate to resources owned by an organization that you have control over and also the extent of its marketing.



Opportunities and threats exist in the external environment. Opportunities relate to the market, new technologies, and the external factors such as government policies, climate, and trends. Threats replace what the competitors are doing. It also includes legal and other constraints.

Now that you have read some important considerations to explore to be successful in any business, you are now ready to explore more about the environment and market.

To begin with, let's find out the competencies that you will master as you finish this module.

### **Objectives**

At the end of this module, you are expected to:

- identify what is of “value” to the customer,
- identify the customer to sell to,
- explain what makes a product unique and competitive,
- apply creativity and innovative techniques to develop marketable products, and
- employ a unique selling proposition (USP) to a product and/or service.

Now that you have an idea about the things you will learn, take the first challenge in this module – the pre-assessment.

## Pre-assessment

### Task 1: Multiple Choice

**DIRECTIONS:** Choose the letter of the best answer. Write your answer on a separate sheet of paper.

1. It is generated by examining the goods and services sold in the community.
  - A. business creation
  - B. business pricing
  - C. business concept
  - D. business idea
2. It is a process of making new products which will be sold to the customers.
  - A. product analysis
  - B. product conceptualization
  - C. product development
  - D. product implementation
3. These are luxuries, advantages and desires that every individual considers beyond necessary.
  - A. wants
  - B. desires
  - C. requirements
  - D. needs
4. It is a factor or consideration presented by a seller as the reason that a product or service is different from and better than that of the competition.
  - A. unique selling plan
  - B. unique selling proposition
  - C. unique pricing policy
  - D. finding value-added
5. A stage in which the needs of the target market are identified, reviewed, and evaluated.
  - A. concept development
  - B. economic analysis
  - C. project development
  - D. refine specification
6. It is the introduction of new ideas to make the product and services more attractive and saleable to the target customers.
  - A. new idea
  - B. creativity
  - C. product development
  - D. innovation
7. It is a managerial tool used to assess the environment and to gather important information that can be used for strategic planning.
  - A. scanning
  - B. SWOT Analysis
  - C. WOTS Analysis
  - D. survey analysis

8. It is creating names, symbol, or designs that identifies and differentiates a product from the other products.
 

A. product naming	C. branding
B. unique selling proposition	D. tagline
9. It is a meaningful and unforgettable statement that captures the essence of the brand.
 

A. product naming	C. branding
B. unique selling proposition	D. tagline
10. These are things that people cannot live without.
 

A. wants	C. requirements
B. desires	D. needs

**Task 2: Guide Questions:**

**Directions:** Read and study the guide questions below. Use a separate sheet of paper to write your answer.

1. How does one determine the product or services to be produced and/or to be provided to the target customers?

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2. How does one select an entrepreneurial activity?

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3. When can one say that a certain product has “value?”

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4. Does applying creativity to your product or services important? Why?

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5. How can one effectively respond to the needs of the target customer?

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6. From the viewpoint of business owner, discuss the importance of scanning the environment and market in generating business ideas.

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7. Using self-assessment, explain the level of your confidence in formulating a business idea.

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After all the guide questions are answered and skills have been mastered, share insights/ideas with your classmates. Discuss your insights, personal knowledge, and relevant experiences on the topic to make it more exciting and engaging.

### Learning Goals and Target

After reading and understanding the objectives of this module and having gone through the pre-assessment and guide questions, you will be asked to set your own personal goals. These goals will urge you to further achieve the ultimate objective of this module. In the end, these goals will motivate you to learn more about environment and market.



Figure 2: Strategic process to reach the objectives of this module

## Reading Resources and Instructional Activities

After setting your own personal goals and targets in achieving the objectives of this module, you will have the opportunity to read and learn more about environment and market. You will also be given a chance to do practical exercises and activities to deepen your understanding of the topic.



### Product Development

When we talk of product development, we are referring to a process of making a new product to be sold by a business or enterprise to its customers. Product development may involve modification of an existing product or its presentation, or formulation of an entirely new product that satisfies a newly-defined customer's needs, wants and/or a market place.

The term development in this module refers collectively to the entire process of identifying a market opportunity, creating a product to appeal to the identified market, and testing, modifying, and refining the product until it becomes ready for production.

There are basic, yet vital questions that you can ask yourself about product development. When you find acceptable answers to them, you may now say that you are ready to develop a product and/or render services.

These questions include the following:

1. For whom are the product/services aimed at?
2. What benefit will the customers expect from product/service?
3. How will the product/service differ from the existing brand? From its competitor?

In addition, needs and wants of the people within an area should also be taken into big consideration. Everyone has his/her own needs and wants. However, each person has different concepts of needs and wants. Needs in business are the important things that an individual cannot live without in a society. These include:

1. basic commodities for consumption,
2. clothing and other personal belongings,
3. shelter, sanitation and health, and
4. education.

Basic needs are essential to an individual to live with dignity and pride in a community. These needs can obviously help you generate business ideas and subsequently to product development.

Wants are desires, luxury and extravagance that signify wealth and expensive way of living. Wants or desires are considered above all the basic necessities of life. Some examples of wants or desires are: fashion accessories, expensive shoes and clothes, travels, eating in an expensive restaurant, watching movies, concerts, having luxurious cars, wearing expensive jewelry and perfume, living in impressive homes, among others.

Needs and wants of people are the basic indicators of the kind of business that you may engage in because it can serve as the measure of your success. Some other points that might be considered in business undertakings are the kind of people, their needs, wants, lifestyle, culture and tradition, and their social orientation.

To summarize, product development entirely depends on the needs and wants of the customers. Another important issue to deal with is the key concepts of developing a product. The succeeding topic shall enlighten you about the procedure in coming up with a product.

### **Concepts of Developing a Product**

Concept development is a critical phase in the development of a product. In this stage, the needs of the target market are identified, and competitive products are reviewed before the product specifications are defined. The product concept is selected along with an economic analysis to come up with an outline of how a product is being developed. Figure 3 shows the stages of concept development of a product.

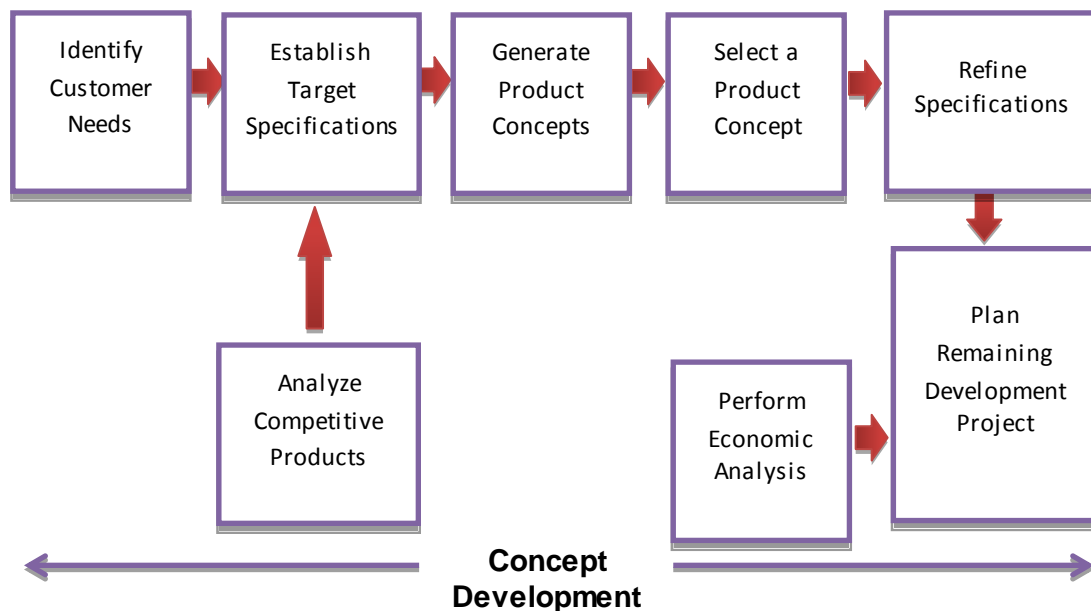


Figure 3: Stages of Concept Development

The process of product development follows the following stages:

1. **Identify customer needs:** Using survey forms, interviews, researches, focus group discussions, and observations, an entrepreneur can easily identify customers' needs and wants. In this stage, the information that can be possibly gathered are product specifications (performance, taste, size, color, shape, life span of the product, etc.). This stage is very important because it would determine the product to be produced or provided.
2. **Establish target specifications:** Based on customers' needs and reviews of competitive products, you can now establish target specifications of the prospective new product and/or services. A target specification is essentially a wish-list.
3. **Analyze competitive products:** It is imperative to analyze existing competitive products to provide important information in establishing product or service specifications. Other products may exhibit successful design attributes that should be emulated or improved upon in the new product or service.
4. **Generate product concepts:** After having gone through with the previous processes, you may now develop a number of product

concepts to illustrate the types of products or services that are technically feasible and will best meet the requirements of the target specifications.

5. **Select a product concept:** Through the process of evaluation between attributes, a final concept is selected. After the final selection, additional market research can be applied to obtain feedback from certain key customers.
6. **Refine product specifications:** In this stage, product or services specifications are refined on the basis of input from the foregoing activities. Final specifications are the result of extensive study, expected service life, projected selling price among others are being considered in this stage.
7. **Perform economic analysis:** Throughout the process of product development, it is very important to always review and estimate the economic implications regarding development expenses, manufacturing costs, and selling price of the product or services to be offered or provided.
8. **Plan the remaining development project:** In this final stage of concept development, you can prepare a detailed development plan which includes list of activities, necessary resources and expenses, and development schedule with milestones for tracking progress.

## **Finding Value**

People buy for a reason. There should be something in your product or service that would give consumers a good reason to go back and buy more. There must be something that will make you the best option for target customers; otherwise, they have no reason to buy what you are selling. This implies further, that you offer something to your customers that will make them value your product or service.

The value you incorporate in your product is called value proposition. Value proposition is a believable collection of the most persuasive reasons why people should notice you and take the action you're asking for. It is what gets people moving, what makes people spend for your product or service.



## **Innovation**

Innovation is the introduction of something new in your product or service. This may be a new idea, a new method, or a new device. If you want to increase your sales and profit, you must innovate. Some of the possible innovations for your products are change of packaging, improvement of taste, color, size, shape, and perhaps price. Some of the possible innovations in providing services are application of new and improved methods, additional featured services, and possibly freebies.

## **Unique Selling Proposition (USP)**

Unique Selling Proposition is the factor or consideration presented by a seller as the reason that one product or service is different from and better than that of the competition. Before you can begin to sell your product or service to your target customers, you have to sell yourself in it. This is especially important when your product or service is similar to your competitors.

USP requires careful analysis of other businesses' ads and marketing messages. If you analyze what they say or what they sell, not just their product or service characteristics, you can learn a great deal about how companies distinguish themselves from competitors.

Here's how to discover your USP and how to use it to increase your sales and profit:

- **Use empathy:** Put yourself in the shoes of your customers. Always focus on the needs of the target customers and forget falling in love with your own product or service. Always remember, you are making/providing this product not for yourself but for the target customers to eventually increase sales and earn profit. Essential question such as what could make them come back and ignore competition, should be asked to oneself. Most possible answers may be focused on quality, availability, convenience, cleanliness, and reliability of the product or service.
- **Identify customer's desires.** It is very important for you to understand and find out what drives and motivates your customers to buy your product or service. Make some effort to find out, analyze and utilize the information that motivates the customers in their decision to purchase the product or service.

- **Discover customer’s genuine reasons for buying the product.** Information is very important in decision making. A competitive entrepreneur always improve their products or services to provide satisfaction and of course retention of customers. As your business grows, you should always consider the process of asking your customers important information and questions that you can use to improve your product or service.



To enhance your understanding of the topic previously presented, you will be tasked to form a group and arrange an interview with a successful entrepreneur or practitioner. You have to document this interview and present this to the whole class for reflection and appreciation.

**Task 3: Interview**

**Directions:** Select a successful entrepreneur or practitioner. Conduct an interview using the set of questions below. Document the interview and present it to the class. Use a separate sheet of paper.

1. How did you identify your customers?

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2. What were your considerations in selecting your customers?

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3. Explain how your product or service became unique to other products.

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4. Did you consult somebody before you engaged in this business? Cite / give sample insights that you gained from the consultation.

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5. What were your preparations before you started the actual business?

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6. What creative and innovative techniques did you adapt in the development of your product or service? What was the effect of the innovative techniques to the sales and profits of your business?

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7. What strategy did you consider to create a unique selling proposition to your product or service?

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### *Reflect and Understand*

#### **Task 4: Browsing the Internet**

**Directions:** To deepen your understanding of the lesson, perform the following tasks:

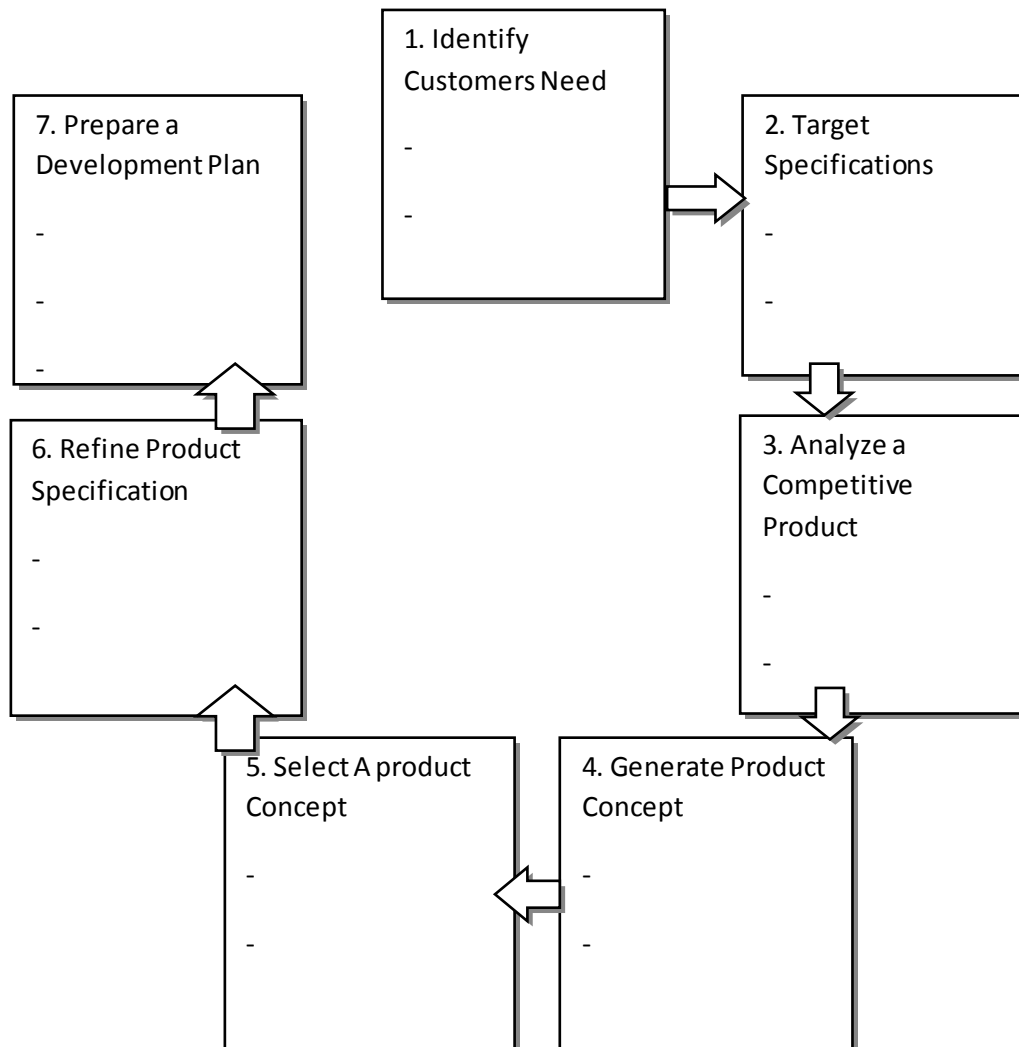
1. Browse the internet and view the topics related to:
  - a. customers' needs and wants
  - b. techniques in identifying customers' needs and wants
  - c. creativity or innovations in products and services
  - d. unique selling proposition
  - e. product development
  
2. Prepare a short narrative report about these topics and discuss it to the class. You can highlight the aspect that intensifies your knowledge of product development.



**Transfer**

### Task 5: Product Conceptualization

**Directions:** In a separate sheet of paper or in your notebook. Develop your own concept of your product or service by using the figures on this page. Use bullets in every stage of product conceptualization in listing important key ideas.





## Generating Ideas for Business

The process of developing and generating a business idea is not a simple process. Some people come up with a bunch of business ideas that are not really feasible. There are two problems that arise; first is the excessive generation of ideas that can forever remain as a dreaming stage and the second is when they don't have ideas and don't want to become entrepreneurs.

The most optimal way is to have a systematic approach in generating and selecting a business idea that can be transformed into a real business. Here are some basic yet very important considerations that can be used to generate possible ideas for business:

1. **Examine existing goods and services.** Are you satisfied with the product? What do other people who use the product say about it? How can it be improved? There are many ways of improving a product from the way it is made to the way it is packed and sold. You can also improve the materials used in crafting the product. In addition, you can introduce new ways of using the product, making it more useful and adaptable to the customers' many needs. When you are improving the product or enhancing it, you are doing an innovation. You can also do an invention by introducing an entirely new product to replace the old one.

Business ideas may also be generated by examining what goods and services are sold outside the community. Very often, these products are sold in a form that can still be enhanced or improved.

2. **Examine the present and future needs.** Look and listen to what the customers, institutions, and communities are missing in terms of goods and services. Sometimes, these needs are already obvious and identified right away. Other needs are not that obvious because they can only be identified later on, in the event of certain development in the community. For example, a province will have its electrification facility in the next six months. Only by that time will the entrepreneur could think of electrically-

powered or generated business such as photo copying, computer service, digital printing, etc.

3. **Examine how the needs are being satisfied.** Needs for the products and services are referred to as market demand. To satisfy these needs is to supply the products and services that meet the demands of the market. The term market refers to whoever will use or buy the products or services, and these may be people or institutions such as other businesses, establishments, organizations, or government agencies.

There is a very good business opportunity when there is absolutely no supply to a pressing market demand.

Businesses or industries in the locality also have needs for goods and services. Their needs for raw materials, maintenance, and other services such as selling and distribution are good sources of ideas for business.

4. **Examine the available resources.** Observe what materials or skills are available in abundance in your area. A business can be started out of available raw materials by selling them in raw form and by processing and manufacturing them into finished products. For example, in a copra-producing town, there will be many coconut husks and shells available as “waste” products. These can be collected and made into coco rags or doormats and charcoal bricks and sold profitably outside the community.

A group of people in your neighborhood may have some special skills that can be harnessed for business. For example, women in the Mountain Province possess loom weaving skills that have been passed on from one generation to another. Some communities set up weaving businesses to produce blankets, decorative, and various souvenir items for sale to tourists and lowlanders.

Business ideas can come from your own skills. The work and experience you may have in agricultural arts, industrial arts, home economics, or ICT classes will provide you with business opportunities to acquire the needed skills which will earn you extra income should you decide to engage in income-generating activities. With your skills, you may also tinker around with various things in your spare time. Many products are invented this way.

5. **Read magazines, news articles, and other publications on new products and techniques or advances in technology.** You can pick up new business ideas from magazines such as Newsweek, Reader's Digest, Business Magazines, "Go Negosyo", Know About Business (KAB) materials, and Small-Industry Journal. The Internet also serves as a library where you may browse and surf on possible businesses. It will also guide you on how to put the right product in the right place, at the right price, and at the right time.

### **Key Concepts of Selecting a Business Idea**

Once you have identified business opportunities, you will eventually see that there are many possibilities available for you. It is very unlikely that you will have enough resources to pursue all of them at once.

You have to select the most promising one among hundreds of ideas. It will be good to do this in stages. In the first stage, you screen your ideas to narrow them down to about few choices. In the next stage, trim down the choices to two options. In the final stage, choose between the two and decide which business idea is worth pursuing.

In screening your ideas, examine each one in terms of the following guide questions:

1. How much capital is needed to put up the business?
2. Where should the business be located?
3. How big is the demand for the product? Do many people need this product and will continue to need it for a long time?
4. How is the demand met? Who are processing the products to meet the needs (competition or demand)? How much of the need is now being met (supply)?
5. Do you have the background and experiences needed to run this particular business?
6. Will the business be legal and not against any existing or foreseeable government regulation?
7. Is the business in line with your interest and expertise?

Your answers to these questions will be helpful in screening which ones among your many ideas are worth examining further and worth pursuing.

## Branding

Branding is a marketing practice of creating a name, a symbol or design that identifies and differentiates product or services from the rest. It is also a promise to your customers. It tells them what they can expect from your product or service and it differentiates your offerings from other competitors. Your brand is derived from who you are, who you want to be and what people perceive you to be.

Branding is one of the most important aspects in any business. An effective brand strategy gives you a major edge in increasingly competitive markets.

A good product can:

- deliver message clearly,
- confirm credibility,
- connect to target prospect,
- motivate buyers, and
- concretize user loyalty.

Here are simple tips to publicize your brand:

- **Develop a tagline.** Write a statement that is meaningful, impressive, and easy to remember to capture the essence of your brand.
- **Design a logo.** Create a logo symbolic of your business and consistent with your tagline and display it strategically.
- **Write a brand message.** Select a key message to communicate about your brand.
- **Sustain a brand quality.** Deliver a promise of quality through your brand.
- **Practice consistency.** Be reliable and consistent to what your brand means in your business.





In generating a business idea, you should first identify the type of business suited to your business idea. You should analyze and scan the potential environment, study the marketing practices and strategies of your competitors, analyze strengths, weaknesses, opportunities, and threats in your environment to ensure that the products or services you are planning to offer will be patronized and within easy reach of target consumers.

How to conduct SWOT Analysis:

- Be realistic about the strengths and weaknesses of your business when conducting SWOT Analysis.
- SWOT Analysis should distinguish between where your business is today, and where it can be in the future.
- SWOT Analysis should always be specific. Avoid any gray areas.
- Always apply SWOT Analysis in relation to your competition, i.e. better than or worse than your competition.
- Keep your SWOT Analysis short and simple. Avoid complexity and over analysis.
- SWOT Analysis is subjective.

### **Task 6: SWOT Analysis**

**Directions:** In a separate sheet of paper or in your notebook list down all your observations for your business idea. Categorize your observations according to strengths, weakness, opportunities and treats. After carefully listing them down, use the stated strategies to come up with a sound analysis, activities and best business idea.

Strength (S)	Weaknesses (W)
<ul style="list-style-type: none"> <li>-</li> <li>-</li> <li>-</li> <li>-</li> <li>-</li> <li>-</li> </ul>	<ul style="list-style-type: none"> <li>-</li> <li>-</li> <li>-</li> <li>-</li> <li>-</li> <li>-</li> </ul>
Opportunities (O)	Threats (T)
<ul style="list-style-type: none"> <li>-</li> <li>-</li> <li>-</li> <li>-</li> <li>-</li> <li>-</li> </ul>	<ul style="list-style-type: none"> <li>-</li> <li>-</li> <li>-</li> <li>-</li> <li>-</li> <li>-</li> </ul>

Strategies:

- SW - Maximize on the Strengths to overcome the internal Weakness.
- OW - Capitalize on the Opportunities to eliminate the internal Weakness.
  
- ST - Maximize on your Strengths to eliminate the external Threats.
- OT - Take advantage of the available Opportunities to eliminate the external Threats.

Analysis:

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Activities:

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My Best Business Idea:

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### *Reflect and Understand*

To deepen your understanding of the topics previously discussed, you will be asked to perform the following activities:

#### **Task 7: Extra Reading and Video Viewing**

Reading books and watching videos have been considered as some of the most effective educational activities that can help learners broaden their understanding on a certain topic. In this particular task, you will be asked to conduct extra reading and video viewing on the Internet with the following topics:

- A. Steps in selecting a business idea
- B. Criteria of a viable business idea
- C. Benefits of a good brand
- D. Ways on developing a brand

After successfully performing the assigned task, make a narrative report about it and share it with the class.



### *Transfer*

#### **Task 8: Designing a Logo**

**Directions:** In a separate sheet of paper or in your notebook draw a logo that you will use in your business. Provide a simple statement to describe your logo.

**Logo**

**Tagline**

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**Task 9: Making My Own Vicinity Map**

**Directions:** In a separate sheet of paper or in your notebook draw a vicinity map reflective of potential market in Technical Drafting in your province. Provide a simple statement to describe your map.

**Vicinity Map**

Content Standard	Performance Standard
The learner demonstrates understanding of concepts and underlying principles in the preparation of drawings using Computer-Aided Design (CAD).	The learner independently prepare drawings using Computer-Aided Design (CAD) based on established industry and/or job requirements.

**Quarter I and II**

**Time Allotment: 80 hrs.**

### **MODULE 3**

## **PREPARING DRAWING USING COMPUTER-AIDED DESIGN (CAD)**

### **Introduction**

Technology and Livelihood Education (TLE) of the K to 12 Basic Education Program (BEP) is composed of four components namely: Agri-Fishery Arts, Home Economics, Industrial Arts and Information and Communication Technology (ICT). In this module, the focus is on **ICT – Preparing Drawings using Computer-Aided Design (CAD)**.

This course introduces the different learning activities that will prepare you to be a skillful draftsman before you take the plunge into the business of CAD. The skills learned will make you feel more confident while providing support where it is needed.

This module is specifically designed to hone your skills and knowledge on **Process and Delivery** of CAD enriched with hands-on activities. Learning procedures are divided into different sections such as: **What to Know, What to Process, What to Reflect and Understand** and **What to Transfer**

So, explore and experience the lessons in Preparing a Computer-Aided Drawing and be a step closer to being a draftsman.

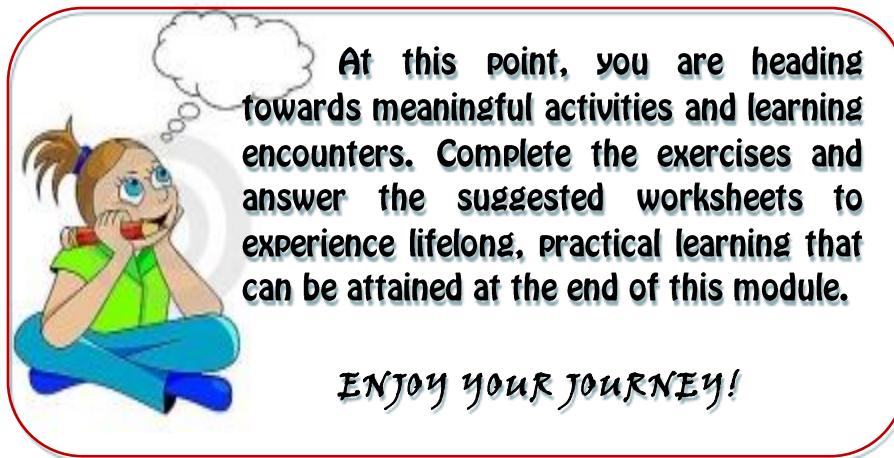


## Objectives:

Upon completion of this module, you are expected to:

- ❖ operate CAD software and computer hardware; and
- ❖ prepare plan using CAD

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## Pre-Assessment:

You will be challenged to recall your prior knowledge and previous experiences about Technical Drafting. This phase will guide you in assessing yourself by answering the questions below before you further explore the basics of preparing computer-aided drawings.

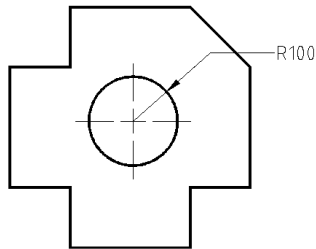
**Directions:** Choose the letter of the correct answer. Write your answer in the space provided for before each number.

- \_\_\_\_\_ 1. This is commonly known as the physical equipment that makes up the computer system.  
A. Hardware      B. Mouse      C. Printer      D. Software
- \_\_\_\_\_ 2. It is the brain of the computer where most of the “computing” takes place.  
A. CPU      B. Disk Drive      C. Hardware      D. Monitor

- \_\_\_\_\_ 3. This is the main purpose of the left mouse button.
- A. To execute a command                      C. To serve as abort button  
 B. To repeat the last command              D. To serve as pick button
- \_\_\_\_\_ 4. The set of programs, and other related applications associated with a computer system.
- A. Disk Drive                                      C. Printer  
 B. Hardware                                        D. Software
- \_\_\_\_\_ 5. Of the following softwares, which is not an application software?
- A. Adobe Photoshop                            C. Flash  
 B. AutoCAD                                        D. Windows 8
- \_\_\_\_\_ 6. Which of the following options is not a type of workspaces?
- A. 2D Drafting & Annotation                  C. 3D Modeling  
 B. My workspace                                 D. AutoCAD Classic
- \_\_\_\_\_ 7. Which of the function keys can be used for activating the Osnap Mode?
- A. F3    B. F5    C. F9    D. F8
- \_\_\_\_\_ 8. Which command is used to change the size of an existing objects?
- A. Move    B. Rotate                                        C. Scale                                        D. Zoom
- \_\_\_\_\_ 9. Which command can be used to create a new text style (TS) and modify the existing ones?
- A. Dtext    B. Mtext                                        C. Text    D. Style
- \_\_\_\_\_ 10. Which of the keyboard keys must be pressed to execute a command or to accept an Auto CAD default?
- A. F2 and Enter                                    C. Enter and Esc  
 B. Enter and Space bar                         D. Esc and Space bar
- \_\_\_\_\_ 11. With a hot grip you can perform these editing tasks
- A. Move    B. Offset                                        C. Rotate                                        D. Scale
- \_\_\_\_\_ 12. Which of the following is important in setting the chamfer command?
- A. Angle point 1 and 2                         C. Distance 1 and 2  
 B. Base point 1 and 2                         D. Radius 1 and 2
- \_\_\_\_\_ 13. What is the default file extension of an AutoCAD drawing?
- A. Dwg    B. Dwf    C. Dws    D. Dwt
- \_\_\_\_\_ 14. If you need the text to be reversed, you mirror the text, then you need to set
- A. MIRRTEXT to 0                                C. TEXTMIRR to 0  
 B. MIRRTEXT to 1                                D. TEXTMIRR to 1
- \_\_\_\_\_ 15. Which keystrokes will UNDO a command?

- A. Alt+U      B. Alt+Z      C. Control+U      D. Control+Z

\_\_\_\_\_ 16. Which of the following dimensioning commands is shown in the drawing?



- A. Dimaligned  
B. Dimangular  
C. Dimlinear  
D. Qleader

\_\_\_\_\_ 17. Which of the following is necessary in setting the fillet command?

- A. Angle      C. Distance  
B. Base point      D. Radius

\_\_\_\_\_ 18. Which of the following can be joined using the Join command

- A. Arc      B. Circle      C. Construction line      D. Ray

\_\_\_\_\_ 19. The following are some of the properties and settings that you can save in a layout, except.

- A. Plot scale      C. Line weight  
B. Paper size      D. Drawing orientation

\_\_\_\_\_ 20. What command is used to specify settings in dimension style manager?

- A. Ddim      B. Dimspec      C. Dimalt      D. Dimsiz

### Skills Assessment

**Directions:** Below are some important skills in computer-aided drawing. Read the skills carefully, write “Not much,” if you are not really familiar, “A little” and “A lot,” if you are familiar with the skill. Write your answers in your notebook.

Skills in Preparing Computer-Aided Drawing	No Knowledge	A Little	A Lot
I can identify CAD software features according to the software provider.			
I know how to explore CAD working environment.			
I know how to manipulate CAD features as per job requirements.			



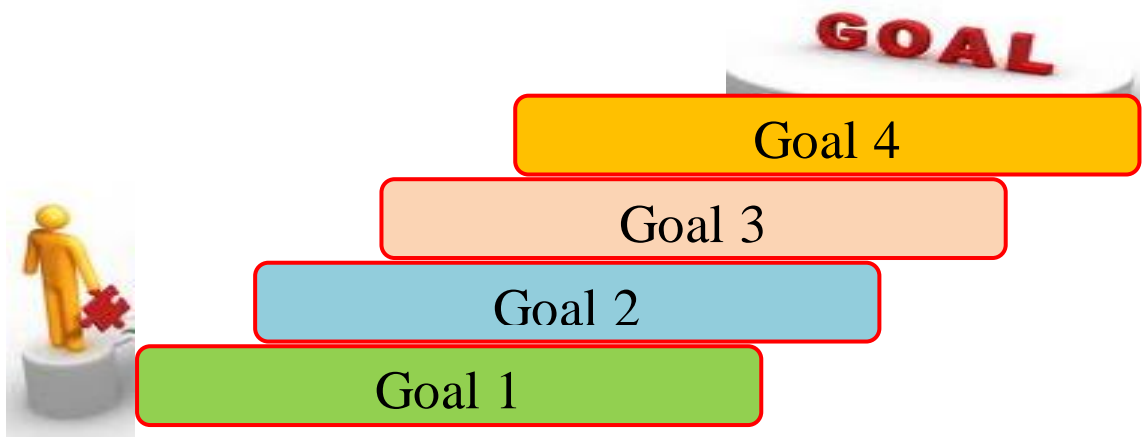
I can observe OHS policies and procedures when preparing plan using CAD.			
I know how to setup drawings according to standard drawing scale and paper size.			
I know how to prepare working drawings using CAD software as per building standards.			



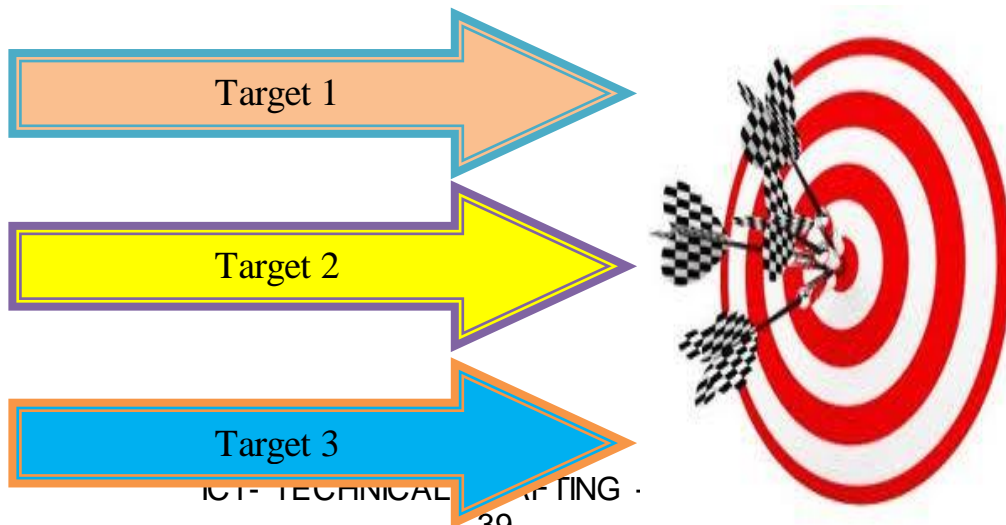
## Learning Goals and Targets

After reading the introduction and carefully answering the pre-assessment skills test, you might have ideas of what to expect in this module. Now prepare to set your goals and targets for this lesson by completing the activity below. Write your answer in your notebook.

**My goals are:**



**My targets are:**



After creating your awareness about the learning goals and targets that you are supposed to achieve, are you now ready to move on with this module? This will include topics on the operation of CAD software and computer hardware.

This module will guide you to learn the basics of AutoCAD commands that will enhance your skills in using the program. As you move along, you will learn to use some of the unique techniques that give AutoCAD an advantage over manual drawing.



## Lesson 1. Operating CAD Software and Computer Hardware

This lesson is to enable the student to prepare and to familiarize himself with the different things needed in operating the CAD software and the computer hardware.

### Some Technical Terms in Operating CAD Software and Hardware

**Hardware** - is all the physical equipment that makes up the computer system.

**Software** - is the set of programs and other related applications associated with a computer system.

**Central Processing Unit (CPU)** - is the brain of the computer where most of the “computing” takes place.

### CAD Software and Hardware

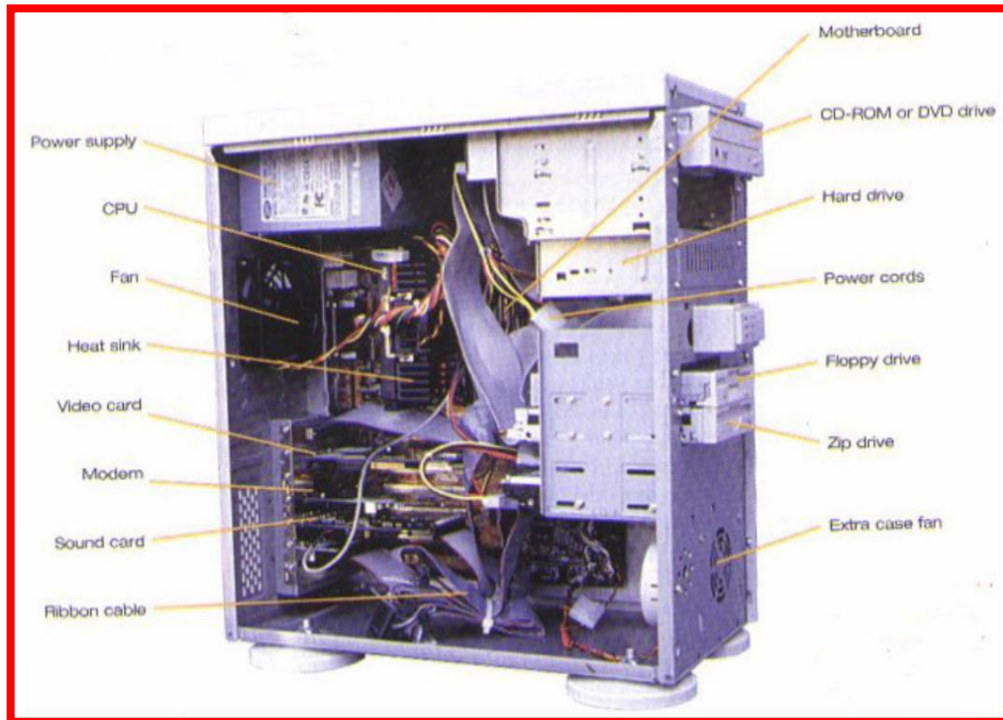
Computer system can be broken down into two basic elements, the *hardware* and the *software*.

### THE HARDWARE

The hardware is the physical equipment that makes up the computer system. It is divided into *system hardware* and *peripherals*. The system

hardware includes the Central Processing Unit (CPU), the keyboard, the monitor and primary storage memory (RAM), and the secondary storage memory. Peripherals includes disk drives, mouse, digitizers, printers/plotters, etc.

**System Unit** – The main part of a microcomputer, is sometimes called the chassis. It includes the following parts: motherboard, microprocessor, memory chips, buses, ports, expansion slots and cards.



### Sample Tower Type System Unit

Source: computerit4u.com

**The Central Processor Unit (CPU)** – is the brain of the computer where most of the “computing” takes place. It is also known as processor. It performs all instructions and calculations that are needed to manage the flow of information.

### Sample of CPU



### (Intel Core 2 Duo and AMD Athlon)

Source: products.yumecompare.com

**Keyboard** – is the principal device for communicating with your computer. All keyboards have letter keys, punctuation keys, and a space bar which is similar to the keys on a typewriter. Keyboards also have functions, numeric and arrow keys in addition to Alt, Ctrl, and Enter keys.



**Sample Keyboard**

Source: news.techgenie.com

**Monitor** – it has a screen that displays information, such as the instruction you send to your computer and the information and results your computer sends back after interpreting your instruction. A color monitor will not display color unless there is a video card fits inside your computer. The video card determines the screen resolution and the number of colors that the monitor can display.



## Sample Types of Monitor

**Hard Disk Drive (HDD)** – it also known as hard drive. It is a magnetic storage device that is installed inside the computer. The hard drive is used as a permanent storage for data. In a Windows computer, the hard drive is usually configured as the C: drive and contains the operating system and applications.



**Hard Disk**

Source: [news.techgenie.com](http://news.techgenie.com)

**Optical Drive** – is a storage device that uses lasers to read data on the optical media. There are three types of optical drives: Compact Disc (CD), Digital Versatile Disc (DVD) and Blu-ray Disc (BD).



**CD ROM**

Source: [www.ktclear.in](http://www.ktclear.in)

**Mouse** – is a small hand-held device used to control the cursor/crosshair on the screen. They can be used to select an item by pointing to it and clicking a button.



**Sample Mouse**

Source: [www.ztenterprise.com](http://www.ztenterprise.com)

**Digitizer Tablet** – is a graphics drawing tablet used for sketching new images or tracing old ones. It is also called a "graphics tablet," where the user writes or draws on the surface of the device with a wired or wireless pen or puck. Often, mistakenly called a mouse, the puck is officially the "tablet cursor."



### Sample Digitizer Tablet

Source: [www.tutorialspoint.com](http://www.tutorialspoint.com)

**Printer** – It is an output device that used to print information processed by your computer. Printers and plotters varies in speed and output capabilities.



Ink-jet Printer



Laser Printer



LCD Printer



Line Printer



Thermal Printer

### Sample Types of Printer

ICT- TECHNICAL DRAFTING - Grade 10



Source: [www.pcworld.co.uk](http://www.pcworld.co.uk)

**Plotter** – an output device able to produce better quality drawings as compared to printer, however the speed of plotter is generally slower than printer.



**Sample Plotter**

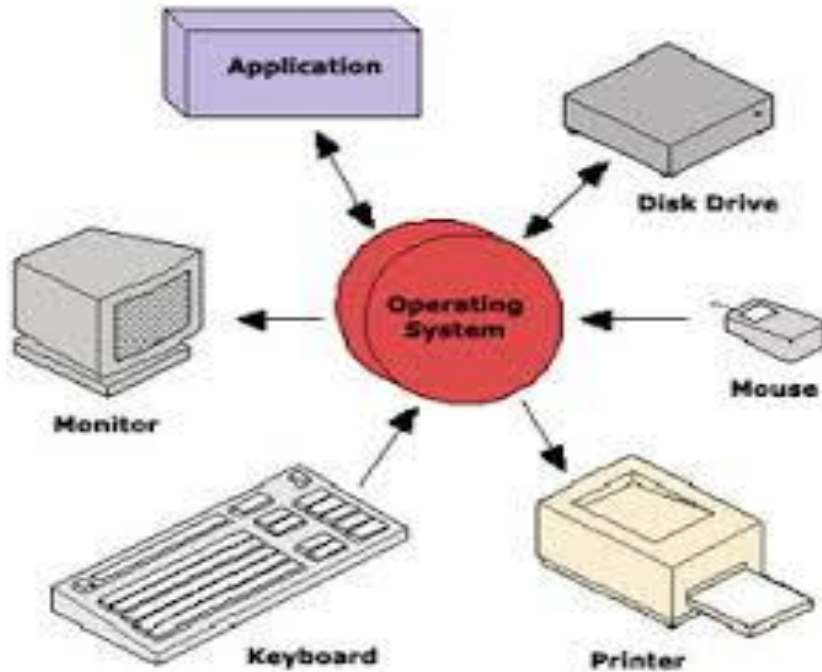
Source: [www.digitalcutterplotter.asia](http://www.digitalcutterplotter.asia)

## THE SOFTWARE

The software is the set of programs, procedures, and related documentation associated with a computer system. A program is a coded set of instructions that interprets the information given to the computer with the keyboard or mouse and directs the computer to carry a task. Softwares can be categorized into two main groups: *operating system software* and *application software*.

### Operating System Software

The operating system software provides various levels of interaction (called interface) between the computer and the user, as well as between the computer and the application software.



### Application Software

The application software also called programs, has a specific use or task to perform such as AutoCAD for Architectural drawings and layouts, Lotus 1-2-3 for business and marketing, Adobe Photoshop for image processing, and so on.



### Sample Application Software Logos





## Introduction to CAD System

Computer-aided design and drafting, otherwise known as CADD has been around since 1964. However, it was not widely used until 1982, when CAD system such as AutoCAD became available on microcomputers. ACAD software uses either vector-based graphics to depict the objects of traditional drafting, or may also produce faster graphics showing the realistic images of the designed objects.

Computer-aided design (CAD), also known as computer-aided drafting and design (CADD), is the use of computer systems to assist in the creation, modification, and analysis of a design. It describes the process of creating technical drawings with the use of computer software. CAD software is used to increase the productivity, to improve the quality of design, and to create a database for manufacturing.

CAD may be used to design curves and figures in two-dimensional (2D) space; or curves, surfaces, and solids in three-dimensional (3D) space. CAD is an important industrial art extensively used in many applications, including automotive, shipbuilding, and aerospace industries; industrial and architectural design; prosthetics; and many more. CAD is also widely used to produce computer animation for special effects in movies, advertising, and technical manuals.

Modern electronic drafting tools are often specialized computer-aided design packages. Basic drafting tools are included in all CAD programs, but some offer advanced automation are specifically designed for drafting and architectural design. The tools that are right for you will depend on your budget.

### AutoCAD



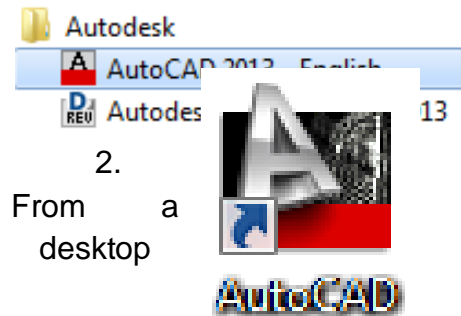
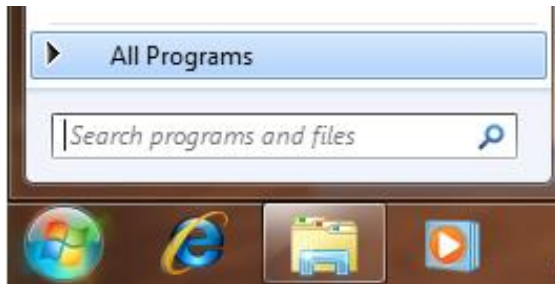
An AutoCAD is a commercial product made by Autodesk, with many versions, including one called AutoCAD Architecture. AutoCAD Architecture has purpose-built features specifically

designed for architectural drafting. In addition to design tools for initial architectural conceptualization, it offers tools to make building renovations faster and easier. The productivity tools include those that reflect the actual design of walls and other structures. AutoCAD can maintain precise dimensional spacing among components such as walls, beams, columns, and doors. AutoCAD Architecture offers a library of pre-built components to help speed up and automate the design and construction process.

## Starting an AutoCAD

There are several ways of launching the AutoCAD program, depending on the preferences and condition you may want to begin. Follow each of the illustrated steps below:

1. From the Start Menu
  - Click Start >Programs >Autodesk >AutoCAD from the Windows Program Manager



shortcut or quick launch toolbar.

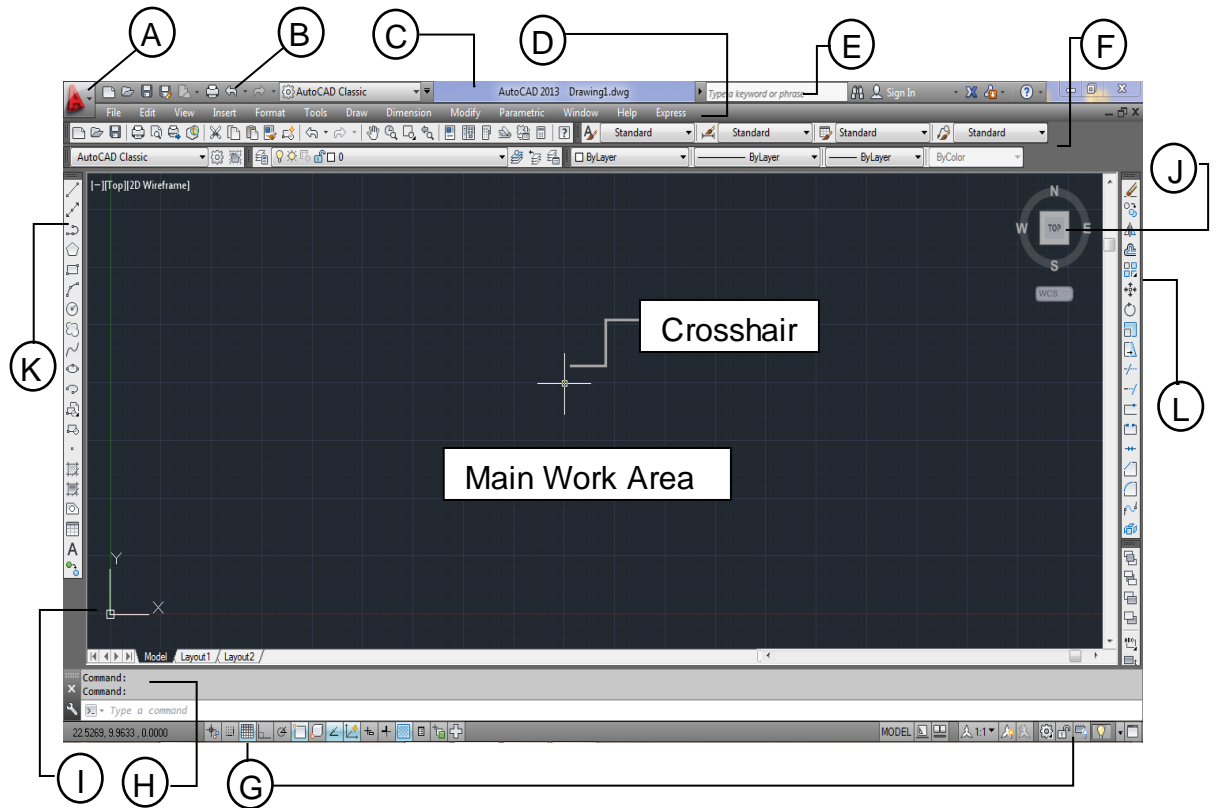
2. From a desktop
  - Double-click the AutoCAD icon from your desktop.

3. By opening the drawing file.
  - Double-click the drawing file icon inside a folder or in any location from your computer.



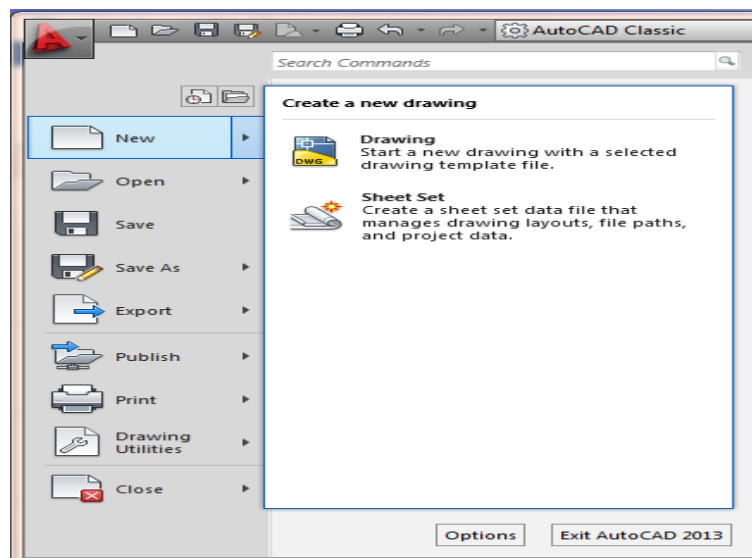
## The AutoCAD Working Environment

Like other windows-based applications, AutoCAD comes with a wide-range of features used in many different aspects of a working drawing.



### A. Menu Browser

– is a client-software that lets users read or scan documents on the World Wide Web.



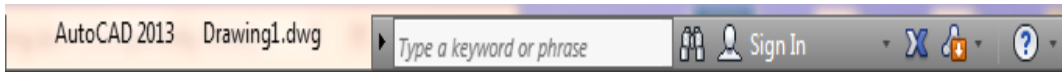
**B. Quick Access Toolbar** - is located along the top of the application window (above or below the ribbon) and provides direct access to common or defined set of commands like New, Open, Save, and Plot.



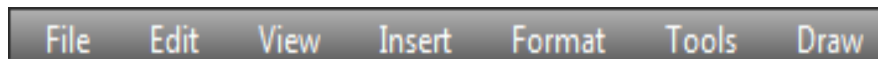
Procedure on how to add command/s to Quick Access Toolbar

1. Right-click the Quick Access toolbar >Customize Quick Access toolbar.
2. Select the preferred commands.
3. Drag the selected commands to quick Access Toolbar.

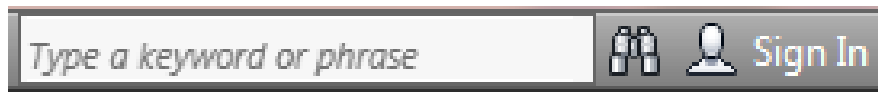
**C. Filename** - The name of the current file you are working on.



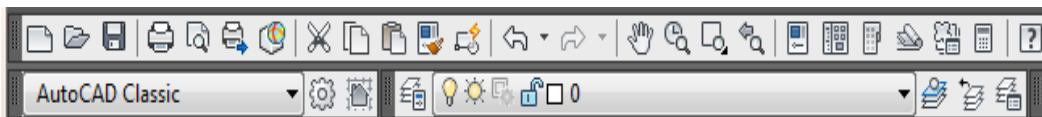
**D. Menu Bar** – is the horizontal strip across the top of an application’s window. Each word on the strip has a context sensitive drop-down menu containing features and actions that are available for the application in use.



**E. Search Box** – is a tool that allows you to search for a particular data or document in a help file or to web.



**F. Toolbars/Ribbon** - provide a single, compact placement for operations/tools that are relevant to the current *workspace*. By default (in its original setting), it contains the Standard, Layers, Properties and Styles toolbars.



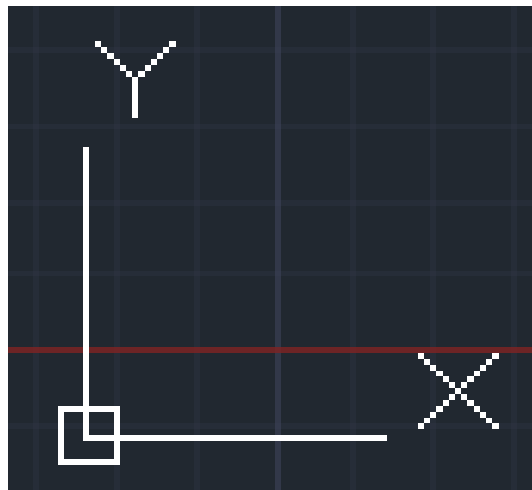
- G. Command Line Bar** - is where you enter the commands from the keyboard and where the prompts are displayed. It has a *text area* where all the previous commands are displayed.



- H. Tray Settings/Info Bar** - quickly search for a variety of information sources, access product updates and announcements, and save topics in the Info Center.



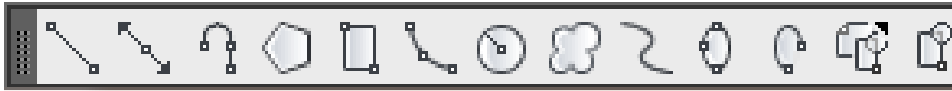
- I. UCS** – is found at the bottom left hand corner of the AutoCAD drawing window. You will see a symbol like the one shown on the right. This is called the UCS (User Coordinate System) icon and it is there to remind you which is the X axis and which is the Y axis.



- J. WCS** - By default when you start a new (blank) drawing you use the World Coordinate System (WCS). This indicates your (0,0,0) point.



- K. Draw Toolbar** - Draw commands can be used to create new objects such as lines and circles. Most AutoCAD drawings are composed purely and simply from these basic components.



- L. Modify Toolbar** – is used to modify the basic drawing objects in some way to suit the image you need. AutoCAD provides a whole range of modify tools such as Move, Copy, Rotate and Mirror.

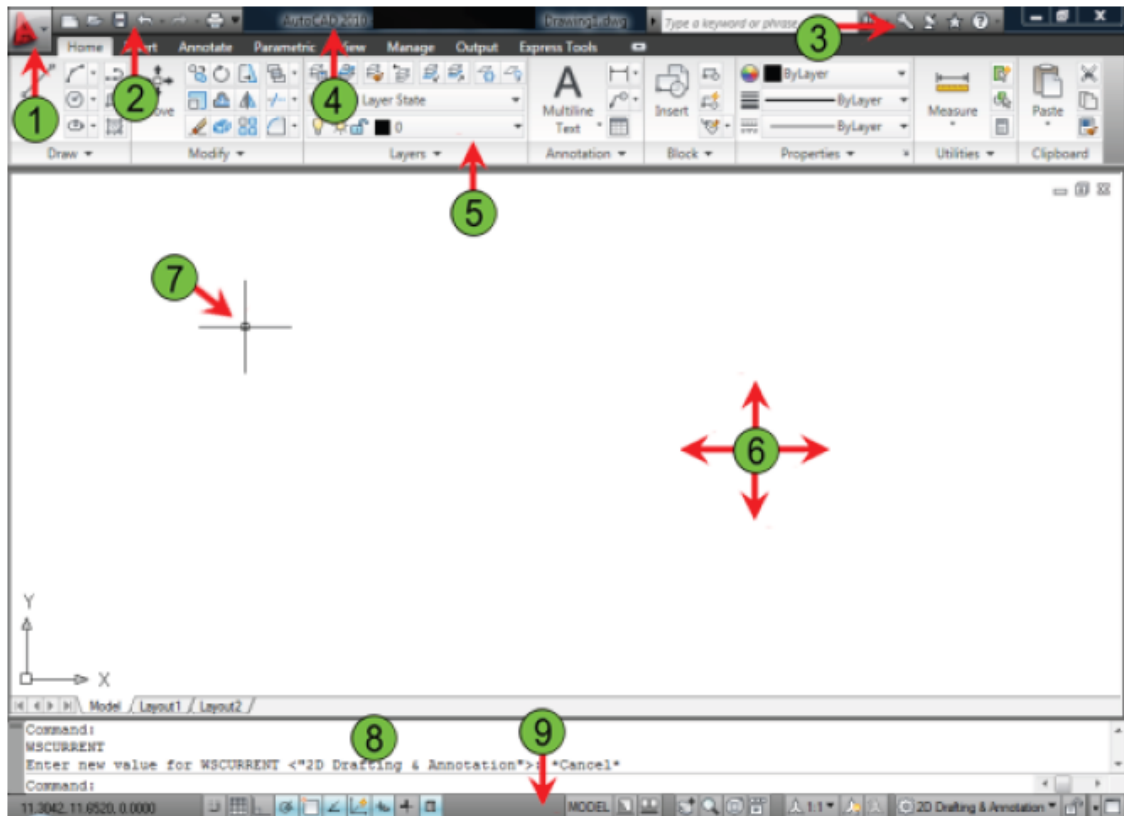


- M. Working/Drawing Area** – is the place where your drawings are displayed and modified.
- N. Crosshairs** – is a type of cursor consisting of two lines that intersect and are used to locate points and select objects in your drawing.
- O. Status Bar** - displays the coordinate location of your crosshairs and the current settings of grid, snap, and other drawing aids.
- P. Dialog Box Launcher** - displays the coordinate location of your crosshairs and the current setting of grid, snap, and other drawing aids.



## Suggested Activity 1

1. Label the parts of the AutoCAD Windows.



## AutoCAD Coordinate Systems

A good understanding of how co-ordinates work in AutoCAD is absolutely crucial if you are to make the best use of the program. If you are not familiar with co-ordinates and co-ordinate systems, take some time to familiarize yourself with the basic concepts.

Co-ordinates fall into two types, namely **Cartesian** and **Polar**. They can be either **Absolute** or **Relative**.

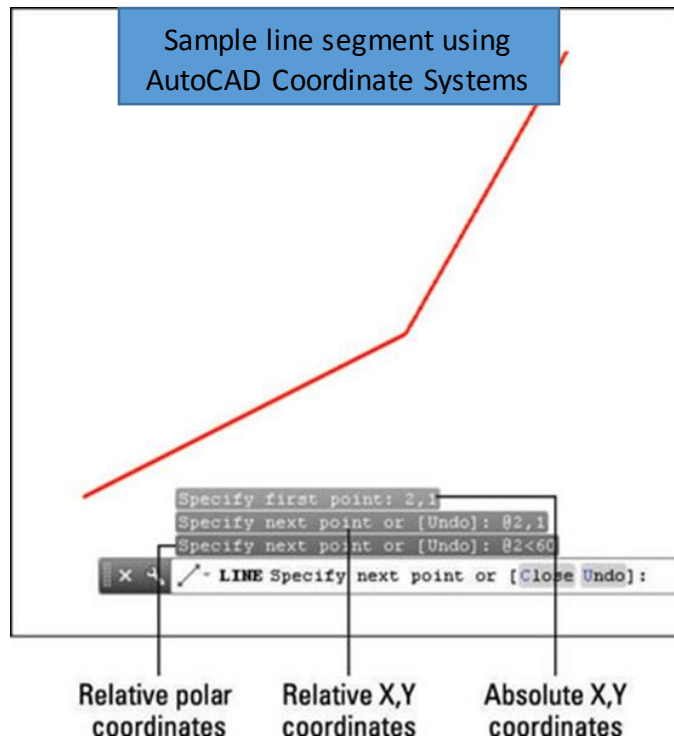
The **Cartesian co-ordinate system** is the standard co-ordinate system. The position of a point can be described by its distance from two axes, **X and Y**.

AutoCAD locates **absolute X,Y coordinates** with respect to the 0,0 point of the drawing — usually, its lower-left corner. AutoCAD locates **relative X,Y coordinates** and **relative polar coordinates** with respect to the previous point you picked or typed.

The **Polar co-ordinates** on the other hand, uses **one distance** and **one angle** to describe the position of a point rather than the two distances. The distance and angle measurements are made relative to an origin.

You will see how AutoCAD uses all three coordinate formats to draw a pair of **line** segments that start at the absolute coordinates 2,1 (see example) and then move to the right 2 units and up 1 unit (**@2,1**) relative to the first point.

Note in particular how the first two coordinate pairs use the same numbers (2,1) but the second pair defines a different point because of the leading @ symbol, then (relative to that point) move 2 units at an angle of 60 degrees (**@2<60**).

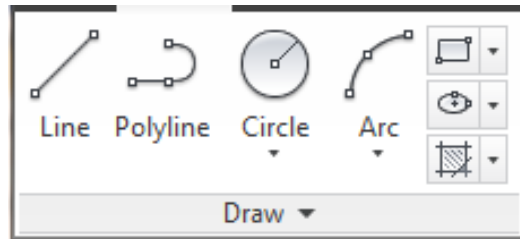


Notice that the separator in the case of polar co-ordinates is the **<** "less than" mathematical symbol.



## Basic Drawing Tools

The Draw commands can be used to create new objects such as lines and circles. Most AutoCAD drawings are composed purely and simply from these basic components. A good understanding of the Draw commands is fundamental to the efficient use of AutoCAD.



The sections below cover the most frequently used Draw commands such as Line, Polyline and Circle as well as the more advanced commands like, Multiline and Multiline Style. As a newcomer to AutoCAD, you may wish to skip the more advanced commands in order to properly master the basics. You can always return to this tutorial in the future after you have mastered the basics and become more confident.

In common with most AutoCAD commands, the Draw commands can be started in a number of ways. Command names or shortcuts can be entered at the keyboard, commands can be started from the Draw pull-down menu, shown on the right or from the Draw toolbar. The method you use is dependent upon the type of work you are doing and how experienced a user you are. Don't worry too much about this, just use whatever method you feel the easiest or the most convenient at the time. Your drawing technique will improve over time and with experience so don't expect to be working very quickly at first.

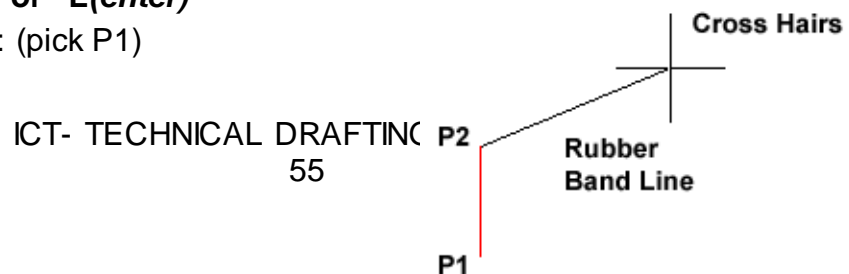
### The Line Command



With the Line command you can draw a simple line from one point to another. When you ***pick*** the first point and move the ***cross-hairs*** to the location of the second point you will see a ***rubber band line*** which shows you where the line will be drawn when the second point is picked.

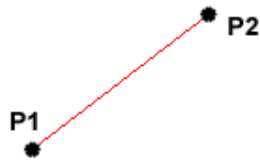
Command: **LINE** or **L(enter)**

Specify first point: (pick P1)



Specify next point or  
Specify next point or

[Undo]: (pick P2)  
[Undo]: [press esc or enter]



## The Polyline

## Command

The Polyline or **Pline** command is similar to the line command except that the resulting object may be composed of a number of segments which form a single object. In addition to the two ends a polyline is said to have vertices (*singular vertex*) where intermediate line segments join. In practice the Polyline command works in the same way as the Line command allowing you to pick as many points as you like. As with the Line command, you also have the option to automatically close a polyline end to end. To do this, type **C** to use the close option instead of hitting . Follow the command sequence below to see how this works.

Command: **PLINE** or **PL[enter]**

Specify start point: (pick P1)

Current line-width is 0.0000

Specify next point or [Arc/Half width/Length/Undo/Width]: (pick P2)

Specify next point or [Arc/Close/Half width/Length/Undo/Width]: (pick P3)

Specify next point or [Arc/Close/Half width/Length/Undo/Width]: (pick P4)

Specify next point or [Arc/Close/Half width/Length/Undo/Width]: (pick P5)

Specify next point or [Arc/Close/Half width/Length/Undo/Width]: (or **C** to close)

## The Rectangle Command

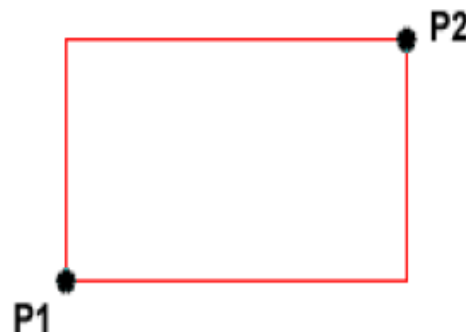
The Rectangle command is used to draw a rectangle whose sides are vertical and horizontal. The position and size of the rectangle are defined by picking two diagonal corners. The rectangle isn't really an AutoCAD object at all. It is, in fact, just a closed polyline which is automatically drawn for you.

Command: **RECTANG** or **REC[enter]**

Specify first corner point or

[Chamfer/Elevation/Fillet/

Thickness/Width]: (pick P1)



Specify other corner point or [Dimensions]: (pick P2)

The Rectangle command also has a number of options. Width works in the same way as for the Polyline command. The Chamfer and Fillet options have the same effect as the Chamfer and Fillet commands.

### The Polygon Command

The Polygon command can be used to draw any regular polygon from 3 sides up to 1024 sides. This command requires four inputs from the user, the number of sides, a pick point for the center of the polygon, whether you want the polygon inscribed or circumscribed and then a pick point which determines both the radius of this imaginary circle and the orientation of the polygon.

Command: **POLYGON** or **POL[enter]**

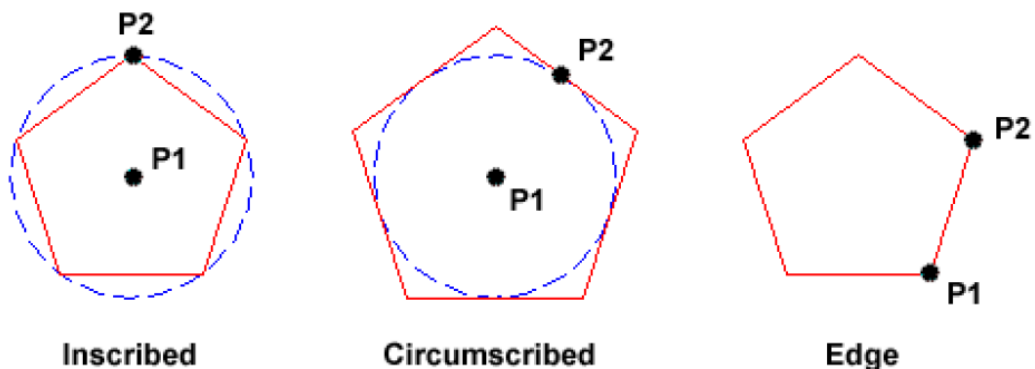
Enter number of sides <4>: **5**

Specify center of polygon or [Edge]: (pick P1 or type **E** to define by edge length)

Enter an option [Inscribed in circle/Circumscribed about circle] <I>:

*(To accept the inscribed default or type **C** for circumscribed)*

Specify radius of circle: (pick P2 or enter exact radius)



### The Donut Command

This command draws a solid donut shape, actually it's just a closed polyline consisting of two arc segments which have been given a width. AutoCAD asks you to define the inside diameter i.e. the diameter of the hole

and then the outside diameter of the donut. The donut is then drawn in outline and you are asked to pick the center point in order to position the donut. You can continue picking center points to draw more donuts or you can hit to end the command.

Command: **DONUT or DO[enter]**

Specify inside diameter of donut <0.5000>:

(pick any two points to define a diameter or enter the exact length)

Specify outside diameter of donut <1.0000>: (pick any two points to define a diameter or enter the exact length)

Specify center of donut or <exit>: (pick P1)

Specify center of donut or <exit>: [Enter]

### The Circle Command

The Circle command is used to draw circles. There are a number of ways you can define the circle. The default method is to pick the center point and then to either pick a second point on the circumference of the circle or enter the circle radius at the keyboard.

Command: **CIRCLE or C[enter]**

Specify center point for circle or [3P/2P/Tr (tan tan radius)]: (pick P1)

Specify radius of circle or [Diameter] <50.0195>: (pick P2 or enter the exact radius)

As you can see from the command prompt above the default options are always indicated in triangular brackets like so <Default> and command options appear within square brackets like so [Option]. Each option is separated by a forward slash like this /.

### The Arc command

The Arc command allows you to draw an arc of a circle. There are numerous ways to define an



arc, the default method uses three pick points - a start point, a second point and an end point. Using this method, the drawn arc will start at the first pick point, pass through the second point and end at the third point.

Command: **ARC or A[enter]**

Specify start point of arc or [Center]: (pick P1)

Specify second point of arc or [Center/End]: (pick P2)

Specify end point of arc: (pick P3)

**Note:** *It is also possible to create an arc by trimming a circle object.*

## The Spline Command

The Spline command creates a type of spline known as a non-uniform rational B-spline, NURBS for short. A spline is a smooth curve that is fitted along a number of control points. The Fit Tolerance option can be used to control how closely the spline conforms to the control points. A low tolerance value causes the spline to form close to the control points.

A tolerance of 0 (zero) forces the spline to pass through the control points. The illustration on the right shows the effect of different tolerance values on a spline that is defined using the same four control points, P1, P2, P3 and P4. Splines can be edited after they have been created using the SPLINEDIT command, Modify Object Spline from the pull-down menu. Using this command, you can change the tolerance, add more control points move control points and close splines, among other things. However, if you just want to move spline control points, it is best to use grips.

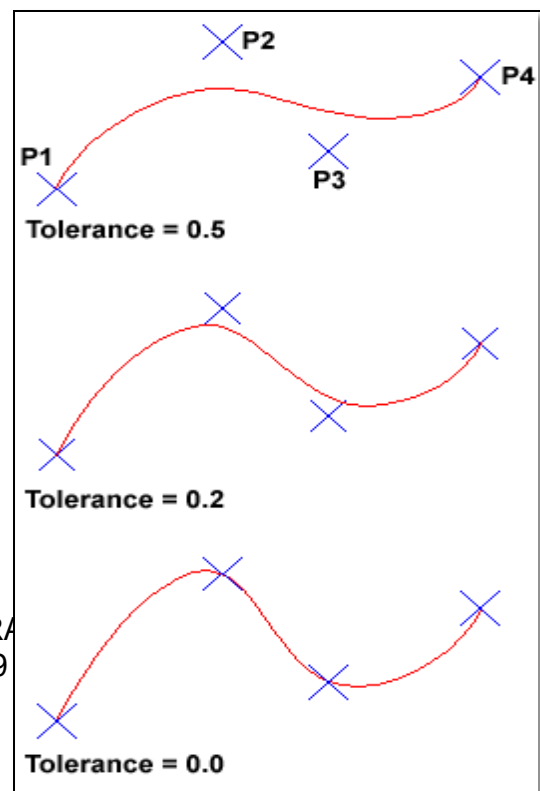
Command: **SPLINE or SPL[enter]**

Specify first point or [Object]: (Pick P1)

Specify next point: (Pick P2)

Specify next point or [Close/Fit tolerance] <start tangent>: (Pick P3)

Specify next point or [Close/Fit tolerance] <start tangent>: (Pick P4)



Specify next point or [Close/Fit tolerance] <start tangent>:

Specify start tangent: (pick a point)

Specify end tangent: (pick a point)

## Sample Spline Output

### The Ellipse Command

The Ellipse command gives you a number of different creation options whereas the default option has only three options, that is it picks that is, it picks the two end points of an axis and then a third point to define the eccentricity of the ellipse. After you have mastered the default option, try out the ellipse command.

Command: **ELLIPSE** or **EL[enter]**

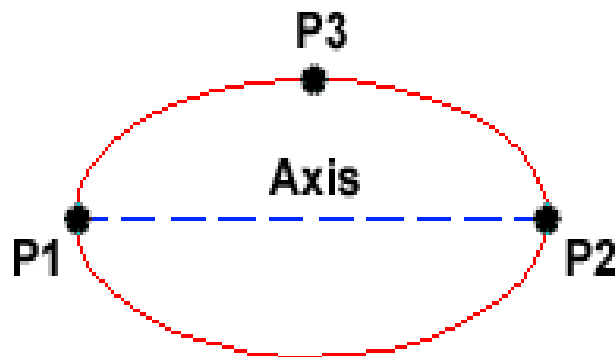
Specify axis endpoint of ellipse or [Arc/Center]: (pick P1)

Specify other endpoint of axis: (pick P2)

Specify distance to other axis or

[Rotation]: (pick P3)

*The ellipse command can also be used to draw isometric circles.*



### Object Selection

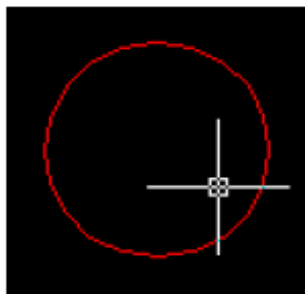
Before you start to use the AutoCAD Modify commands, you need to know something about selecting objects. All of the Modify commands require

that you take one or more object selections. AutoCAD has a whole range of tools which are designed to help you select just the objects you need.

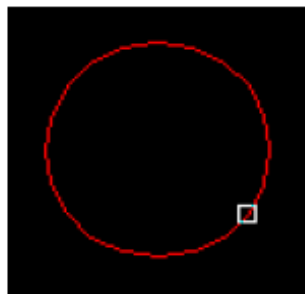
## Selecting Objects by Picking

Perhaps the most obvious way to select an object in AutoCAD is simply to pick it. Those of you who have used other graphics based utilities will be familiar with this concept. Generally all you have to do is place your cursor over an object, click the mouse button and the object will be selected. In this respect AutoCAD is no different from any other graphics utility.

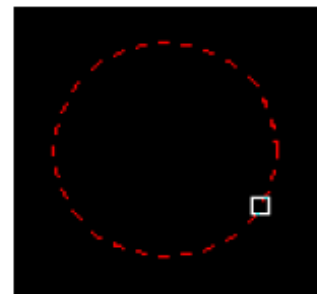
When you start a Modify command such as ERASE, two things happen. First, the cursor changes from the usual crosshairs to the *pickbox* and second, you will see the "Select objects" prompt on the command line. Both of these cues tell you that AutoCAD is expecting you to select one or more objects.



The Crosshairs



The Pickbox



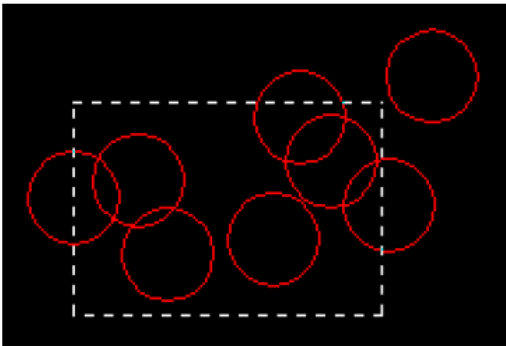
Highlighted Object

To select an object, place the *pickbox* over a part of the object and left-click the mouse. When the object has been picked it is highlighted in a dashed line to show that it is part of the current selection and the command line reports "1 found". You will now see the "Select objects" prompt on the command line again. At this point you can continue adding more objects to the current selection by picking them or you can press the Space Bar to complete the selection.

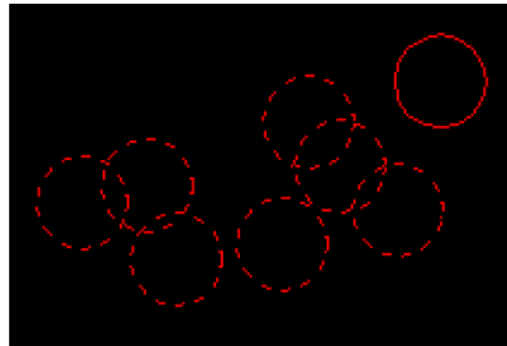
When you pick one or more objects in response to the "Select objects" prompt, you are effectively creating a selection set. Selection sets are an important concept in AutoCAD because they can be used to great effect, especially when drawings become larger or complicated.

## Crossing and Window Selection Method

The Crossing method is invoked by typing **C** at the "Select objects" prompt and is a variation of the Window command. The command sequence is exactly the same but objects are selected which lie entirely within the window and those which cross the window border.



The Crossing selection box is shown as a rectangle with a broken line



Objects within and crossing the window will be selected

Command: (start one of the Modify commands such as ERASE)

Select objects: **W**

First corner: (pick first corner)

Specify opposite corner: (pick second corner)

Select objects: (at this point you can either select more objects or complete the selection set, and continue with the current command.)

## Adding and Removing Objects

AutoCAD provides two methods for adding and removing objects to and from a selection set. As you know, objects can be added to a selection set simply by picking them or by using one of the methods outlined above. You can remove selected objects from a selection set just as easily by shift picking. If you hold the *Shift* key down on the keyboard while picking a selected object, that object will be deselected (removed from the current selection set).

You can tell when a selected object has been deselected because it is no longer highlighted. You can remove more than one object at a time by

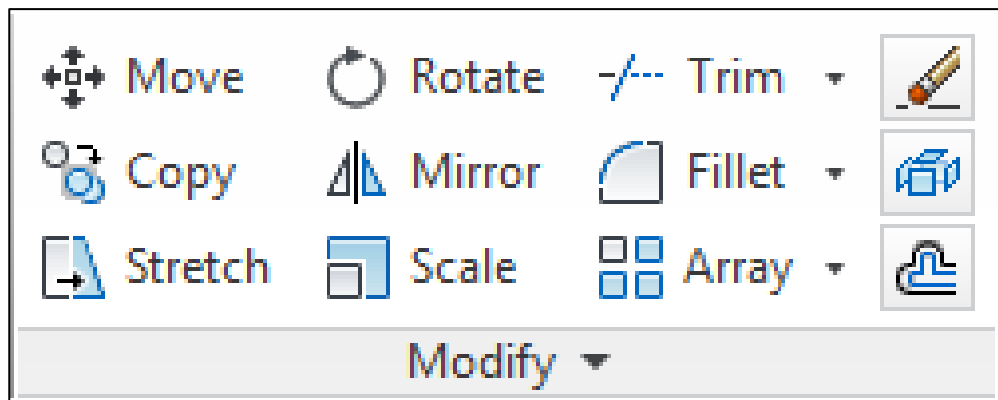


holding down the Shift key while using implied windowing. However, none of the other selection options which require keyboard input will work using the *shift pick* method.

**Tips:** When you are picking objects in a complex drawing, use the ZOOM command transparently to make object selection easier. All Zoom options selected from the toolbars are automatically transparent but if you invoke the command from the keyboard you will need to enter zoom.

## Modifying Objects

AutoCAD drawings are rarely completed simply by drawing lines, circles etc. Most likely you will need to modify these basic drawing objects in some way or another in order to create the image you need. AutoCAD provides a whole range of modify tools such as Move, Copy, Rotate and Mirror. As you



can see, the command names are easily understandable. However, the way these commands work is not always obvious.

## The Erase Command

The Erase command is one of the simplest AutoCAD commands and is one of the most used. The command erases (deletes) any selected object(s) from the drawing. Remember you can always get deleted objects back by typing U to undo, from the Standard toolbar or by using the OOPS command.

Command: **ERASE** or **E[enter]**

Select objects: (pick an object to erase)

Select objects: (to end the selection and erase the object)

## The Copy Command

The Copy command can be used to create one or more duplicates of any drawing object or objects which you have previously created. Copy is a very useful and time-saving command because you can create very complex drawing elements and then simply copy them as many times as you like.

Command: **COPY or CO[enter]**

Select objects: (pick object to copy, P1)

Select objects: (to end selection)

Specify base point or displacement, or [Multiple]: (pick P2 or M for multiple copies)

Specify second point of displacement or <use first point as displacement>: (pick P3)

The multiple option allows you to create additional copies of the selected object(s) by picking as many new points as you like. To end a multiple copy, just hit the key.

## The Mirror Command

The Mirror command allows you to mirror selected objects in your drawing by picking them and then defining the position of an imaginary mirror line using two points.

Command: **MIRROR or MI[enter]**

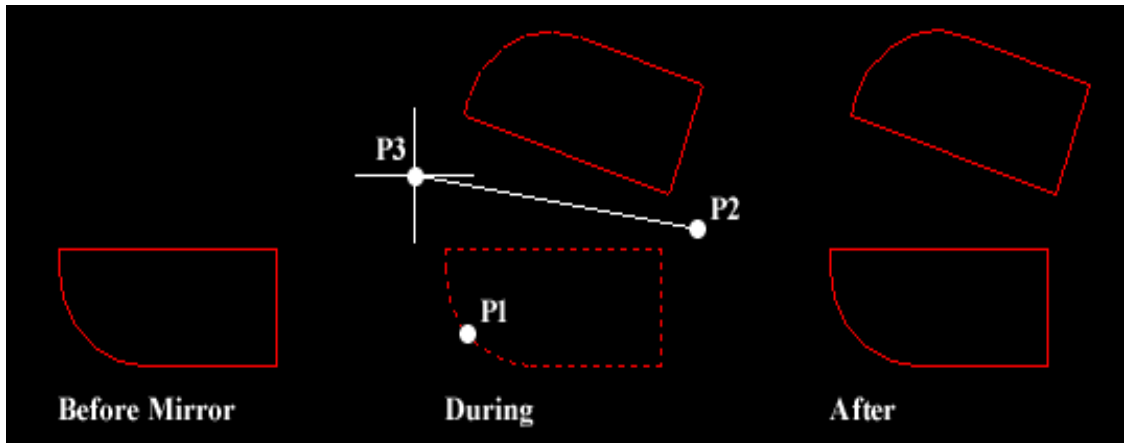
Select objects: (pick object to mirror, P1)

Select objects: (to end selection)

Specify first point of mirror line: (pick P2)

Specify second point of mirror line: (pick P3)

Delete source objects? [Yes/No] <N>: (for No to keep the original object)



## The Offset Command

Offset is probably one of the most useful commands for constructing drawings. The Offset command creates a new object parallel to or concentric with a selected object. The new object is drawn at a user defined distance (the offset) from the original and in a direction chosen by the user with a pick point. You can offset lines, arcs, circles, ellipses, 2D polylines, xlines, rays and planar splines.

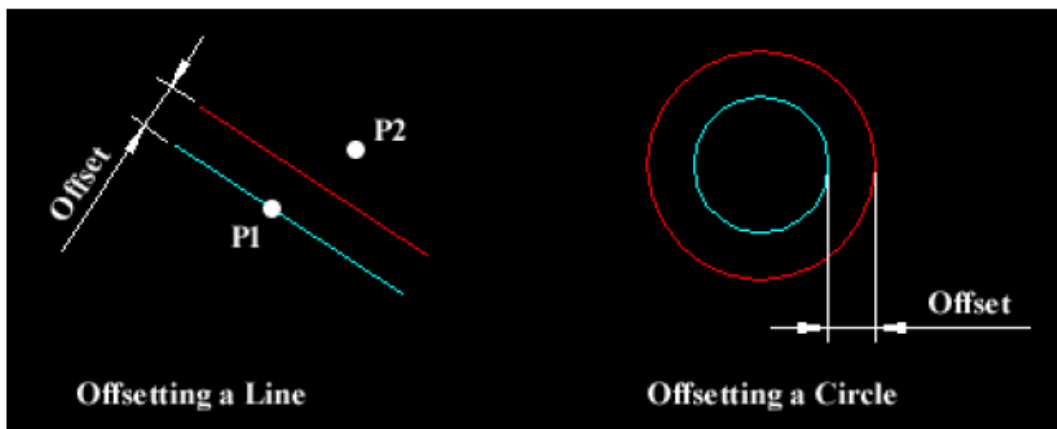
Command: **OFFSET** or **O[enter]**

Specify offset distance or [Through] <1.0000>: 10 (specify distance)

Select object to offset or <exit>: (select object, P1)

Specify point on side to offset: (pick direction, P2)

Select object to offset or <exit>: (to end or select another object to offset)



## The Move Command

The Move command works in a similar way to the Copy command except that no copy is made, the selected object(s) is simply moved from one location to another.

Command: **MOVE** or **M[enter]**

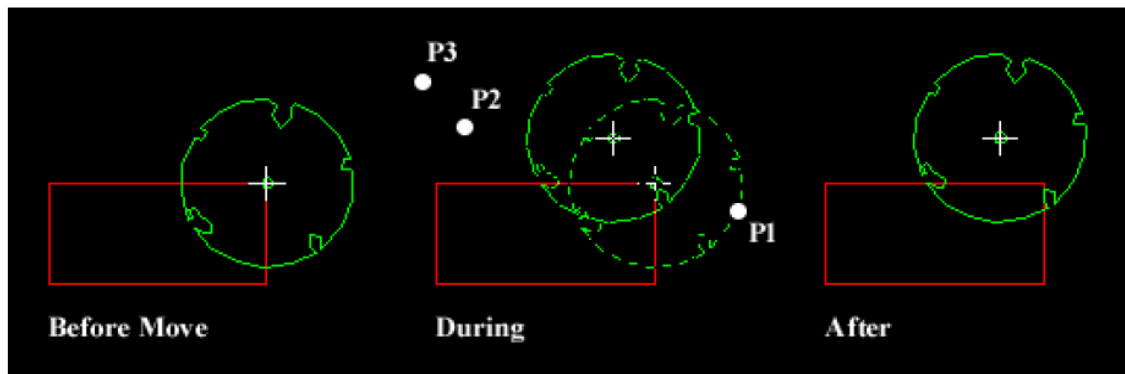
Select objects: (pick object to move, P1)

Select objects: (to end selection)

Specify base point or displacement: (pick P2)

Specify second point of displacement or <use first point as displacement>:  
(pick P3)

**Note:** The Copy command, the two pick points, P2 and P3 are used only to indicate the distance and direction of movement.



### The Rotate Command

The Rotate command allows an object or objects to be rotated about a point selected by the user. AutoCAD

Command: **ROTATE** or **RO[enter]**

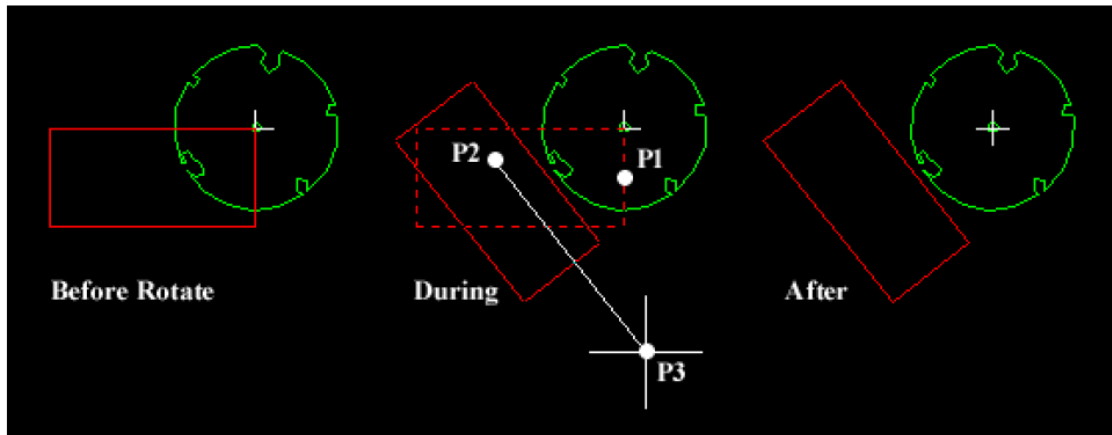
Current positive angle in UCS: ANGDIR=counterclockwise ANGBASE=0

Select objects: (pick object to rotate, P1)

Select objects: (to end selection)

Specify base point: (pick base point, P2)

Specify rotation angle or [Reference]: (pick second point, P3 or enter angle)



Remember, by default, AutoCAD angles start at 3 o'clock and increase in an anti-clockwise direction. The "ANGDIR" and "ANGBASE" variables remind you of this. If you want to rotate in a clockwise direction you can enter a negative angle by using a minus sign.

**Note:** You can change the angle direction and the base angle using the *Units* command, *Format Units...* from the pull-down menu. Click the "Clockwise" check box to change the direction and click the "Direction..." button to set the base angle.

## The Scale Command

The Scale command can be used to change the size of an object or group of objects. You are prompted for a pick point about which the selection set will be scaled. Scaling can then be completed by picking a second point (not always easy because it can sometimes be difficult to precisely control the scaling) or by entering a scale factor at the keyboard. For example a scale factor of 2 will double the size of the objects in the selection set and a factor of 0.5 will reduce them into half.

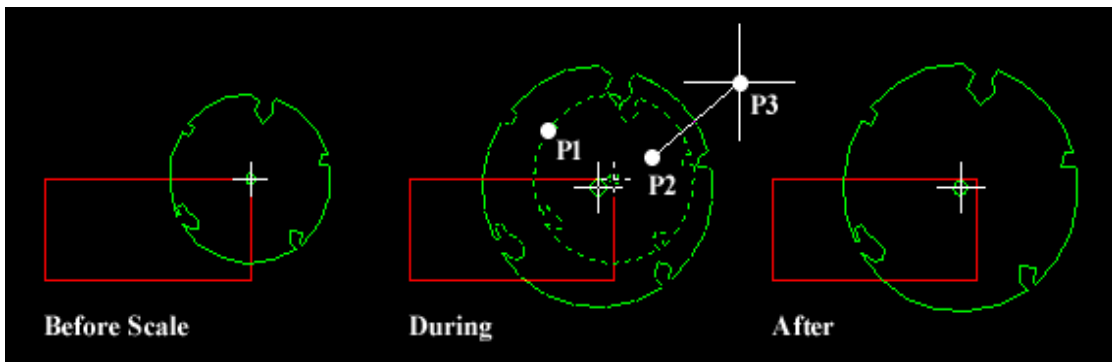
Command: **SCALE** or **SC[enter]**

Select objects: (pick objects to be scaled, P1)

Select objects: (to end selection)

Specify base point: (pick base point, P2)

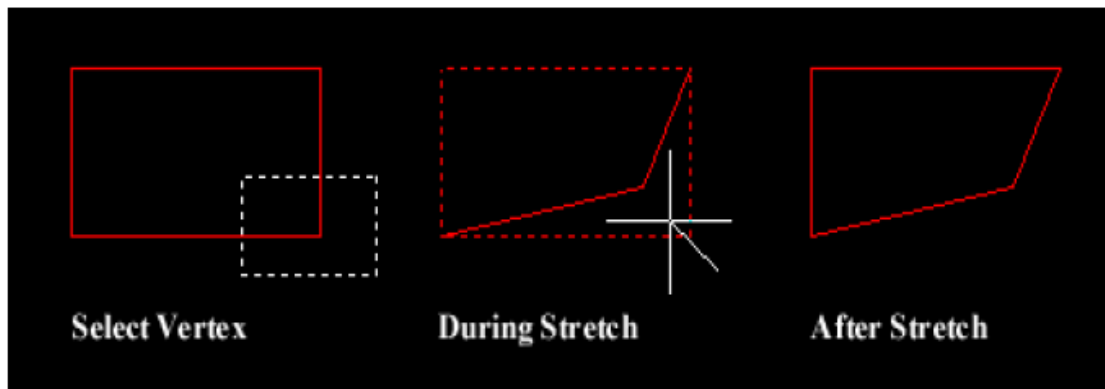
Specify scale factor or [Reference]: (pick second point, P3 or enter scale factor)



As shown above, the original tree symbol has been enlarged by dynamically scaling it using pick points to determine the change in scale. If you want to scale an object precisely, it is much easier to enter a scale factor using the keyboard.

### The Stretch Command

The Stretch command can be used to move one or more vertices of an object while leaving the rest of the object unchanged. In the example below, a rectangle has been stretched by moving one vertex to create an irregular shape.



#### Command: **STRETCH** or **S[enter]**

Select objects to stretch by crossing-window or crossing-polygon...

Select objects: (pick first point of crossing window)

Specify opposite corner: (pick second point of window)

Select objects: (to end selection)

Specify base point or displacement: (pick base point)

Specify second point of displacement: (pick second point)

**Note:** To select vertices to stretch, you must use a crossing window or polygon.

## The Trim Command

The Trim command can be used to trim a part of an object. In order to trim an object you must draw a second object which forms the "cutting edge". Cutting edges can be lines, xlines, rays, polylines, circles, arcs or ellipses. Blocks and text cannot be trimmed or used as cutting edges.

Command: **TRIM** or **TR[enter]**

Current settings: Projection=UCS Edge=None

Select cutting edges ...

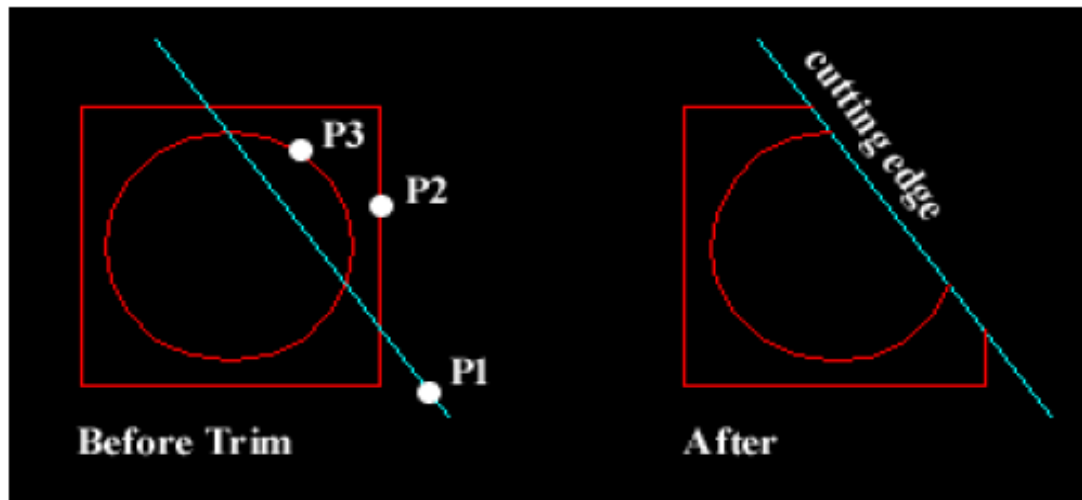
Select objects: (select the cutting edge, P1)

Select objects: (to end cutting edge selection)

Select object to trim or shift-select to extend or [Project/Edge/Undo]:  
(pick the part of the square which you want to trim, P2)

Select object to trim or shift-select to extend or [Project/Edge/Undo]:  
(pick the circle, P3)

Select object to trim or shift-select to extend or [Project/Edge/Undo]: (to end)



**Note:** Notice that at each trimming step you are given the option to undo the previous trim. This can be very useful if you inadvertently pick the wrong object.

## The Chamfer Command

The Chamfer command enables you to create a chamfer between any two non-parallel lines as in the illustration below or any two adjacent polyline segments. Usually, the Chamfer command is used to set the chamfer distances before drawing the chamfer. Follow the command sequence below where the chamfer distances are changed to 20 before the chamfer is made.

Command: **CHAMFER** or **CHA[enter]**

(TRIM mode) Current chamfer Dist1 = 10.0000, Dist2 = 10.0000

Select first line or [Polyline/Distance/Angle/Trim/Method]: D (to set distances)

Specify first chamfer distance <10.0000>: 20 (enter required distance)

Specify second chamfer distance <20.0000>:

(first distance value or enter a different value)

Select first line or [Polyline/Distance/Angle/Trim/Method]: (pick P1)

Select second line: (pick P2)

The chamfer is made and the command ends.



**Note:** Notice from the command sequence that there are a number of options which can be used to control the way the Chamfer command behaves.

## The Fillet Command

The Fillet command is a very useful tool which allows you to draw an arc between two intersecting lines or adjacent polyline segments. You need first to use the command to set the required radius and then a second time to select the two lines.



Command: **FILLET** or **F[enter]**

Current settings: Mode = TRIM,  
Radius = 10.0000

Select first object or

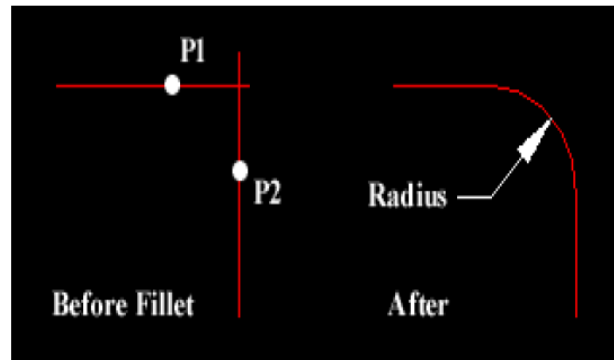
[Polyline/Radius/Trim]: R

Specify fillet radius <10.000>: 25

Select first object or

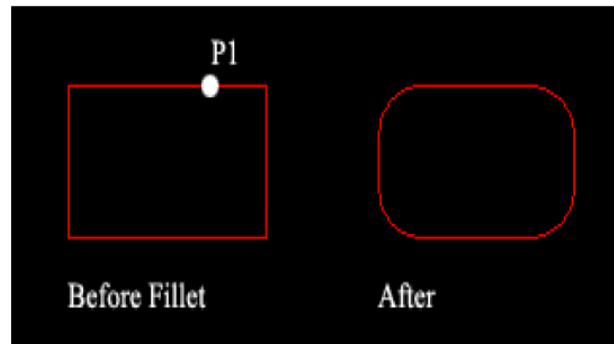
[Polyline/Radius/Trim]: (pick P1)

Select second object: (pick P2)



The Fillet command can also be used to fillet arcs and circles. The "Polyline" option also allows you to fillet all vertices of a polyline with a single command.

***Tips:** Make sure that the radius you specify will fit the objects you select, otherwise the fillet command will not work.*



## The Array Command

Using the Array command, you can duplicate existing objects in a rectangle or circular (polar) pattern. You can select which type of array to use in the Array dialog box. Click the Rectangular or Polar options to see point, distance, and method requirements for each type.

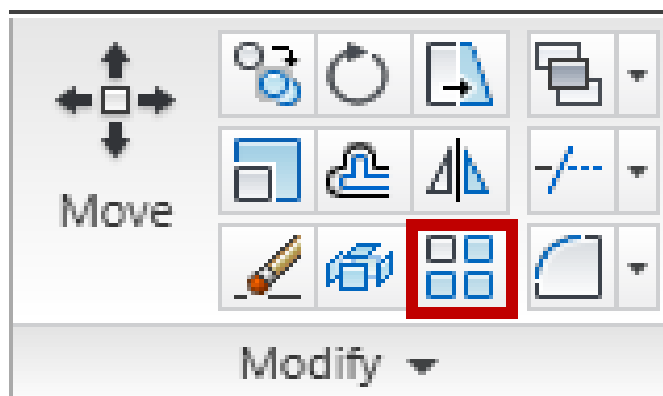
The following illustration shows a rectangular and polar array.

Command: **ARRAY** or **AR[enter]**

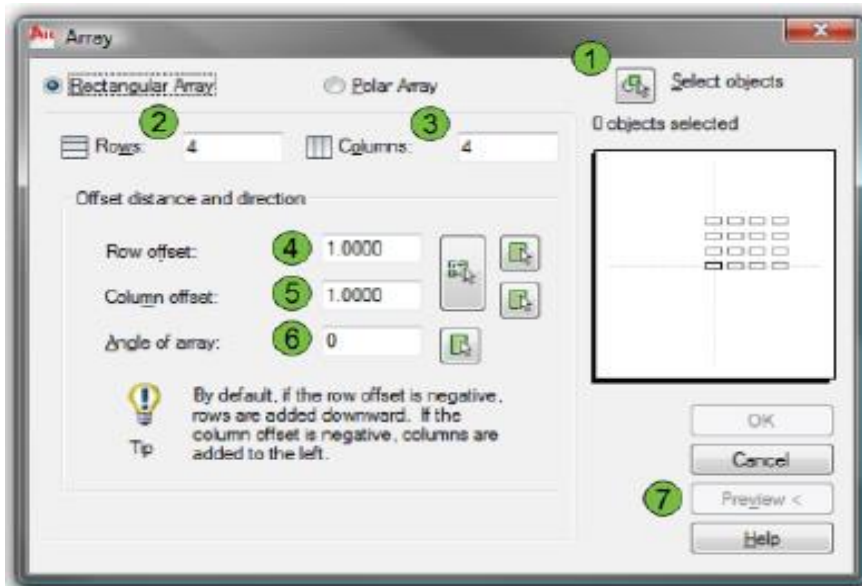
Ribbon: **Home tab > Modify panel > Array**

**Note:** Do not confuse this command with the 3D Array command.

Menu Browser: **Modify > Array**

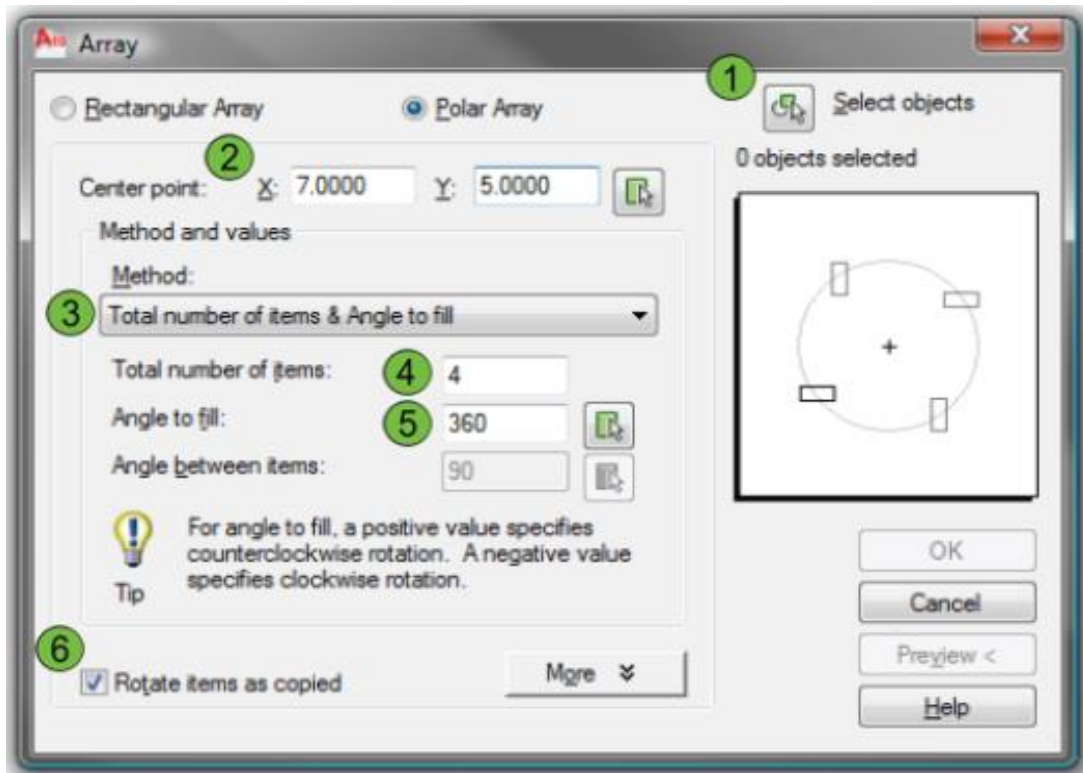


## Array Dialog Box: Rectangular Array



1. Click to select the object(s) to include in the array.
2. Enter the number of rows (horizontal patterns) for the array.
3. Enter the number of columns (vertical patterns) for the array.
4. Enter a distance to offset each row. Use the simulated preview window to see the direction of the pattern.
5. Enter a distance to offset each column.
6. Enter an angle for the pattern.
7. Click Preview to preview the array. Preview is not available until you select an object or objects for the array.

## Array Dialog Box: Polar Array



1. Click to select the object(s) to include in the array.
2. Enter the center point's coordinates in the X and Y fields or click the Select Point icon to select a center point in the drawing window.
3. Select the method for calculating the polar array.
  - Total number of items and angle to fill.
  - Total number of items and angle between items.
  - Angle to fill and angle between items.
4. Enter the total number of items for the array. This includes the original object.
5. Enter the total angle for the array. A negative number creates the array in a clockwise direction.
6. Select to rotate each object as it is placed in the array.

## Drawing Aids

Drawing with AutoCAD is really just like drawing on a drawing board. Most new comers to Computer Aided Design assume that they will need to learn how to draw all over again. In fact, many of the drawing aids that AutoCAD provides are analogous to traditional drafting tools

### Ortho Mode

Ortho is short for orthogonal, which means either vertical or horizontal. Like the other options on the status bar, Ortho is not really a command, it is a drawing mode which can either be turned on or off. Ortho mode can be toggled on or off in one of three ways.

Command: ORTHO  
Enter mode [ON/OFF] <OFF>: (type ON or OFF)

### The Drawing Grid

The drawing grid is a regular pattern of dots displayed on the screen which acts as a visual aid, it is the equivalent of having a sheet of graph paper behind your drawing on a drawing board. You can control the grid spacing, so it can give you a general idea about the size of drawn objects. It can also be used to define the extent of your drawing.

Command: **GRID**  
Specify grid spacing(X) or [ON/OFF/Snap/Aspect] <10.000>: (enter grid spacing)

### Snap Mode

Snap mode takes AutoCAD one step further than the drawing board. With Snap mode turned on AutoCAD only allows you to pick points which lie on a regular grid. The Snap grid is completely independent of the display grid.

Command: **SNAP or SN[enter]**  
Specify snap spacing or [ON/OFF/Aspect/Rotate/Style/Type] <10.0000>:  
(enter the required snap spacing in drawing units)

## **Units and Scales**

Among the most important concepts that newcomers to AutoCAD need to come to grips with are those of drawing scales and drawing units. You cannot start creating sensible drawings with AutoCAD until you are familiar with scale, units and the commands you use to control them.

When drawing on paper you must decide to draw and say, 1:20 or 1:200 depending upon the size of the object that you are drawing so that your scaled drawing will fit on the drawing sheet, be that A3 or A1. In AutoCAD you do not need to decide upon a drawing scale until you come to print the drawing and because the scaling of your drawing takes place at the printing stage, you can create drawings at a scale of 1:1.

## **Units Control**

When you start the Units command, the first thing you see is the Drawing Units dialogue box, shown on the next page at the right. The dialogue box is divided into four main sections. The upper two are "Length", which refers to linear units and "Angles", referring to angular units. Settings for linear units and angular units can be made independently and in each case, you can control both the type and precision.

Command: units

## **Object Snap**

The main reason for this flexibility in using the Object Snaps is that they are used very frequently. Experienced AutoCAD users will always use Object Snaps because they are the only way to make sure that the objects they are drawing are drawn accurately.

You must practice using Object Snaps until they become second nature to you. There are thirteen (13) Osnaps in all and although they are all useful in certain situations you will probably find yourself using about half of them on a regular basis and the other half in special circumstances.

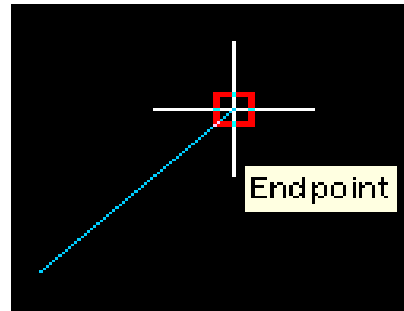
However, it's a good idea to get to know all of the Osnaps so that you can plan your drawing, knowing all of the tools at your disposal. A sensible use of Osnaps is the best way to improve your drawing efficiency.

### Endpoint Osnap

The Endpoint Osnap breaks to the end points of lines and arcs and to polyline vertices. This is one of the most useful and commonly used Osnaps.

Command: **END**

Short-cut: **Shift + Right Click Endpoint**

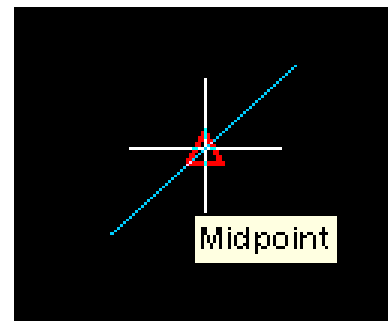


### Midpoint Osnap

The Midpoint Osnap breaks to the mid points of lines and arcs and to the mid-point of polyline segments.

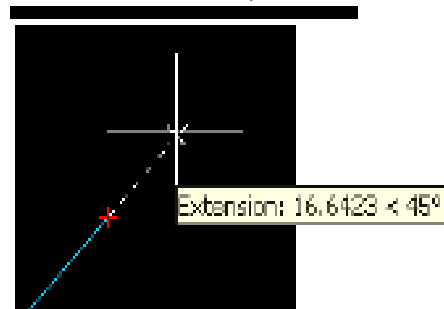
Command: **MID**

Short-cut: **Shift + Right Click Midpoint**

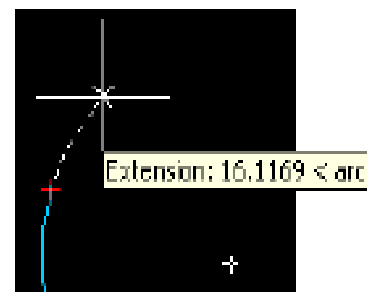


### Intersection

The Intersection Osnap snaps to the physical intersection of any two drawing objects (i.e. where lines, arcs or circles etc. cross each other) and to Polyline vertices. However, this osnap can also be used to snap to intersection points which do not physically exist. This feature is called the Extended Intersection (see the illustration on the right). To use the apparent intersection feature, you must pick two points to indicate which two objects should be used.



### Extension



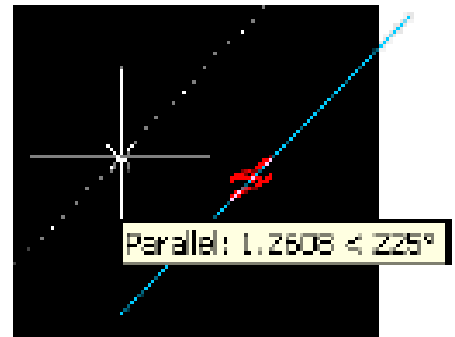
The Extension Osnap enables you to snap to some point along the imaginary extension of a line, arc or polyline segment. To use this osnap, you must hover the cursor over the end of the line you want to extend. When the line end is found, a small cross appears at the endpoint and a dashed extension line is displayed from the endpoint to the cursor, providing the cursor remains close to the extension.

Command: **EXT**

Short-cut: **Shift + Right Click Extension**

## Parallel

The Parallel Osnap is used to draw a line parallel to any other line in your drawing. In operation, this osnap is slightly less intuitive than some of the others. To draw a parallel line, first start the Line command, specify the first point when prompted and then start the Parallel Osnap. Hover the cursor over an existing line until you see the Parallel snap marker.



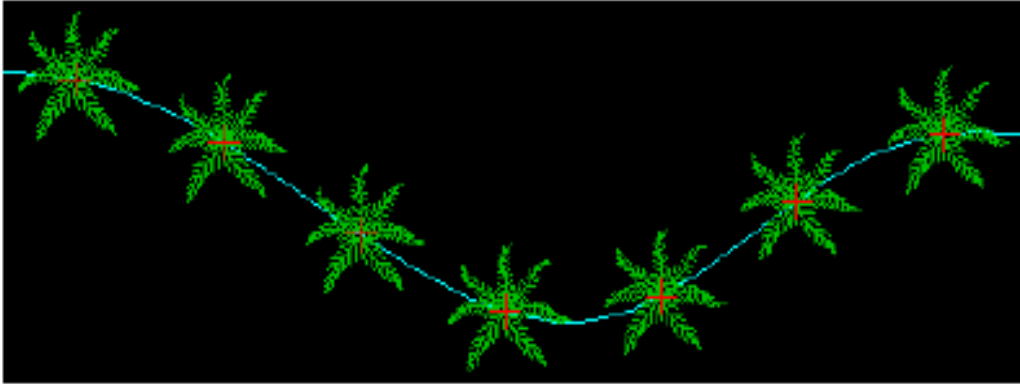
Now, move the cursor close to a parallel position and a dotted line will appear, indicating the parallel. You can now pick the second point of your line. The Snap Tip also includes a relative polar co-ordinate.

## Node

The Node Osnap snaps to the center of a Point object. This osnap can be useful if you have created a number of Points with the Measure or Divide commands. You could, for example insert a number of regularly spaced tree symbols (blocks) along a line by using the Node Osnap for the insertion point of each block.

Command: **NODE**

Short-cut: **Shift + Right Click Node**



**Tips:**

- When you are drawing, take a few moments to consider how you will construct each part of the drawing and decide which Osnaps you will use before starting to work. There is always more than one way to draw anything in AutoCAD but the quickest, most accurate and the most efficient way always requires the use of one or more of the Osnap tools.
  
- Dock the Object Snap toolbar to your drawing window for quick access to the Osnaps. You will be using them all the time, one-click access is essential. See Object Snaps to find out how to display the Object Snap toolbar. To dock the toolbar, click on the toolbar title and drag it to the edge of the drawing window.

### **Creating AutoCAD Blocks**

In this lesson you will be introduced to creating AutoCAD blocks to create your AutoCAD library for symbols. By definition, a *block* is a collection of objects (*lines, arcs, circles, text, etc.*) that form a more complex entity that normally represents an object in the real world, e.g. a door, a chair, a window, a computer.




There are many advantages to using blocks, here are the major ones:

- A. Blocks are a single entity. You can modify (move, copy, rotate) a block by selecting only one object in it.



B. Using blocks can help keep your file size-down. AutoCAD stores block definitions in its database. When you insert a block, AutoCAD only stores the name of the block, its location (insertion point), scale and rotation. This can be very noticeable in large drawing.

Here are the commands that you will need for using blocks in this lesson:

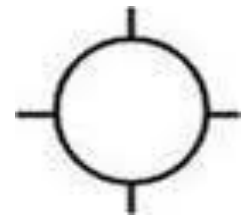
Command	Keystroke	Icon	Location	Result
<b>Block</b>	wmake / B	 Create	Home > Block > Create	Creates a block from separate entities (internal to current drawing)
<b>Write Block</b>	wblock / W	None	None	Creates a block and writes it to a file (external)
<b>Insert</b>	insert / I	 Insert	Home > Block > Insert	Inserts a block (internal or external)
<b>Explode</b>	explode / X		Home > Modify > Explode	Explodes a block or other compound object into its component parts

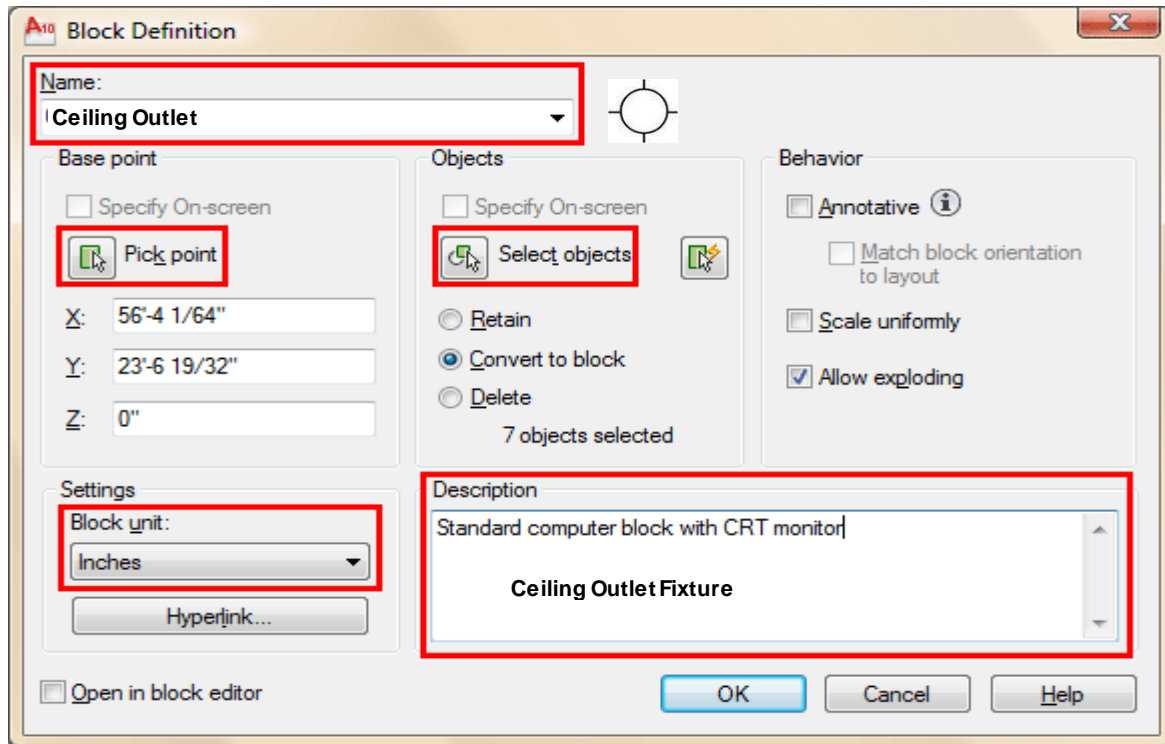
### Steps in Creating AutoCAD Blocks

1. Launch the AutoCAD.
2. Create a new initial layer.
3. Name it according to the standards.
4. Make the Zero Layer current.

**NOTE:** Zero Layer has special properties. When creating blocks, if the objects in the block are drawn on Zero layer, they will assume the properties of the current layer when they are inserted.

5. Select one of the symbols that you want to draw. This example uses only arc/circle and line command.
6. Pull down the menu or the icon and a dialogue box appears.
7. Enter information you want to include.



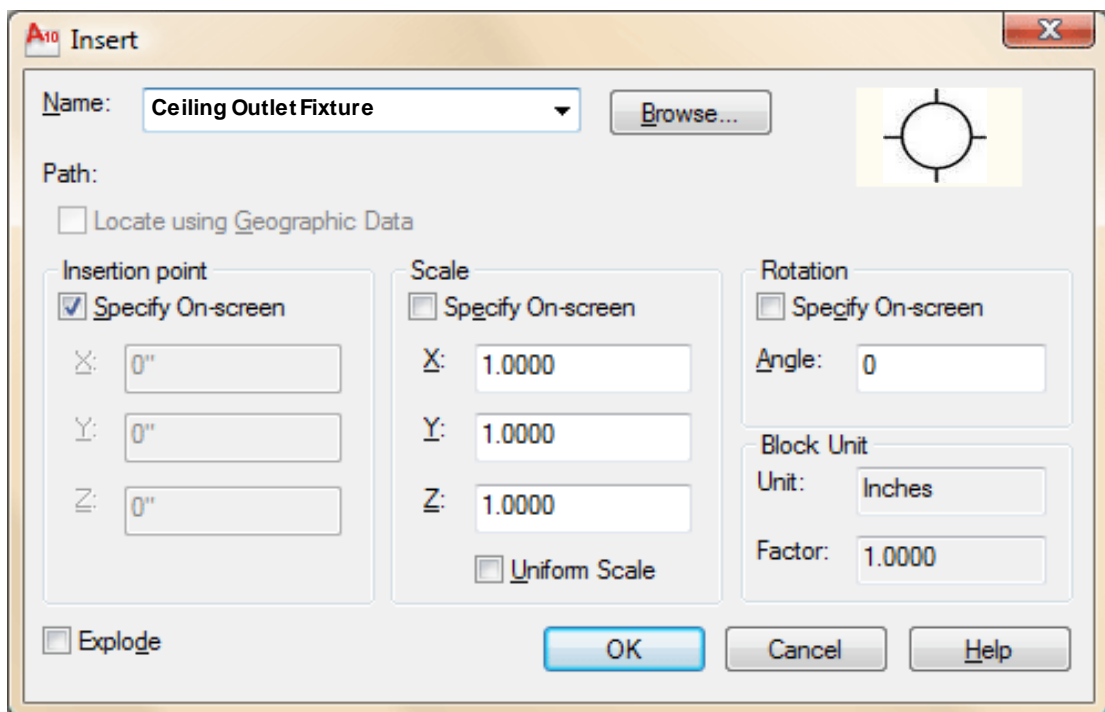


8. The first thing that you want to do is give your block a name. Type **Ceiling Outlet Fixture** in the edit box beside Block Name. Some names may need to be more descriptive, such as part number, or size. Give your block a name by typing Ceiling Outlet Fixtures.
  
9. Pick the **Pick Point** button and then pick the midpoint of the bottom line. Make sure that the retain button is selected, this will keep your objects on the screen as individual objects. If you don't select a base point, your block will default to 0,0,0 and you will insert all your blocks at the same location - the origin.  
  
(You will see in a moment that selecting the Pick Point with blocks is very important when you later insert them into the drawing - always pick a point that will allow you to place the block easily.)
  
10. Pick the **Select Objects** button and then select all the parts of your drawing/object and press **<ENTER>**.
  
11. Select the drawing units you used to create the original object.
  
12. Pick the OK Button and the dialog box closes. Your drawing file will contain a "Block Definition" called **Ceiling Outlet Fixture**. Congratulations, you have created your first block!

If the default radio button "Convert to block" was checked, move your mouse over the objects and you will see that they all highlight - signifying that it is now one object.

## Inserting the AutoCAD Blocks

Once a block is created you may insert it by typing, I <ENTER>. Change to the Ceiling Outlet Fixture Layer. You will see this dialog box on the screen:



By default, all the options you need are pre-selected. Since you only have one block in your drawing, its name is displayed.

Make sure that the **Insertion Point - Specify On-screen** box is checked, and the **Explode** button is not checked. The **Scale - Specify On-screen** should not be checked. Then press the **OK** button. Pick anywhere on your screen and you will see the block appear. Notice how the block that you drew on the white **Zero Layer** is now **Red** and on the **Ceiling Outlet Fixtures** layer.

You may now insert a **Ceiling Outlet Fixture** on every floor plans in your drawing. You can also copy the block instead of re-inserting each time, but make sure you know how to insert.

## AutoCAD COMMON FUNCTION KEYS

<b>F1:</b> Display Help	<b>F7:</b> Toggles GRID mode
<b>F2:</b> Toggles the Text Window	<b>F8:</b> Toggles ORTHO mode
<b>F3:</b> Toggles OSNAP	<b>F9:</b> Toggles SNAP mode
<b>F4:</b> Toggles Tablet mode	<b>F10:</b> Toggles Polar Tracking
<b>F5:</b> Toggles ISOPLANE	<b>F11:</b> Toggles Object Snap Tracking
<b>F6:</b> Toggles Dynamic UCS	<b>F12:</b> Toggles Dynamic Input

### SPECIAL KEY FUNCTIONS

**Escape Key** – Cancels the current command, menu or dialogue box.

**Enter Key** – Ends a command, or will repeat the previous command if blank.

**Space Bar** – Same as the Enter Key, except when entering key.

<b>CTRL+0:</b> Toggles Clean Screen	<b>CTRL+PAGE DOWN:</b> Move to the next layout tab to the right of the current tab
<b>CTRL+1:</b> Toggles the Properties palette	<b>CTRL+D:</b> Toggles Dynamic UCS
<b>CTRL+2:</b> Toggles the Design Center palette	<b>CTRL+E:</b> Cycles through isometric planes
<b>CTRL+3:</b> Toggles the Tool Palettes window	<b>CTRL+F:</b> Toggles running object snaps
<b>CTRL+4:</b> Toggles the Sheet Set Manager	<b>CTRL+G:</b> Toggles the grid
<b>CTRL+6:</b> Toggles the dbConnect Manager	<b>CTRL+H:</b> Toggles PICKSTYLE
<b>CTRL+7:</b> Toggles the Markup Set Manager	<b>CTRL+I:</b> Toggles COORDS
<b>CTRL+8:</b> Toggles the QuickCalc calculator palette	<b>CTRL+J;CTRL+M:</b> Repeat the last command (pressing Enter does the same)
<b>CTRL+9:</b> Toggles the Command Window	<b>CTRL+L:</b> Toggles Ortho mode
<b>CTRL+A:</b> Selects all objects in the drawing	<b>CTRL+N:</b> Creates a new drawing
<b>CTRL+SHIFT+A:</b> Toggles Groups	<b>CTRL+O:</b> Opens an existing drawing
<b>CTRL+B:</b> Toggles Snap mode	<b>CTRL+P:</b> Prints/plots the current drawing
<b>CTRL+C:</b> Copies an objects to Clipboard	<b>CTRL+R:</b> Cycles through layout viewports
<b>CTRL+SHIFT+C:</b> Copies objects to Clipboard with Base Point	<b>CTRL+S:</b> Saves the current drawing
<b>CTRL+X:</b> Cuts object to Clipboard	<b>CTRL+T:</b> Toggles Tablet mode
<b>CTRL+Y:</b> Cancels the preceding Undo action	<b>CTRL+SHIFT+V:</b> Pastes data from the Clipboard as a Block
<b>CTRL+V:</b> Pastes data from the Clipboard	
<b>CTRL+Z:</b> Reverses the last action	
<b>CTRL+CTRL+S:</b> Opens the Save As dialog box	
<b>CTRL+[;CTRL+\:</b> Cancels the current Command (pressing Esc does the same)	

**CTRL+ PAGE UP:** Moves to the next layout Tab to the left of the current tab

Now, you can simply draw lines by picking their position from the workspace. If you want to draw lines with precise direction and length you can use the *Direct Distance Entry* or the *Relative Polar Coordinate*.



### **Suggested Activity 1**

**Directions:** Using the given drawing menu below, perform the following tasks.

#### **A. Draw Menu: LINE or L[enter]**

##### **By Picking**

Command: **LINE**

Specify first point: **(pick 1)**

Specify next point or [Undo]: **(pick 2)**

Specify next point or [Undo]: **(pick 3)**

Specify next point or [Undo]: **(pick 4)**

Specify next point or [Undo]: **press Enter Key**

##### **By Direct Distance Entry**

Command: **LINE**

Specify first point: **(pick)**

Specify next point or [Undo]: **(activate ortho enter the distance) 100**

Specify next point or [Undo]: **press Enter Key**

#### **B. Draw Menu: PLINE or PL[enter]**

##### **By Direct Distance Entry and Polar Coordinate**

Command: **PLINE**

Specify start point: **(pick 1)**

Current line-width is 0.0

Specify next point or [...]: **(ortho ON and drag the mouse for desired position) 400**

Specify next point or [...]: **200**

Specify next point or [...]: **@300<30**

Specify next point or [...]: **press Enter Key**

**C. Draw Menu: ARC or A[enter]**

Command: **ARC or A (press enter key)**

Specify start point of arc or [Center]: **(pick 1)**

Specify second point of arc or [Center/End]: **(pick 2)**

Specify end point of arc: **(pick 3)**



**Reflect and Understand**

**Suggested Activity 2**

1. **Directions:** With the suggested commands, draw the traffic signs below in free size.



**Suggested Commands:**


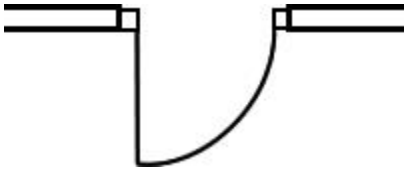



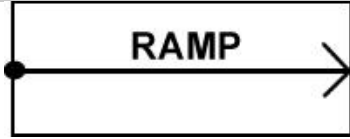
REC, OFFSET, LINE, ROTATE, FILLET, HATCH, ERASE, ARC, CIRCLE, TRIM, OSNAP, & ORTHO

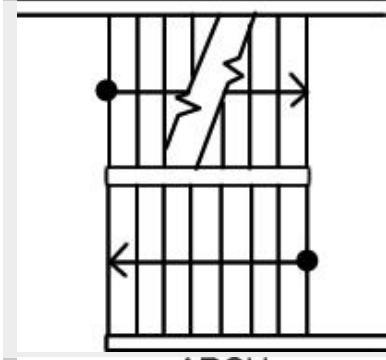

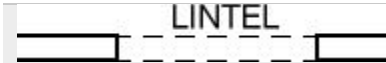



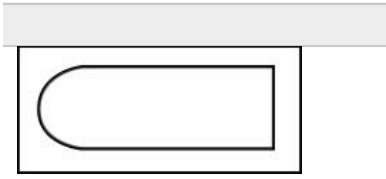
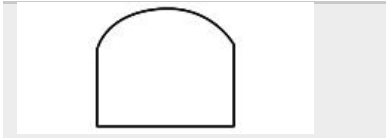
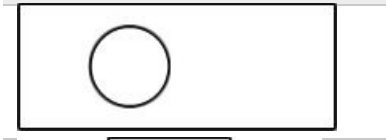
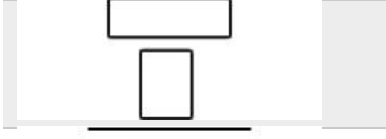

**Note:** Assessment tool – Performance Rubrics (Refer to Appendix A)



### Suggested Activity 3: Creating architectural symbols for AutoCAD blocks

**Directions:** As additional exercise while you are preparing for AutoCAD drawings, create the following architectural symbols for AutoCAD blocks that you will insert later on succeeding activities.

Symbol	Name
	Fixed Window
	Single-swing door (90 degrees)
	Pocket Sliding Door
	Bi-fold Door
	Sliding Door
	Ramp

		Stairs
		Arch
		Lintel
		Scale
		North Direction
		Windows / Door
		Bath Tub
		Lavatory
		Sink (Single)
		Water Closet with Bowl
		Urinal

**Note:** You may add other symbols, fixtures and components of architectural floor plans as desired. Just bear in mind, the more symbols you create the easier it is for you to insert members in your future drawings, the more efficient you become.





## Lesson 2: Preparing a Plan Using CAD

### Introduction

#### Setting Up AutoCAD to Work With Architectural Drafting Style

You will need to make some changes to AutoCAD to use it as a drafting tool for architectural drawings. AutoCAD “out-of-the-box” is set up primarily for mechanical drafting (drawing small parts for machinery using the metric system). This type of drafting is commonly practiced in the world. However, making drawings of a building is quite different from making drawings of an automobile part. Not only is the scale of the object drawn very different, but the conventions of drafting are significantly different between architectural and mechanical parts. In order to make the drafting environment correct for architectural drafting conventions, several changes must be made. These changes are relatively simple to accomplish, and involve the following two types of set-up.

1. **Creating a Template File** that has desirable variables set, as well as layers, text styles, dimension styles, layouts and plotting standards created specifically for architectural drafting purposes. Your Template file can then be used to open new drawings to eliminate having to set up these changes again in the future.

2. **Creating a User Profile** will save the way you want the screen to look and where AutoCAD will search for files. Your personal Profile can be loaded when you start a new AutoCAD session at whatever computer you are working.

## Template Files

When you begin a drawing using AutoCAD, you will be drawing in an environment which has pre-set variables setup by Autodesk for what they consider to be the most common use. However, the settings which come with the software "out of the box" are not good for drawings used in the architectural and interior design industry, so they must be changed by you to comply with standard drafting conventions in those fields.

## Using Template Files

To use a template file to begin a new drawing,

- Click the Menu Browser >Save As...>Drawing Template> specify the filename, then Save.

Templates have the filename extension of \*.dwt. The easiest way to make your standard settings permanent for later reuse is to create your own Template File. Begin a new drawing, set the drawing variables as you want them to be set, and then save the drawing as a "Template" file for reuse on future drawings. This new file will have no "entities" in it (lines, arcs, or circles), but it will include the following variables:

- Your list of LAYERS, with associated line types, colors, and line weights
- Text styles
- Dimension styles
- AutoCAD variable settings
- Layout settings
- Viewport(s)

- Name of each viewport
- Scale of each viewport
- Plotting parameters of each viewport, such as what printer to plot to
- paper size,
- plot scale
- drawing orientation,
- plot style table (pen assignments)
- Title sheet information etc.



### Suggested Activity 1

#### A. IDENTIFICATION.

**Directions:** Identify shortcut of the following commands. Write your answer in a separate sheet of paper or in your notebook.

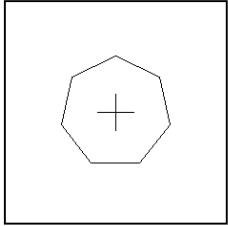
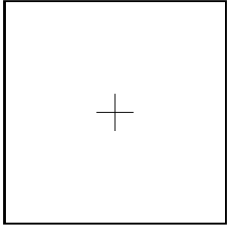
- |              |       |             |       |
|--------------|-------|-------------|-------|
| 1. Move      | _____ | 11. Scale   | _____ |
| 2. Spline    | _____ | 12. Stretch | _____ |
| 3. Copy      | _____ | 13. Fillet  | _____ |
| 4. Offset    | _____ | 14. Arc     | _____ |
| 5. Polyline  | _____ | 15. Erase   | _____ |
| 6. Donuts    | _____ | 16. Circle  | _____ |
| 7. Polygon   | _____ | 17. Trim    | _____ |
| 8. Snap      | _____ | 18. Extend  | _____ |
| 9. Rotate    | _____ | 19. Chamfer | _____ |
| 10. Ellipses | _____ | 20. Array   | _____ |

**B. Directions:** Choose the best command from inside below that is applicable to the drawing. The given are on the left side and the output are on the right side. Write your answer in a separate sheet of paper or in your notebook.

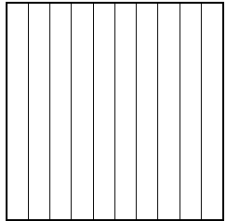
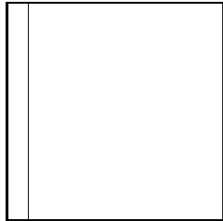
Line	Array	Trim	Offset	Copy
------	-------	------	--------	------

Scale		Rectang		Extend	
Pline	Mirror	Polygon	Rotate	Erase	

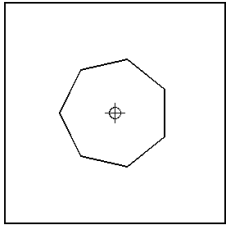
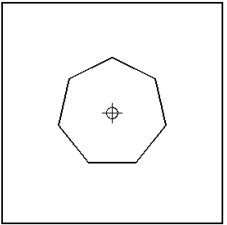
1. \_\_\_\_\_



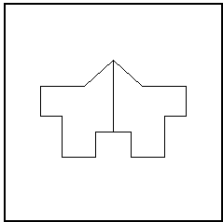
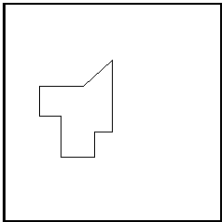
2. \_\_\_\_\_



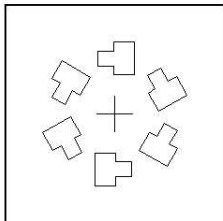
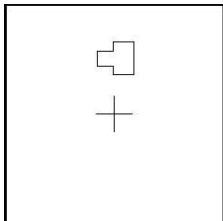
3. \_\_\_\_\_



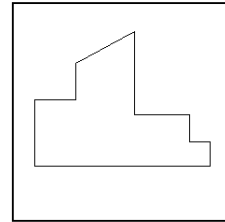
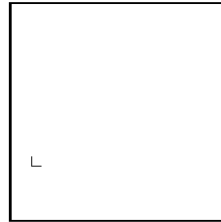
4. \_\_\_\_\_



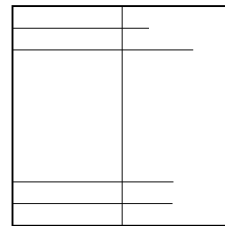
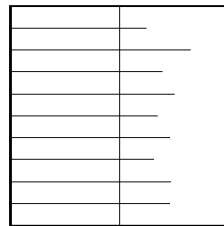
5. \_\_\_\_\_



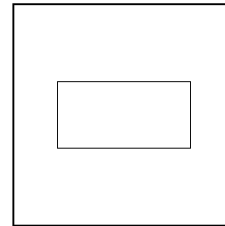
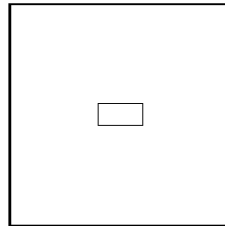
6. \_\_\_\_\_



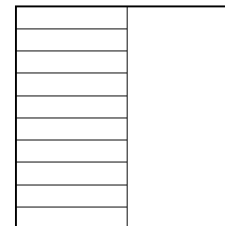
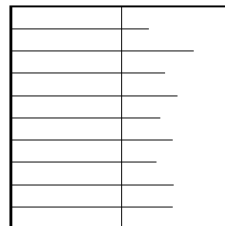
7. \_\_\_\_\_



8. \_\_\_\_\_



9. \_\_\_\_\_

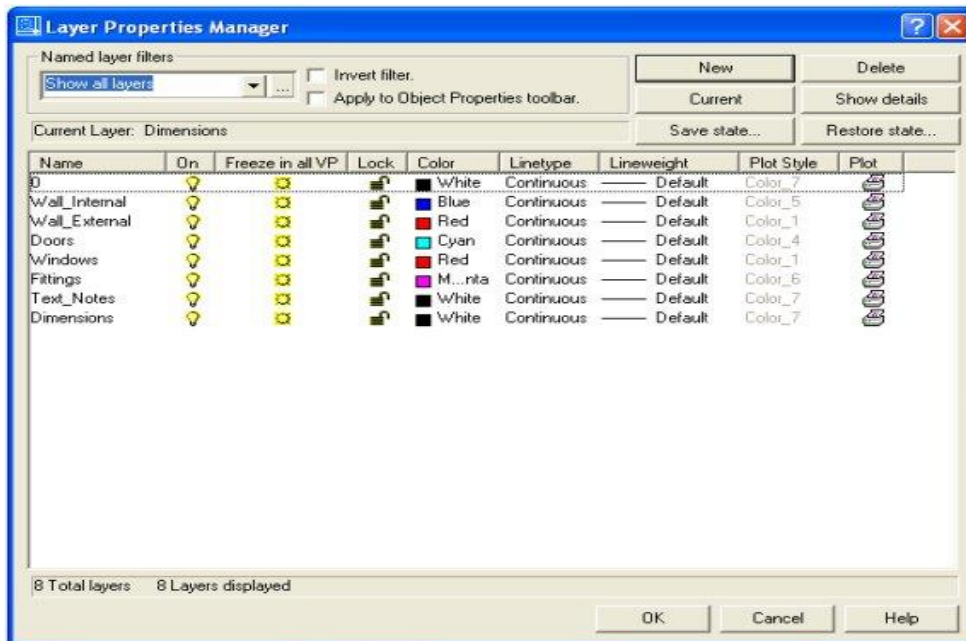
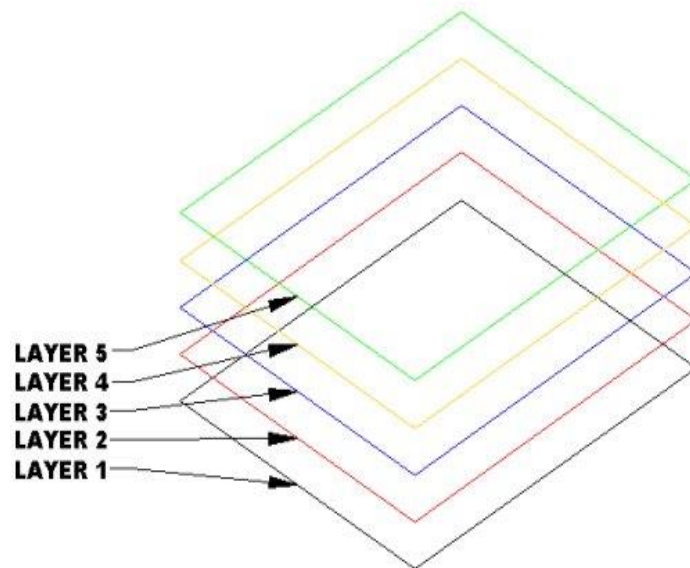


## Layers

Layers are key components for organizing AutoCAD drawings. Layers are ways of managing, tidying, and also controlling the visual layout of a drawing. A whole section of a drawing can be turned on or off, or simply one aspect can be controlled - text for example. This is all done by using layers within AutoCAD.

A layer can be thought of as a large piece of clear plastic, as infinitely large as the drawing area in AutoCAD. When drawing in AutoCAD, everything is drawn on the default layer which is set current. Only the objects you are drawing are visible on the layer, the layer itself can never be seen - it is invisible. Each new layer is created by you, the user.

Normally, it is acceptable to have a layer for each different part of a drawing. The layers created for a simple house plan could be external walls, internal walls, doors, windows, fittings, text notes, dimensions etc. The separate lines and shapes representing each part of the house would be arranged on its relevant layer. Each layer could be assigned its own color so that



everything drawn on that layer to be of the same color.

**Note:** Layers are controlled by the **layer properties manager** button  which is located on the object properties toolbar.

The **layer property manager** is where all the layers are controlled. The layout above shows a typical use of layers.

From the layer property manager we can:

**Add a New Layer** - Press the **New** button to create a new layer.

**Delete a Layer** - Press the **Delete** button to delete the selected layer.

**Set Current layer** - Press the **Current** button to set the selected layer current. All objects drawn will then be drawn on this current layer.

**Show Details** - Press the **Show details** button to see more detailed information about the selected layer.

Each layer also has the following options against it:



**Name** - Displays the layer name.

**On** - Controls if the layer is on or off. Select the light bulb to turn the layer off on the drawing.

**Freeze in all VP** - Pressing this will freeze the layer in all viewports as well as the current model view (see lesson 10 to learn about viewports)

**Lock** - This handy feature locks a layer preventing any content of the layer from being modified.

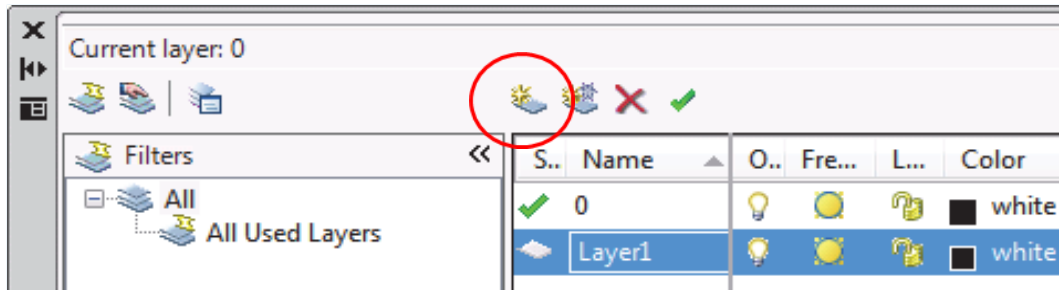
**Color** - Change this to whichever color you like. All objects drawn on the layer will display the chosen color provided that the objects color setting in the object properties toolbar (shown above) is set to 'By Layer'.

**Linetype** - Set the default linetype for all objects drawn on the layer. i.e continuous, dashed, dotted etc.

**Lineweight** - Set the thickness a line appears .Default is no thickness. This option can be toggled on/off on the display by the LWT button above the command console.

**Plot** - Select if the layer will be shown when the drawing is plotted (printed).

When a new AutoCAD drawing is created, everything which is drawn appears on the one default layer, named 0. When creating drawings, the layer 0 shouldn't really be used. New layers should be set up with names corresponding to the content contained on them.



The color and line style of entities drawn with AutoCAD are generally determined by the layer on which those objects reside. However, it is possible to override this by specifically defining these attributes for the objects in the drawing. This is done using the COLOR and LINETYPE commands. The color of an entity is used to determine which pen will be used when the drawing is plotted. This means that part of the function of layers can be to determine which pen is used for drawing on a multi-pen plotter.

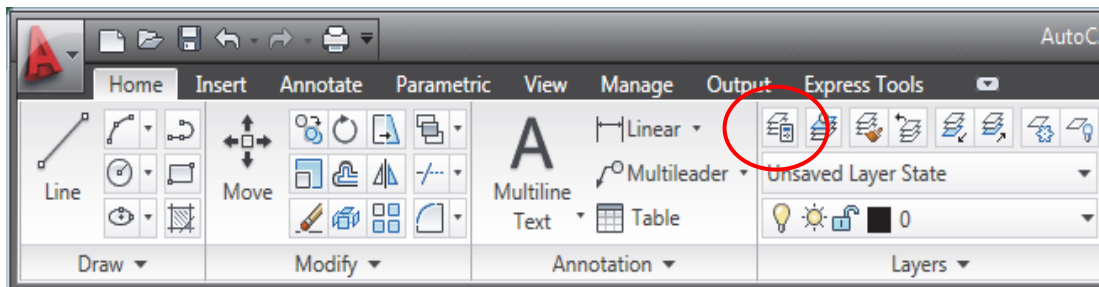
### CAD Layer Standards

Thickness for pens and plot: 0.10 mm RED (Extension line, Dimension line, Center lines, Leader line, or Construction lines); 0.20 mm YELLOW; 0.30 mm. GREEN (Hidden line); 0.50 mm. CYAN (Object line); 0.80 mm BLUE (Cutting-Plane line).

In AutoCAD usually parts to be printed in black are drawn in 1 to 7 basic colors. Color layer: Green-Center, Magenta-Measure of length and Blue-Hidden. (Refer to CAD Handout)

### Creating a Layer

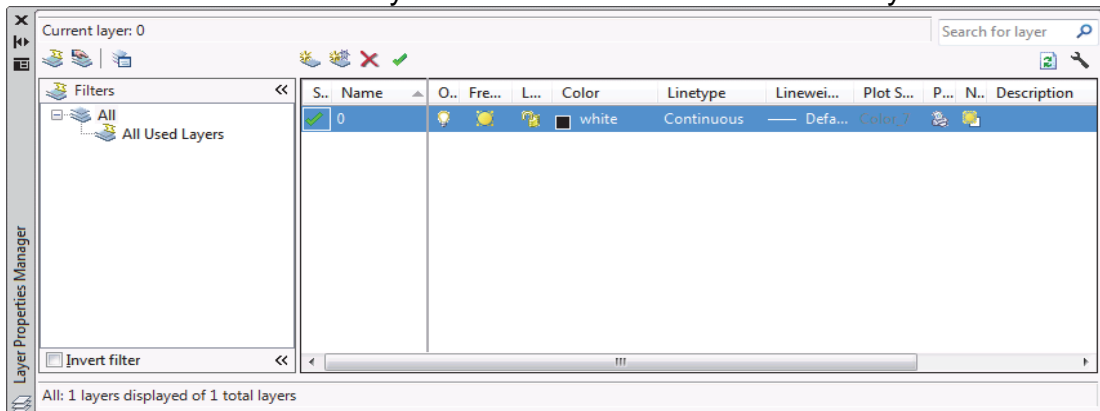
1. Click the accentuated button:



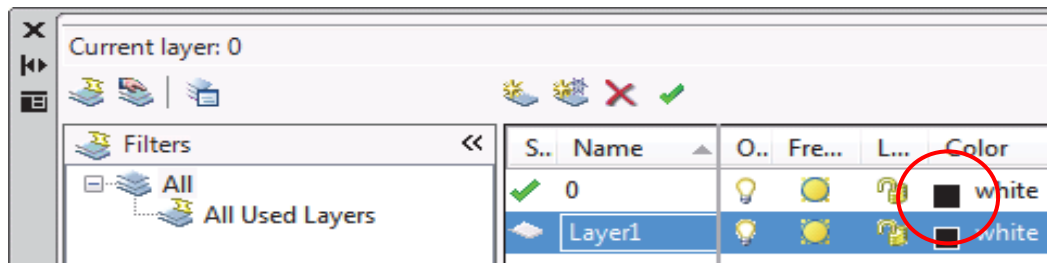


This dialog box appears:

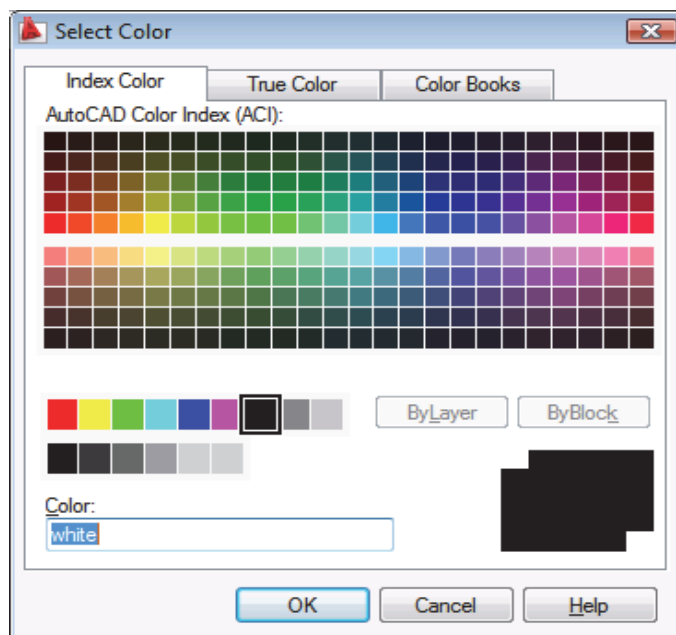
2. Click the encircled button:  
*Create a layer called LAYER1 - see the illustration below.*
3. Write the name of the layer in the blue box - note that the text marked with blue automatically disappears.
4. Press ENTER when you have written the name of the layer.



5. Color the layer by clicking on the encircled box below:



A dialog box appears showing all the colors available in the program.



Select the desired color – refer to the table.

6. Now create the layers shown in the table below.

7. Specify the right lineweight for the layers by clicking in the box **Lineweight**  
See the weight in the table below.

Description	Line Thickness in mm.	Color Codes
Object line	0.50	CYAN
Hidden Line	0.30	GREEN
Center Line	0.10	RED
Cutting Plane Line	0.80	BLUE
Reference Line	0.10	RED
Reference Bubbles	0.10	RED
Dimension Line	0.10	RED
Extension Line	0.10	RED
Leader Line with Arrows	0.10	RED
Text		

**Note:** You might also add descriptions as shown in the table - it makes it a little easier to navigate through the layer names. You need not exert yourself to learn these layer names as they will largely be linked to the drawing objects.

### **Metric Units in Modelspace and Paperspace:**

Modelspace: 1 unit = 1000 millimeter

Paperspace: 1 unit = 1000 millimeter

Your title block should be sized in accordance with millimeters. For example, an E size sheet is about 43" x 33". That same sheet in metric will be 1092.20 mm x 838.20 mm (There are 25.4 mm in one inch). So in paperspace, your E size sheet will be 1092.20 units x 838.20 units.

**Scaling the viewports** - A common metric scale is 1:1000. That means 1 meter on paper = 1000 millimeters in the model space drawing. Supposing, you want to scale your drawing into 1:100, so your input or syntax in the command line would be 1/100xp.

**Zooming scales for common metric scales:**

<u>Metric Scale</u>	<u>Zooming Scale</u>
1:100	100xp
1:200	200xp
1:250	250xp
1:500	500xp
1:1000	1000xp
1:2000	2000xp
1:10000	10000xp

*Then when you plot, you will still be plotting 1 to 1 or 1 drawing unit = 1 mm.*

**Dimensioning**

Dimscale for different metric scales:

<u>Metric Scale</u>	<u>Dim Scale</u>
1:100	.1
1:200	.2
1:250	.25
1:500	.5
1:1000	1
1:2000	2
1:10000	10

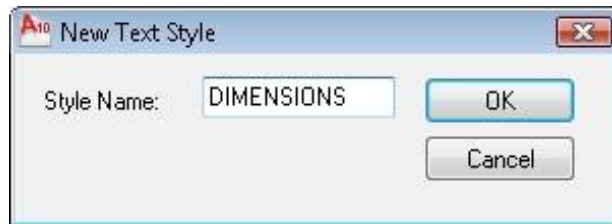
*All the dimensioning variables should be sized in terms of millimeters. If you want your arrow size to be 4 mm on paper, set that variable to 4.*

**Text Style to Assign to Dimensions**

This text style will not need to be "Annotative," but it will be compressed horizontally in order to facilitate placing dimension numbers between extension lines. It will also give dimension text a distinctive look so they will not be confused with notes.

### Create Dimension Text Style

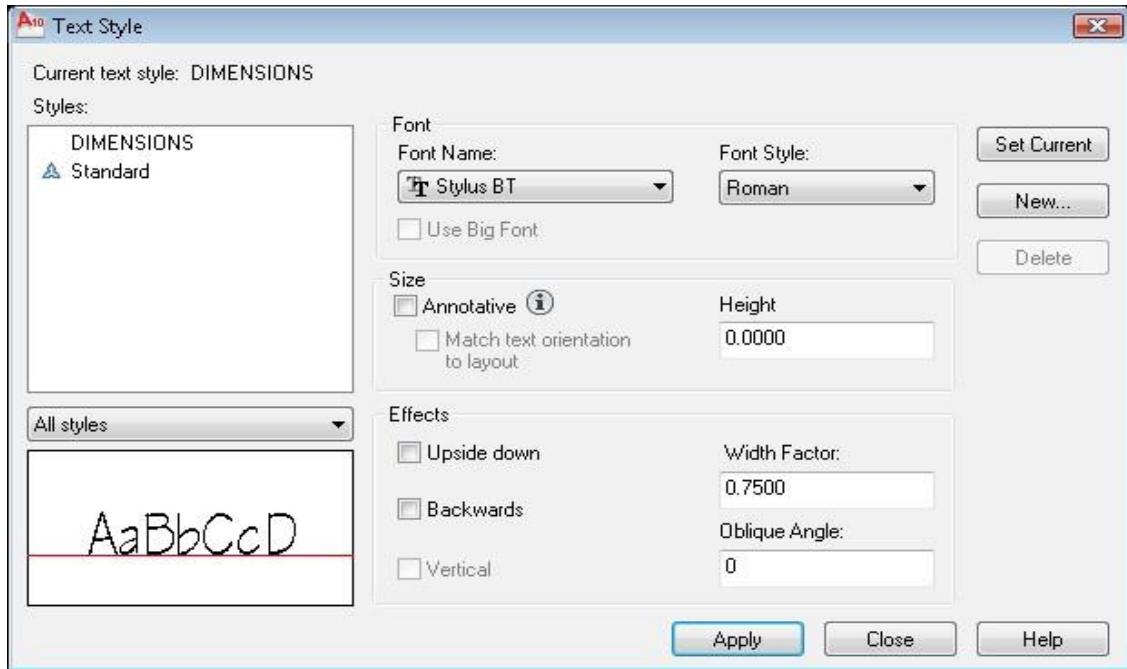
1. On the Annotate tab, click the dialog Box Launcher of the Text panel.
2. Click New.
3. Set Style Name to "DIMENSIONS", then click OK
4. Set the following properties:
  - Font Name: Stylus BT
  - Height : 0
  - Width Factor: 0.75
5. Click Apply, then Close.



### Create Title Text Style

1. On the Annotate tab, click the Dialog Box Launcher of the Text panel.
2. Click New.
3. Set Style Name to "Title", then click OK
4. Set the following Properties:
  - Font Name: Stylus BT
  - Height : 0
  - Width Factor: 1

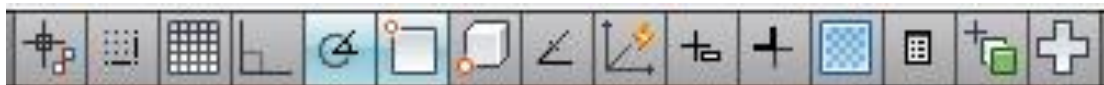
5. Click Apply, then Close.



### Set up the Status Bar

The Status Bar is at the bottom of the screen on the left side and displays ten pictorial icons representing drawing status settings. If you prefer, you can turn the pictorial icons to words to help remember what they stand for. To do this, right-click one of the buttons and turn off "Use Icons." If you don't want to see a particular button in the Status Bar, you can make it invisible by right clicking on any button and select the "Display" command, then uncheck the ones you don't want to appear.

Set the Status Bar buttons to the following settings - buttons that have been pushed in are turned on and turned light blue color.



Turn On (*turns icon in light blue*) only the following buttons on the Status Bar, Turn off all the rest (*grayed icons*):

- Polar Tracking
- Object Snap

## **Set the following Object Snap functions**

Right click on the Object Snap button in the Status Bar and select “Settings...”

- a. Endpoint
- b. Midpoint
- c. Center
- d. Node
- e. Quadrant
- f. Intersection
- g. Perpendicular
- h. Nearest

## **Create a Layout of Border and Title Block**

Each “Layout” that you create will carry with it the following elements:

A unique name of each “Layout” as displayed on a tab at the bottom of the drawing. One or more “Viewports” including a scale for each viewport, locked or unlocked status for each viewport, and plotting parameters for each viewport, such as what printer to plot to, paper size, plot scale, drawing orientation, and plot style table (pen assignments)

Drawing entities you want to have visible and printable in the Layout, such as drawing title information and a border.

Click on the "Layout1" tab at the bottom of the drawing. This will bring you into “Paper Space” and allow you to set up viewports and draw a border. By default you always are drawing in so-called "Model Space," which is where you should be to draw the 3-dimensional "model" of the building.

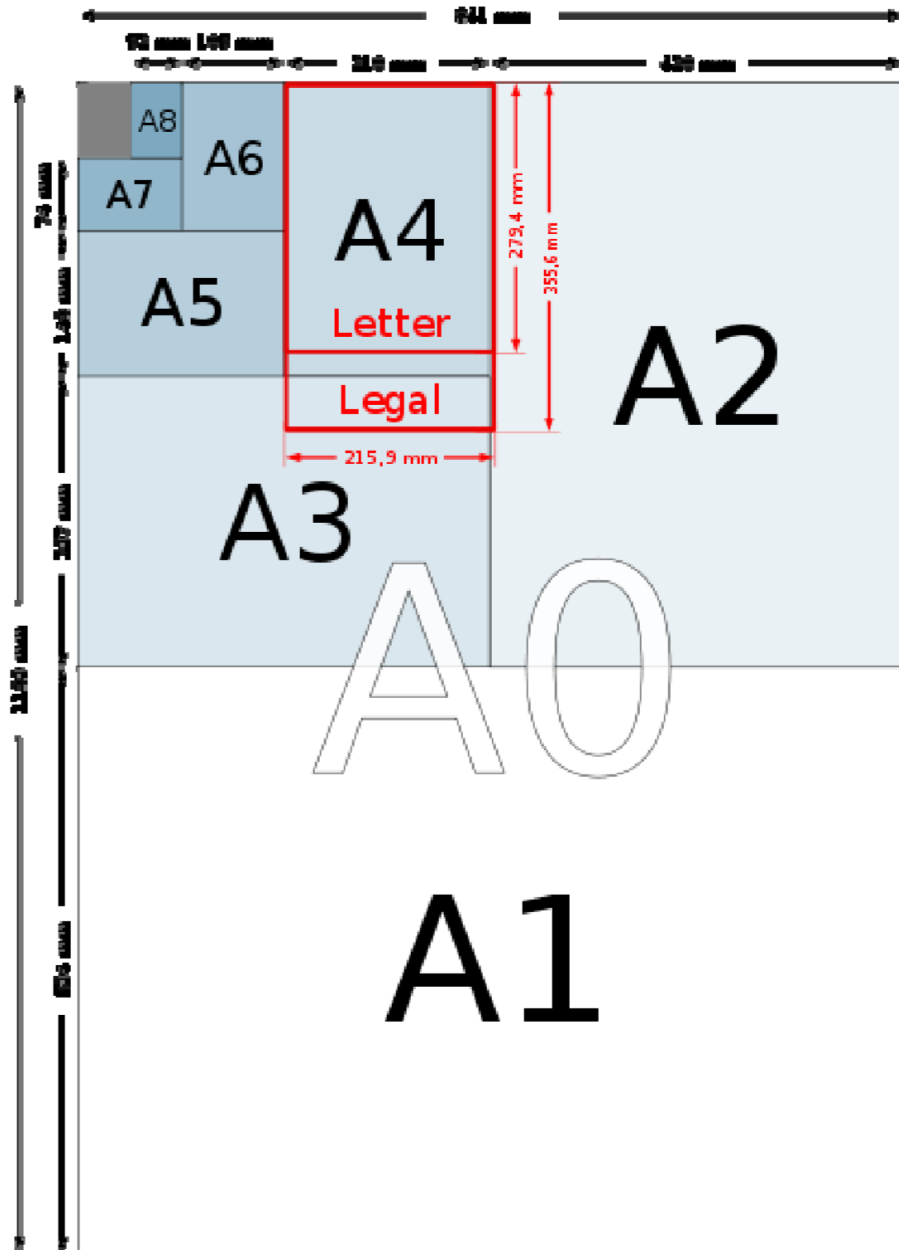
However, the border of the sheet should be drawn in so-called "Paper Space." "Paper Space" is a special 2D drawing mode in which you can group various "views" of your 3D "model" of the building for plotting purposes.

These views are typically plan, elevation, section, and perspective and are created in "viewports" drawn in the Paper Space Layout. Since the model of the building is the only drawing, when the model is changed, the plans, elevations, and sections are automatically changed in their viewports. The great advantage of working this way is that you can visualize the building or space as it will actually exist in three dimensions.

### **Standard Printing Specifications**

Given this ease of changing sizes, it is of course common to copy or print a given document on different sizes of paper. Text made with technical pen of 5 mm in height has a stroke or line thickness of 0.5 mm, and so requires a brown-nibbed 0.5 mm technical pen. If this text were drawn on an ISO-sized document (e.g. A0), and the document were reproduced at half its original size (A1), the text would be rendered 3.5 mm high with a stroke thickness of 0.35 mm - the yellow-nib size.

Thus, changes to reductions or enlargements can be made easily as everything is in proportion. This standard ensures that drawings can always be legible even after microfilming, photocopying, and faxing. Below is the European standard paper sizes and their relationship:



Sample European Standard Paper Size



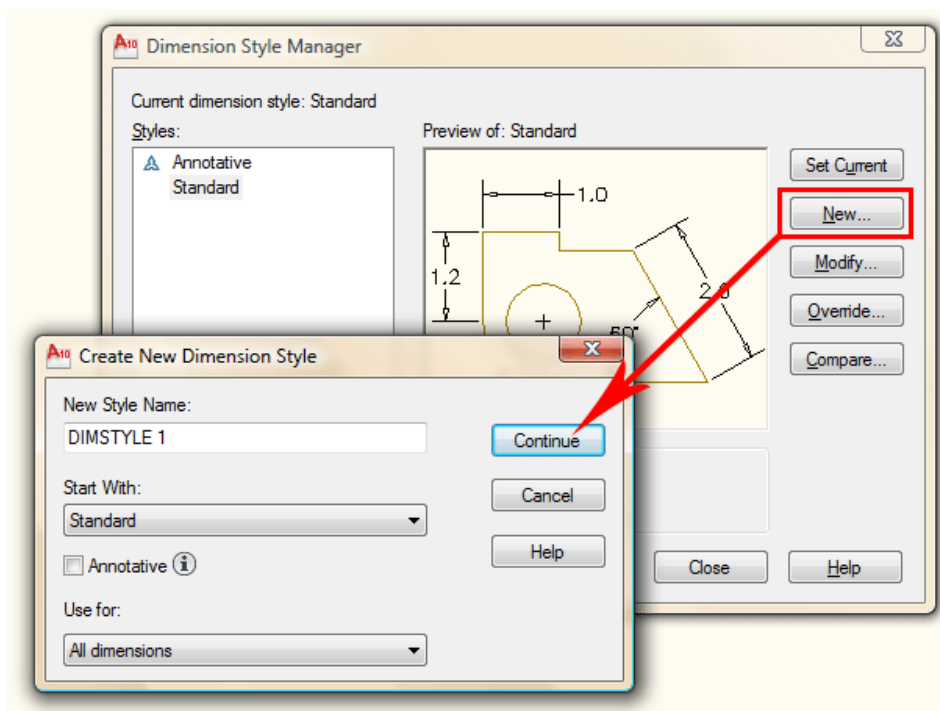
### Suggested Activity 2: Create Dimension Style

#### DDIM Dialog Box



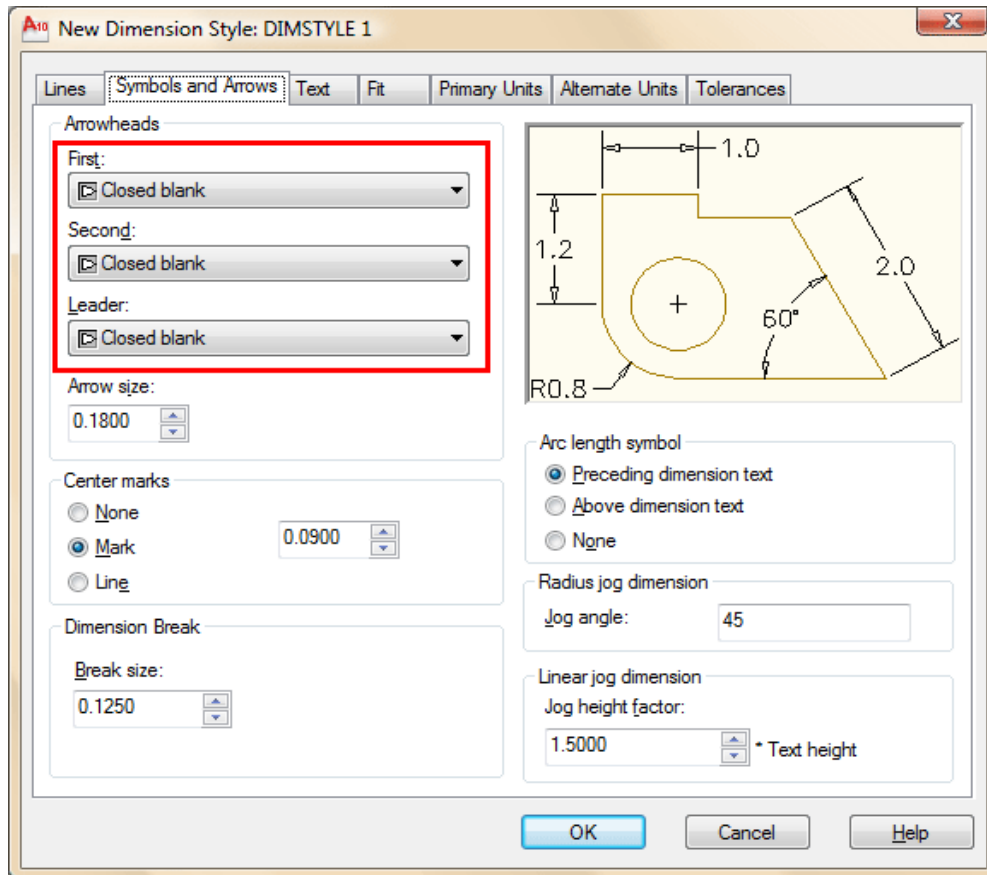
In this lesson, you will create a new Dimension Style and use it in a drawing. From there, you should try different styles and get familiar with the options. Most companies these days will have a standard style (or set of styles) to use on drawings, but this is a very important tool to know if you want to turn out professional looking drawings.

1. Start but invoking the **DDIM** command and press the **NEW** button to open the small dialog for entering the name of the style you are creating. In this example use the name "**DIMSTYLE 1**".



## 2. New Dimstyle

Make sure that "**Start with**" has "**Standard**" as its setting. Press the **Continue** Button when everything is set. This will open the dialog box for settings, so just press **OK** to close it for now.

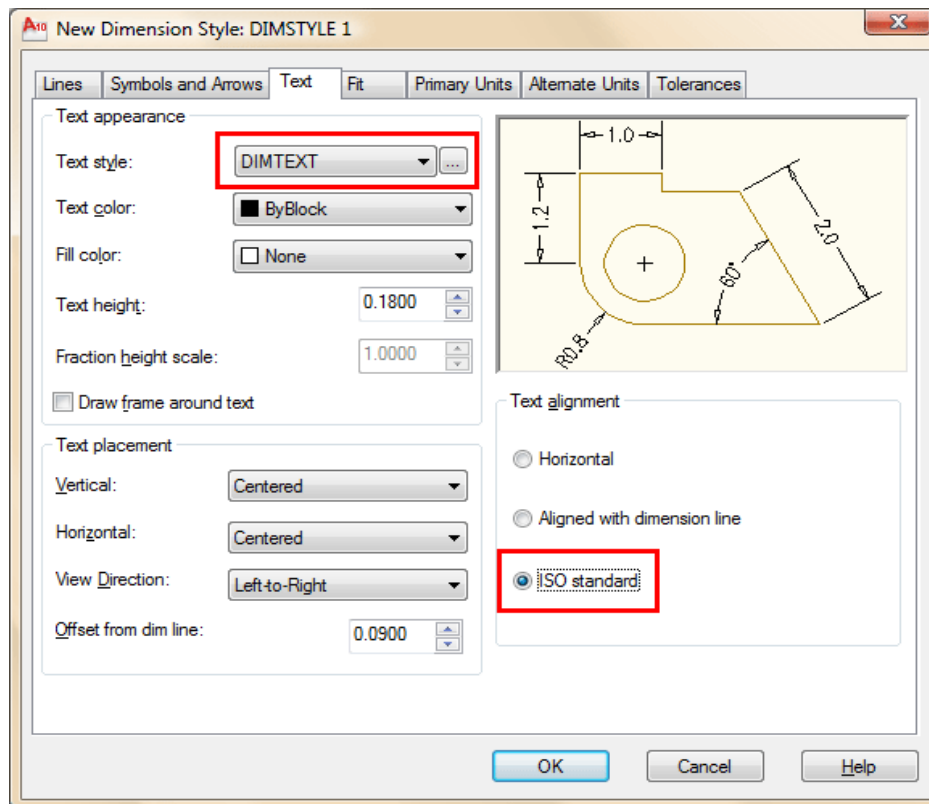


- Back at the "Dimension Style Manager" dialog box, you will see that the new style you created is listed at the top (left side). To modify it, select the name, then press the modify button. The dialog box opens and click on the second tab **Symbols and Arrows**.

As a general rule, we recommend not to change much on this tab. Set as defaults, the dimensions are sized proportionately, if you change the setting on one parameter, your dimension can look *'off-balance'*.

For example, you could end up with huge arrows and small text. For the purposes of this lesson, the only thing that will change on this tab is the arrowheads. Select something other than the standard. You'll also see that you can set the colors, but just like regular objects, it is best to leave them set to **"Bylayer"** - and make sure you have a separate layer for all dimensions.

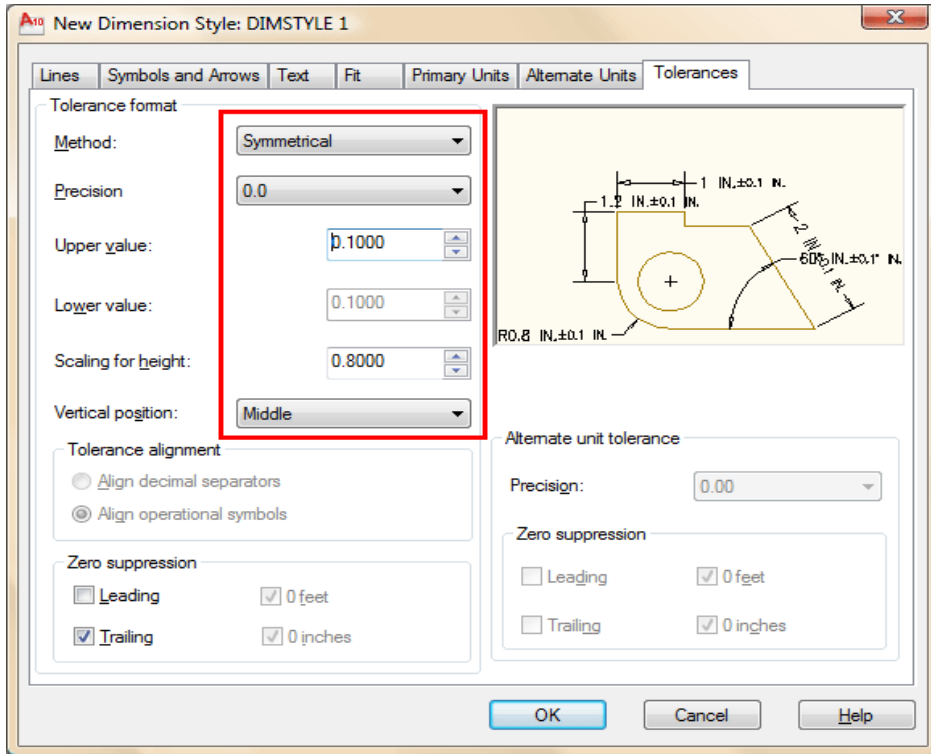
4. Go to the third tab **Text**.
5. Start up the Text Styles dialog box by pressing the button with the ... next to the text name. Create a new textstyle using **RomanS** and a width of **0.8** and call it "**DIMTEXT**".



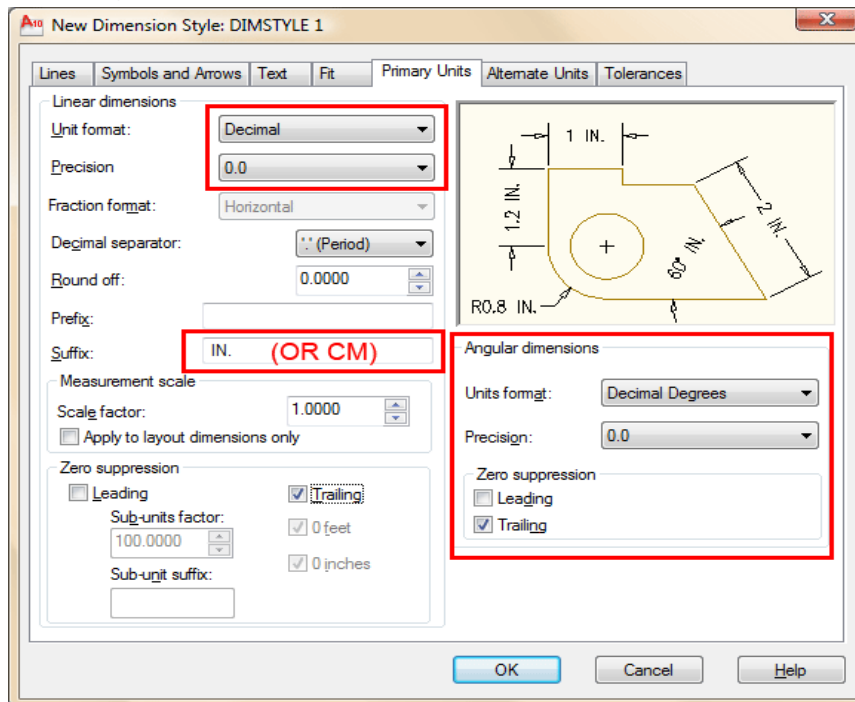
6. Close the **Text Styles** dialog box. Select **DIMTEXT** as your text for dimensions as shown.

*The great thing about this dialog box is that it shows you a preview of what your changes will do the final dimension in the top right window. In the bottom right, select ISO as the Text Alignment option. Try some other changes to see their effects in the preview, then end with the settings as shown below.*

7. Click on the next tab to continue.
8. Click on the next tab (Primary Units) to continue.



9. In the **Primary Units**, you find some of the more common parameters that need to be changed. Precision is very important. 3 Decimal places is usually enough.





## Reflect and Understand

### Suggested Activity 3 – Creating Text Styles

**Directions:** Create the following Text Styles.

Multiline Text:

1. Type MT command and press enter key.
2. On the workspace, pick the first point and the second point that will serve as the text box.
3. Set the height of the text...say 200
4. Type the desired text... say plan
5. Close text editor
6. Apply zoom extents command by pressing Z (enter key) E (enter key)



## Know

### Create a Layout of Border and Title Block

Elements of the Layout of Border and Title Blocks

#### A unique name

1. Tab at the bottom of the drawing. One or more Viewports including a scale for each viewport, locked or unlocked status for each viewport, and plotting parameters for each viewport, such as what printer to plot to, paper size, plot scale, drawing orientation, and plot style table (pen assignments)

#### Title informational border

2. Drawing entities you want to have visible and printable in the Layout, such as drawing title information and a border.

### **Paper Space and Model Space**

3. Click on the "Layout1" tab at the bottom of the drawing. This will bring you into "Paper Space" and allow you to set up viewports and draw a border. By default you always are drawing in so-called "Model Space," which is where you should be to draw the 3-dimensional "model" of the building.

### **3D-Dimensional Model**

4. However, the border of the sheet should be drawn in so-called "Paper Space." "Paper Space" is a special 2D drawing mode in which you can group various "views" of your 3D "model" of the building for plotting purposes.

### **Viewpoints**

5. These views are typically plan, elevation, section, and perspective and are created in "viewports" drawn in the Paper Space Layout. Since the model of the building is the only drawing, when the model is changed, the plans, elevations, and sections are automatically changed in their viewports. The great advantage of working this way is that you can visualize the building or space as it will actually exist in three dimensions.



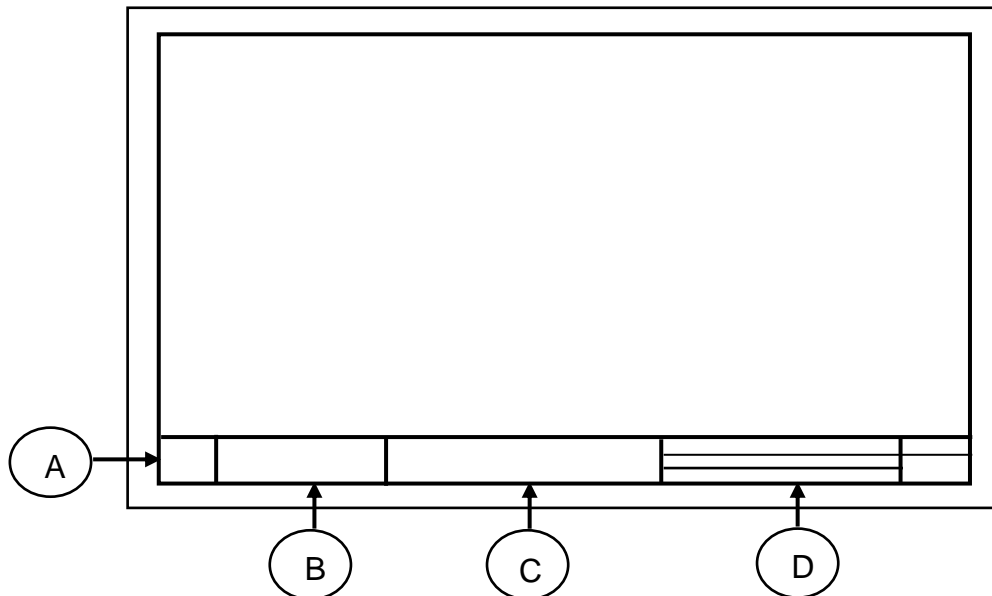
## **SUMMATIVE ASSESSMENT**

### **Suggested Activity 4**

**Directions:** Using the Floor Plan in Appendix B, page 113 - 114 draft the same floor plan using autoCAD. Your finished working drawing will be assessed using the suggested rubric in Appendix A, page 112.

### Suggested Activity 5

**Directions:** Apply the basic and modifying commands in creating a Layout of Border Line and Title Block.



### Requirements for the Layout Plan

1. Paper Size: A4
2. Boarder Line: 15.00 mm. around
3. Title Block:
  - 3.1 Height = 30.00 mm.
    - A. 30.00 mm.
    - B. 90.00 mm.
    - C. 70.00 mm.
    - D. 100. 00 mm.

### Suggested Commands:

REC, OFFSET, LINE, TRIM, OSNAP, & ORTHO



### Post-Assessment:

ICT- TECHNICAL DRAFTING - Grade 10

Answer the post-assessment below to determine whether there is significant increase in your understanding of preparing drawings using computer-aided designing.

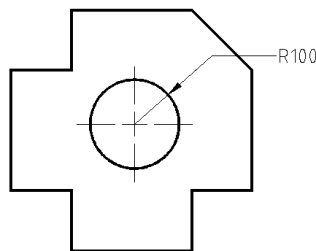
**Directions:** Choose the letter of the correct answer. Write your answer in the space provided before each number.

- \_\_\_\_\_ 1. This is commonly known as the physical equipment that makes up the computer system.  
A. Hardware      B. Mouse      C. Printer      D. Software
- \_\_\_\_\_ 2. It is the brain of the computer where most of the “computing” takes place.  
A. CPU      B. Disk Drive      C. Hardware      D. Monitor
- \_\_\_\_\_ 3. This is the main purpose of the left mouse button.  
A. To execute a command      C. To serve as abort button  
B. To repeat the last command      D. To serve as pick button
- \_\_\_\_\_ 4. The set of programs, procedures, and related documentation associated with a computer system.  
A. Disk Drive      C. Printer  
B. Hardware      D. Software
- \_\_\_\_\_ 5. Of the following software, which is not an application software?  
A. Adobe Photoshop      C. Flash  
B. AutoCAD      D. Windows 8
- \_\_\_\_\_ 6. Which of the following options is not type of workspaces?  
A. 2D Drafting & Annotation      C. 3D Modeling  
B. My workspace      D. AutoCAD Classic
- \_\_\_\_\_ 7. Which of the function keys can be used for activating the Osnap Mode?  
A. F3      B. F5      C. F9      D. F8
- \_\_\_\_\_ 8. Which command is used to change the size of an existing objects?  
A. Move      B. Rotate      C. Scale      D. Zoom
- \_\_\_\_\_ 9. Which command can be used to create a new text style (TS) and modify the existing ones?



- A. Dtext      B. Mtext      C. Text      D. Style
- \_\_\_\_\_ 10. Which of the keyboard keys must be pressed to execute a command or to accept an Auto CAD default?
- A. F2 and Enter      C. Enter and Esc  
B. Enter and Space bar      D. Esc and Space bar
- \_\_\_\_\_ 11. With a hot grip you can perform these editing tasks
- A. Move      B. Offset      C. Rotate      D. Scale
- \_\_\_\_\_ 12. Which of the following is important in setting the chamfer command?
- A. Angle point 1 and 2      C. Distance 1 and 2  
B. Base point 1 and 2      D. Radius 1 and 2
- \_\_\_\_\_ 13. What is the default file extension of an AutoCAD drawing?
- A. Dwg      B. Dwf      C. Dws      D. Dwt
- \_\_\_\_\_ 14. If you need the text to be reversed, you mirror the text, then you need to set:
- A. MIRRTEXT to 0      C. TEXTMIRR to 0  
B. MIRRTEXT to 1      D. TEXTMIRR to 1
- \_\_\_\_\_ 15. Which keystrokes will UNDO a command?
- A. Alt+U      B. Alt+Z      C. Control+U      D. Control+Z

- \_\_\_\_\_ 16. Which of the following dimensioning commands is evident in the drawing?



- A. Dimaligned      C. Dimlinear  
B. Dimangular      D. Qleader
- \_\_\_\_\_ 17. Which of the following is necessary in setting the fillet command?
- A. Angle      B. Base point      C. Distance      D. Radius
- \_\_\_\_\_ 18. Which of the following can be joined using Join command
- A. Arc      B. Circle      C. Construction line      D. Ray
- \_\_\_\_\_ 19. The following are some of the properties and settings that you can

save in a layout, except.

- A. Plot scale
- B. Line weight
- C. Paper size
- D. Drawing orientation

\_\_\_\_\_ 20. What command is used to specify settings in dimension style manager?

- A. Ddim
- B. Dimspec
- C. Dimalt
- D. Dimsize

### Appendix A.

#### Assessment Tool: Product & Performance Rubric

Name: \_\_\_\_\_ Date: \_\_\_\_\_

Year & Section: \_\_\_\_\_

Criteria	5 points	3 points	1 point
Proficiency	Perform the task with competence and exceptional performance	Perform the task with competence and with standard performance	Perform the task with competence but below standard performance
Layout/Proportion	All drawings were drawn proportionately	Layout was good but 1-2 drawing were out of	More than 2 drawings were drawn out of

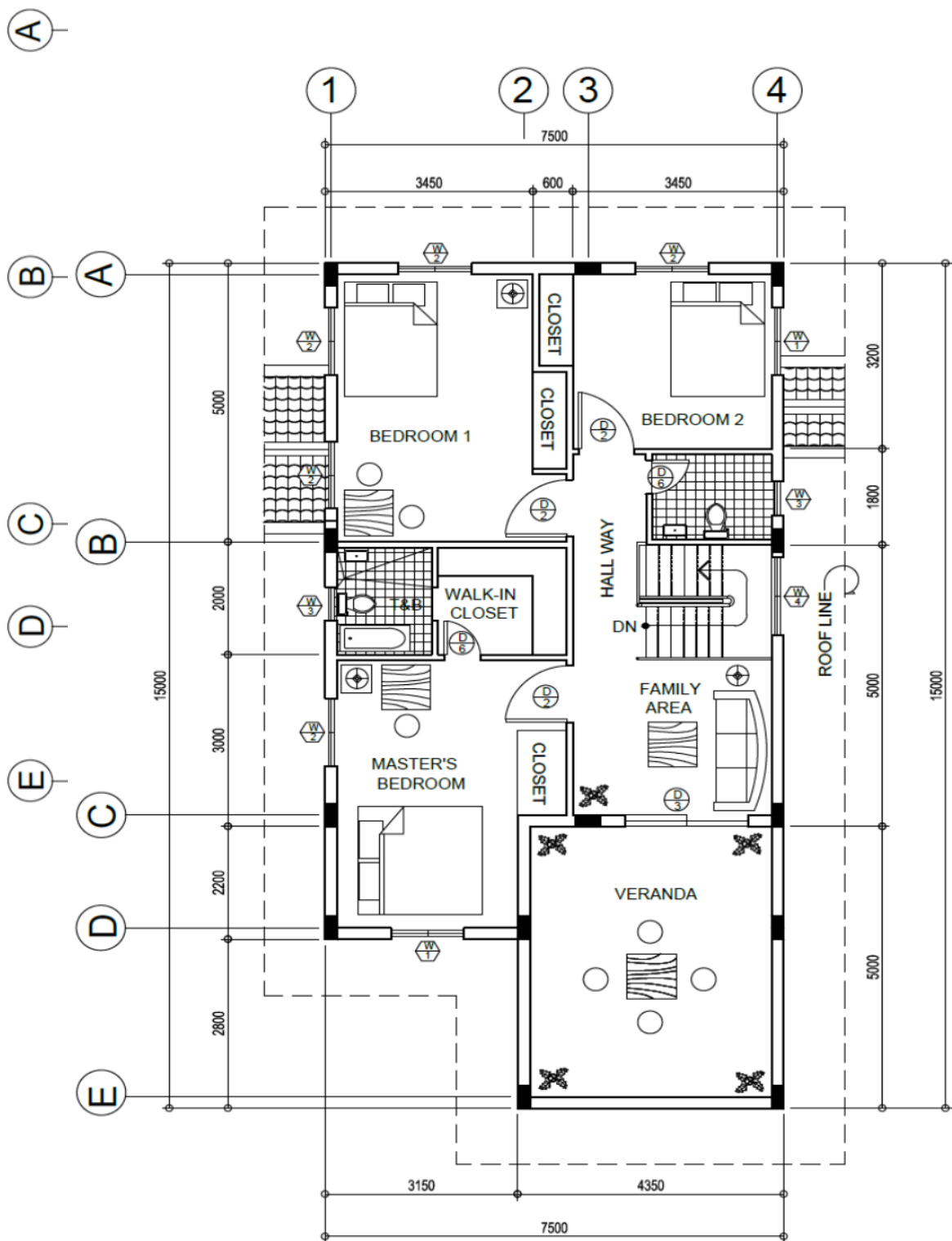
	and was layout properly	proportion	proportion and improperly layout
Completeness	Perform all the steps in sequence	Perform the task with at least 1-3 steps are not met	Perform the task with 3 or more steps are not met
Time Management	Finish the task ahead of the given time and date	Finish the task on the given time and date	Unable to finish the task on the given time and date

**Rating Scale:**

Points Earned	Numerical Rating	Descriptive Rating
17 – 20	91 – 100	Outstanding
13 – 16	86 – 90	Very Good
9 – 12	81 – 85	Good
5 – 8	76 – 80	Fair
1 - 4	71 - 75	Needs Improvement
Teacher's Comments:		
Teacher's Signature: _____		Date: _____

**Appendix B.**

**FLOOR PLAN**



**SECOND FLOOR PLAN**  
 SCALE 1:100

Appendix C.

PERSPECTIVE



 PERSPECTIVE VIEW  
SCALE NTS

Content Standard	Performance Standard
The learner demonstrates understanding of concepts and underlying principles in drafting structural layout and details using Computer-Aided Design (CAD).	The learner independently drafts structural layout and details following the job requirements using Computer-Aided Design (CAD).

**Quarter III**

**Time Allotment: 12 hrs.**

## **MODULE 4**

### **DRAFTING STRUCTURAL LAYOUT AND DETAILS USING COMPUTER-AIDED DESIGN (CAD)**

#### **Introduction**

Technology and Livelihood Education (TLE) is one of the nomenclature in the implementation of the K to 12 Basic Education Program (BEP) composed of four components namely: Agri-Fishery Arts, Home Economics, Industrial Arts and Information and Communication Technology (ICT). In this module, the focus is on **Drafting Structural Layout and Details using CAD**.

In this course, you will be introduced to different learning activities that will prepare you to be skillful before you to do the actual work as a draftsman and to be more confident to start your own CAD business.

This module is specifically designed to hone your knowledge and skills specifically on ***Process and Delivery*** where you have a hands-on activities as you go along. The learning procedures are divided into different sections such as: **What to Know, What to Process, What to Reflect and Understand, and What to Transfer**.

So, explore and experience the lessons in Structural Layout and Details using CAD and be a step closer to being a skillful draftsman.



## Objectives:

Upon completion of this module, you are expected to:

- ❖ draft foundation plans
- ❖ draft structural floors and roof framing plans

\*\*\*\*\*



At this point, you are heading towards meaningful activities and learning encounters. Complete the exercises and answer the suggested worksheets to experience relevant and practical learning that awaits you at the end of this module.

*ENJOY YOUR JOURNEY!*



## Pre-Assessment:

You will be challenged to recall your prior knowledge and experiences about drafting structural layout and details. This Phase will guide you in assessing yourself by answering the questions below. It will also give you the opportunity to explore the basics of drafting structural layout and details using CAD.

**Directions:** Choose the letter of the correct answer. Write your answer in the space provided to each number.

- \_\_\_\_\_ 1. Which circle is drawn with a bow compass?  
A. 360° circle      C. irregular curve  
B. circle template      D. flexible curve
- \_\_\_\_\_ 2. Where do you set your compass to draw a 2 1/2 diameter-circle?  
A. 1.25"      B. 1.50"      C. 2.00"      D. 2.50"

- \_\_\_\_\_ 3. What is the purpose of an erasing shield?  
 A. to prevent tearing the drawing media  
 B. to avoid erasing nearby lines accidentally  
 C. to protect areas that you do not want to erase  
 D. all of the above are correct answers to the question
- \_\_\_\_\_ 4. Which of the following is not an advantage of sketching?  
 A. refinement of ideas      C. to communicate ideas  
 B. to practice drawing      D. to capture ideas
- \_\_\_\_\_ 5. An object is usually shown in more than one view in \_\_\_\_\_ drawing.  
 A. a rough sketch    B. a multi-view    C. an isometric    D. an oblique
- \_\_\_\_\_ 6. Concurrent engineering design involves ideation, implementation, and \_\_\_\_\_.  
 A. aesthetics    B. creativity      C. life cycle      D. refinement.
- \_\_\_\_\_ 7. What are the three principal views of orthographic drawings?  
 A. Isometric, Perspective, Oblique      C. CAD, ISO, ANSI  
 B. Top, Front, Side (end)                  D. Top, Bottom, Side
- \_\_\_\_\_ 8. When using the TRIM command, which do you select first?  
 A. The cutting edges      C. The object to be trimmed  
 B. Everything                  D. Nothing
- \_\_\_\_\_ 10. How many snap points does an object have?  
 A. One                          C. Depends upon the object  
 B. Two                          D. At least four
- \_\_\_\_\_ 11. How many points do you need to define for the rectangle command?  
 A. One                          B. Two                  C. Four                  D. None
- \_\_\_\_\_ 12. How many AutoCAD objects are in a rectangle?  
 A. None                          B. One                  C. Four                  D. Eight
- \_\_\_\_\_ 13. If you draw a line at 270 degrees, where does it point to?  
 A. Up                            B. Down                  C. Left                  D. Right
- \_\_\_\_\_ 14. How long will a line be when drawn from 1,4 to 4,4?  
 A. Four units                  C. Three Units  
 B. Eight Units                  D. None of the above
- \_\_\_\_\_ 15. How long will line from 1,4 to @4<5 be?  
 A. Three units    B. Four units    C. Five units    D. 6.4031 units
- \_\_\_\_\_ 16. How many points do you need to draw a line using Absolute Coordinates?  
 A. None                  B. One                  C. Two                  D. Four



- \_\_\_\_\_ 17. When selecting objects, what is selected if you press L?
- A. Select lines only
  - B. Select the last object created
  - C. Select objects when you move your mouse to the left
  - D. Select the last object you modified
- \_\_\_\_\_ 18. What happen when you click Pressing Shift?
- A. It allows you to draw a window
  - B. It removes the next selected object from the set
  - C. It automatically deletes the object(s)
  - D. It highlights the selected objects
- \_\_\_\_\_ 19. What does pressing “F” do when selecting objects?
- A. Allows you to draw a fence
  - B. Limits you to five objects
  - C. Finishes the selection set
  - D. Allows to find specific text
- \_\_\_\_\_ 20. How do you select the last set of object(s) you selected?
- A. Type 'L'
  - B. Type 'P'
  - C. Type 'H' to highlight them
  - D. Can't be done
- \_\_\_\_\_ 21. What is the best way of drawing a rectangle?
- A. By using the Line command
  - B. By using the Rectangle command
  - C. By using the Polyline command
  - D. By using the Multiline command
- \_\_\_\_\_ 22. If you move something four units to the right, what would be the 2nd point of displacement?
- A. @4,0
  - B. @4<0
  - C. Neither 1 nor 2
  - D. Both 1 and 2
- \_\_\_\_\_ 23. How would you select objects when using the stretch command?
- A. With a crossing window
  - B. Hold the shift key while selecting
  - C. Pick them one by one
  - D. Type 'S'
- \_\_\_\_\_ 24. At what point does a drawing start?
- A. The first point you select
  - B. 0,0
  - C. A random point in space
  - D.10,10
- \_\_\_\_\_ 25. At what point are objects rotated?
- A. Base point
  - B. Bottom right of the object
  - C. Centre of the object
  - D. Origin

## Skills Assessment

**Directions:** Read the drafting skills carefully. Then write "No Knowledge," if you are not very familiar, "A little," and "A lot," if you are familiar with the skills. Write your answers in your notebook.

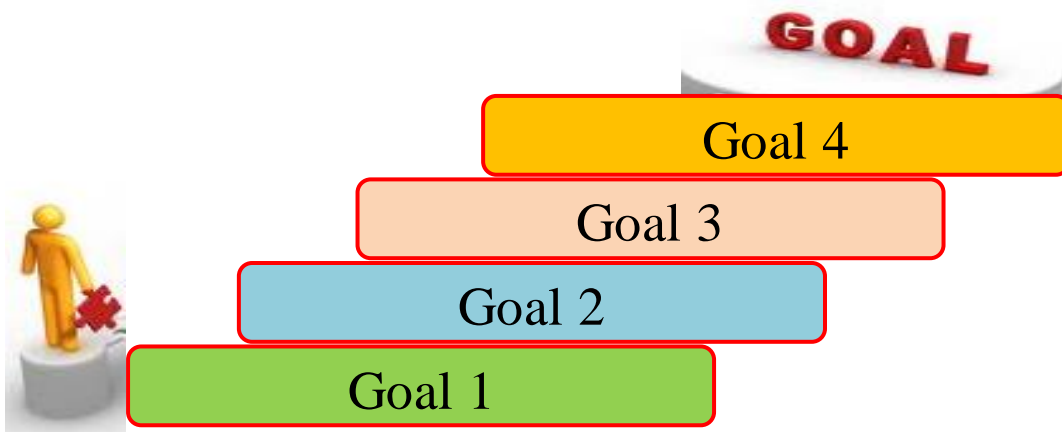
<b>Skills in Drafting Structural Layout and Details using Computer-Aided Design</b>	<b>No Knowledge</b>	<b>A Little</b>	<b>A Lot</b>
I can indicate the locations of wall footings, footings and columns in drafting the floor plan.			
I know how to draw in a larger scale details of wall footings, footings and columns.			
I know how to draft structural floor and roof framing plans based on floor and foundation plans using timber, concrete or steel construction.			
I know how to draft structural floor and roof beams showing sizes, shapes and detailed connections.			



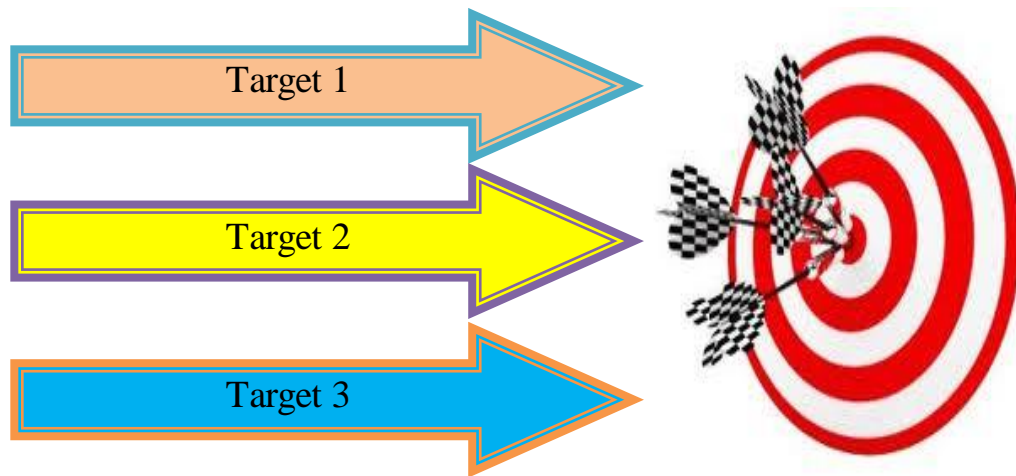
## *Learning Goals and Targets:*

After having understood the introduction and carefully answered the pre- assessment skills test, you may now have ideas of what you will be dealing with in this module. Now prepare to set your goals and targets for this module by completing the activity below. Write your answer in your notebook.

**My goals are:**



**My targets are:**



*After knowing your learning goals and targets, are you ready to move on with this module? This will include topics like: the preparation of drafts in foundation plans and drafts in structural floors and roof framing plans using CAD. Enjoy and have fun while performing the activities prepared for you.*

## **Introduction**

All structures are required to have a foundation. The foundation provides a base to distribute the weight of the structure into the soil. The weight, or load, must be evenly distributed over enough soil to prevent it from compressing the soil. In addition to resist the load from gravity, the foundation must resist floods, winds, and earthquakes. Where flooding is a problem, the foundation system must be designed for the possibility that much of the supporting soil may be washed away. The foundation must also be designed to resist any debris that may be carried by floodwaters.

Symbols are used on floor plans to describe items that are associated with living in the home, such as doors, windows, cabinets, and plumbing fixtures. Other symbols are more closely related to the construction of the home, such as electrical circuits and material sizes and spacing. One of the most important concerns of the drafter is to carefully combine all of the symbols, notes, and dimensions on the floor plan so the plan is uncluttered and easily read.

The design of the roof must be considered before the roof plan is drawn. The designer will consider the basic shape of the roof as the floor plan and elevations are drawn in the preliminary design stage. This does not mean that the designer plans the entire structural system for the roof during the initial stages, but the general shape and type of roofing material to be used will be planned. Often the roof can present a larger visible surface area than the walls.

In addition to aesthetic considerations, the roof can also be used to provide rigidity in a structure when wall areas are filled with glass. To ensure that the roof will meet the designer's criteria, a roof plan is usually drawn by the drafter to provide construction information. In order to draw the roof plan, a drafter should understand types of roof plans, various pitches, common roof shapes, and common roof materials.



## Lesson 1: Drafting Foundation Plans

This lesson is designed to help you recognize the most appropriate design, proper locations in doing such foundation plans (footing, wall footing, and columns) and to familiarized you to the different materials needed in making a house or building foundations.

### Technical Terms Encountered in Drafting Foundation Plans

**Foundation** - is the part of the building below the surface of the ground which is sometimes called the substructure.

**Footing** - is an expansion at the lower end of a wall, pier or column to distribute the load into the ground.

**External Reference** - is a DWG, DWF, DWFx, raster image, DNG, or PDF file incorporated into a drawing for reference only.

**Layer Filters** - are settings that screen out, or filter, layers you do not want to display in the list view pane of the Layer Properties Manager.

**Library Path** – is the path AutoCAD that searches by default to find an xref file, including the current folder and locations set in the Options dialog box.

**Limit Dimensioning** - is a method of dimensioning in which the upper and lower limits are given, instead of the specified dimension and tolerance.

**Limits** - are the size of the virtual drawing area in model space. They are largest and smallest numerical values a feature can have.

**Linear Parameter** - creates a measurement reference between two points.

**Line Conventions** - are standards related to line thickness, type, and purpose.

**Line Spacing** - is the vertical distance from the bottom of one line of text to the bottom of the next line.

**Line type Scale** - is the lengths of dashes and spaces in line types.

**Truss** - is the framework, typically consisting of rafters, posts, and struts, supporting a roof, bridge, or other structure.

**Mono Truss** - is a truss has only one slope as opposed two (half of a common truss).

**Hip Truss** - is a truss erected to sustain the angle-rafters of a hip-roof.

**Beam** - is a long, sturdy piece of squared timber or metal spanning an opening or part of a building, usually to support the roof or floor above.

**Joist** - is a length of timber or steel supporting part of the structure of a building, typically arranged in parallel series to support a floor or ceiling.

**Lateral Bracing** - refers to any piece (wood or metal) on a bridge that help keep the top chord from bending *horizontally*.

**Schedule Bracing** - is a structural member, such as a beam or prop, used to reinforced a framework, such a supporting beam in a building.

## Using CAD to Draw Foundation Plans

The six steps used to draw a foundation plan manually are similar to the steps used when drawing with AutoCAD. Below are the sequence in coming up a Foundation Plan based on standard but you may also innovate some techniques which are familiar with you

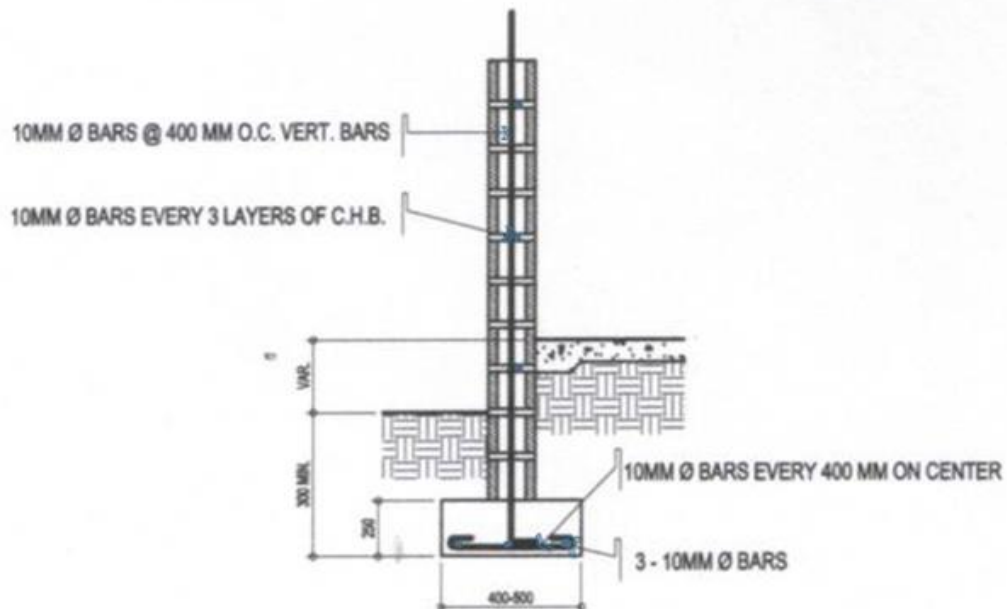
1. Firstly, plan your drawing. This includes planning where the drawing will be created and stored, the needed layers, line types, and what loads will need to be supported. Because you do not have the same kind of accuracy problems when working with CAD as you have with manual drafting, the CAD floor plan may be used as an accurate basis for drawing the foundation plan.
2. Next display the floor plan, and then begin the foundation drawing directly over the floor plan on another layer.
3. Draw the outer side of the stem walls using the OSNAP command.
4. Freeze all floor-related information once the outline of the floor plan has been traced.
5. Use the **OFFSET** command to lay out the thickness of the stem walls and footings. Corners can be adjusted by using the **FILLET** or **TRIM** command.
6. Change the lines representing the footings using the **CHANGE PROPERTIES** command. By following the step-by step instructions for a particular foundation type, the plan can be completed.
7. Use the dimensions used on the floor or framing plan. Show the existing dimensions so that they are displayed on the foundation drawing, or use the **COPY** command to place the needed dimension in the drawing. Use a layer such as **BASE DIM** for placing dimensions required by the floor and foundation plans.
8. Place any dimensions that were not placed on previous plan views as needed on the foundation plan. This will include the locations of openings in the stem wall for any doors into the garage, foundation supports, and braced wall anchor locations. Openings in the exterior envelope that will be above a wood floor system do not need to be located on the foundation plan.

9. Type general notes and store them as a **WBLOCK** to be reused on future foundation plans. Many drafters also store lists of local notes required for a particular type of foundation as a **WBLOCK** and insert them into a drawing. Once inserted into the foundation plan, the notes can be moved to the desired position.
10. Store the foundation plan when completed separately from the floor plan to make plotting easier. Storing the foundation plan with the floor and framing plan will save disk space, and proper use of layering can ease plotting. All foundation walls, bearing footings, and support beams will be in their correct locations.



### Suggested Activity 1

**Directions:** Based on your acquired knowledge and skills in the preparation of computer-aided drawings. Draft the following structural details below, by selecting the appropriate CAD tools/commands.



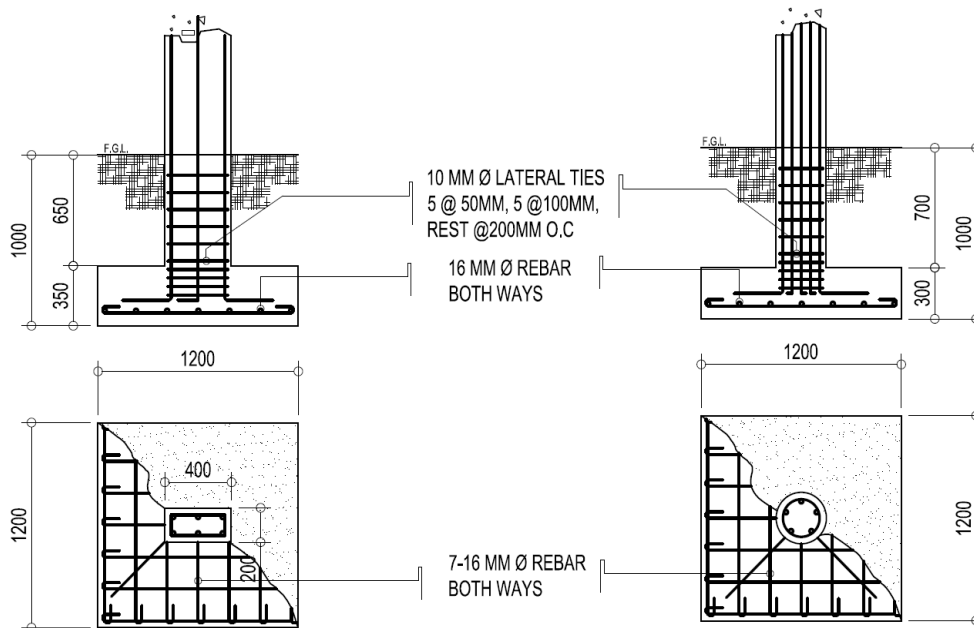
**TYPICAL CHB WALL FOOTING DETAILS**  
 SCALE: 1:30



## Reflect and Understand

### Suggested Activity 2

**Directions:** Using CAD, select the appropriate tools/commands in creating the typical column and footing details. As shown in the drawing below label each details following the sequence for drawing structural plan using AutoCAD.



 TYPICAL COLUMN AND FOOTING DETAILS  
SCALE: 1:30

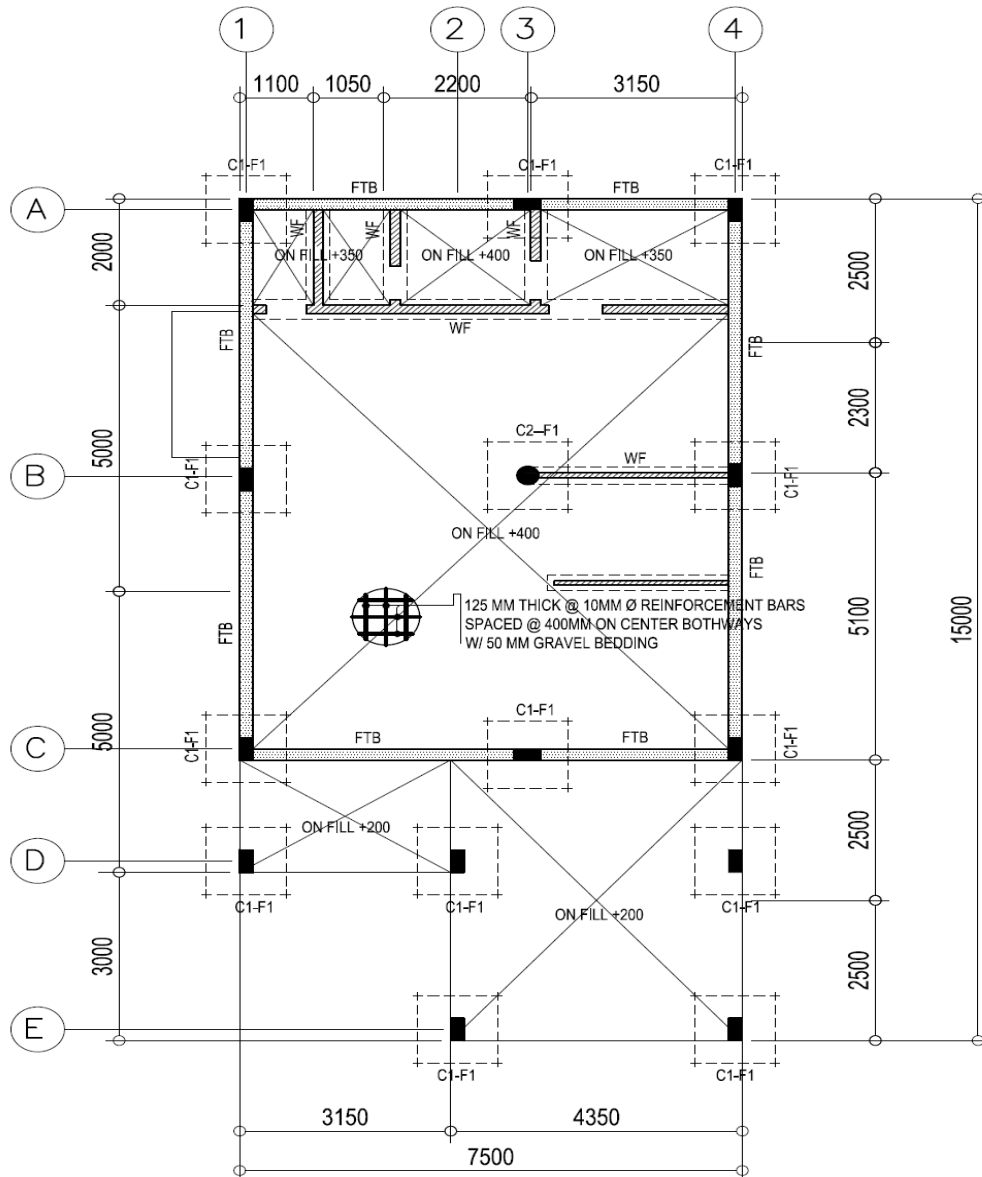
**Note:** Consider the measurements according to the column and footing specified. Layers and colors must conform to the standards.





### Suggested Activity 3

**Directions:** Using CAD, draft and complete the foundation plan below by using the appropriate tools/commands.



**FOUNDATION PLAN**  
 SCALE: 1:100



## SUMMATIVE ASSESSMENT: Lesson 1

**Directions.** Using CAD, perform the following problems below using the appropriate tools/commands.

1. Draw a foundation plan from a sample floor plan provided by your teacher. Indicate complete dimensions, notations, and the required standard specifications of a foundation plan.
2. Draw separate plans for wall footing, column, and footing details you present in your foundation plan.
3. Use appropriate scale dimensions suitable to your drawings.
4. Refer to your floor plan to determine the dimensions and position of load-bearing walls. Review your previous exercises and lecture notes for your guidance to complete information.
5. After finishing your drawing, submit a printed output of your to your instructor for evaluation.



## Lesson 2: Drafting Structural Floor and Roof Framing Plans

**Floor Plan** - is the top cross-sectional view of the floor area of a house.

**Floor Framing Plan** - the plan that is drawn of the roof area used to show the shape of the roof.

**Roof Framing Plan** – is the plan that is drawn of the roof area used to show the shape of the roof.

**Green roof** – is a roof system consisting of some type of vegetation growing in soil, planted over a waterproof membrane.

**Cool roof** – is a roof that features highly reflective materials. It can be something as simple as finishing the roof by painting it with a coating of light-colored water sealant.

**Ridge** – is the horizontal intersection between two or more roof planes and represents the highest point of a roof.

## **Drafting Structural Floor Plans**

The foundation plan shows not only the concrete footings and walls but also the members that are used to form the floor system. Two common types of floor systems are used in residential construction: floor systems built at grade level and floor systems with a crawl space or basement below the floor system. Both on-grade foundations and crawl space floor systems have their own components and information that must be put on a foundation plan.

The final CAD drawing is printed, plotted, or published within a selected sheet size at a specific scale. Most often, sheet size and drawing scale are known standards, set according to drawing and office practices. CAD offers significant flexibility when laying out a floor plan according to sheet and scale requirements. Commands and options are available that allow you to easily adjust the drawing to accommodate a specific sheet size and drawing scale.

Traditional manual drafting setup tasks such as selecting drawing orientation and identifying the working and drawing areas are not as critical when using CAD. A CAD drawing can be rotated as needed to properly orient the view on the sheet. If necessary, a north arrow symbol is inserted and rotated to the exact north direction.

As with manual drafting, the working area of a CAD drawing is relative to the sheet size. However, CAD allows you to select a different sheet size if the plot does not fit within the working area.

Alternatively, if appropriate, you can easily modify the drawing scale to fit the plot on the original sheet. Care in centering the drawing on the sheet is not as important with CAD, because the drawing can be moved at any time. Most CAD applications use a virtual drawing area that is infinite in size. This

allows you to draw a floor plan at actual size, or full scale, and then scale the drawing to fit a specific sheet for plotting.

When using this system, you can focus on the floor plan layout, without having to concentrate on scaling objects. CAD has transformed the traditional process of setting up and laying out a drawing, by offering significant flexibility. Still, effective layout planning and preparation is critical.

Determine the proper drawing orientation, sheet size, working area, scale, and drawing area before you begin drawing to increase productivity and limit costly and time-consuming mistakes.

### **Sequence for Drawing Structural Floor Plan in AutoCAD**

Check off the features used with this floor plan drawing checklist and drawing sequence in AutoCAD. Note that each of these items are not required but rather guide in ensuring all the standard features of a floor plan is observable.

- Exterior walls.
- Interior walls.
- Furring over concrete walls (if used).
- Masonry veneer (if used).
- Doors: Proper use of exterior doors; correct door
- Swing direction; clearance from walls, cabinets, and traffic.
- Door sizes or symbols for door schedule key.
- Windows: Proper symbols; clearance from walls, cabinets, and traffic.
- Window sizes or symbols for window schedule key.
- Skylights located and specified.
- Base cabinets.

- Upper cabinets.
- Closets and storage: Closets and wardrobes labelled and with shelf and pole or additional shelves and drawers, storage closet, linen with shelves, pantry with shelves, special storage features noted.
- Appliances: Cooktop/range, hood with vent or vent, oven, double oven, microwave, refrigerator, lazy Susan, washer and dryer with vent, trash compactor.
- Utilities: Furnace, air conditioner, water heater with platform and straps.

## Floor Framing Plans

Framing plans for each floor are drawn using the floor plan as a base. The floor plan layers that contain the walls, windows, doors, cabinets, and plumbing fixtures should be displayed, with all other floor information frozen. With the proper material displayed, complete the framing plan in the same order that was used with manual methods.

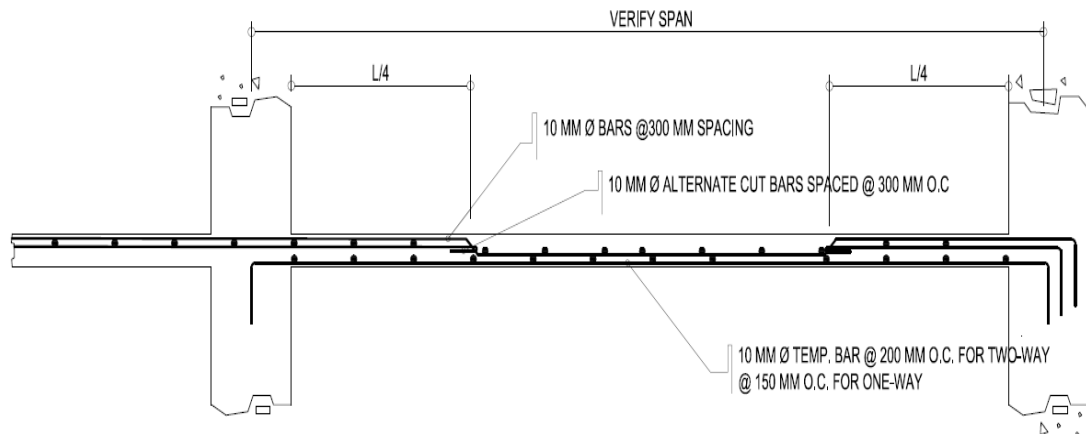
1. Layers can be added to contain materials for the framing plan. Each new layer is given the prefix of **UPPR FRAM**, **MAIN FRAM**, or **LOWR FRAM** to make it easy to identify required layers for plotting.
2. Sub-names for **ANNO**, **DIMN**, **TRUSS**, **LATR**, and **BEAM** layers must also be added.
3. Complete the drawing by adding major framing members first, and then working toward smaller members. Place beams that will be required to support joists or trusses, and then place a marker to represent each joist type. The joist markers can be stored as a block, and then inserted and stretched to the needed size.
4. Lateral bracing information can be added to the drawing using blocks. Schedules for one-level and multilevel construction bracing can be created, and the appropriate schedule can be inserted into the drawing.

5. Symbols to represent each type of bracing can also be created as blocks and inserted into the required position throughout the drawing. Because the upper level materials are different from the lower braces, lateral symbols should be placed on layers that are level specific. This allows the lower floor lateral information to be displayed on the foundation plan without repeating the schedule. This requires the creation of layers such as **UPPR FRAM LAT SYMB**, **MAIN FRAM LAT SYMB**, or **LOWR FRAM LAT SYMB**.
6. Symbol information should be placed on a different layer than the lateral schedule. With the framing and lateral information represented, place dimensions to represent all walls, openings, and framing materials.
7. Dimension layers should be divided by level; some dimensions such as the overall and major jogs will be the same on all levels. This information can be placed on a layer titled **BASE DIMS**.
8. Wall-to-wall, and wall-to-opening dimensions should be placed on a layer that is specific to each level of the structure such as **MAIN FRAME EXT DIMS**.
9. Annotation can now be placed to locate all framing materials.
10. Notes should also be placed on layers that are level-specific. Local notes should be divided by layers to represent title block text and text that is level-specific.



## Suggested Activity 1

**Directions:** Below is a sample illustration of a typical floor slab detail. From your finished foundation plan, draft a floor slab detail, use the given slab schedule using the appropriate CAD tools/commands.



TYPICAL FLOOR SLAB DETAILS  
SCALE: 1:20

SLAB SCHEDULE					
MARK	THK	REINFORCEMENT			REMARKS
		BENDED TOP BARS	ALTERNATE CUT BOTTOM BARS	BOTTOM CONTINUOUS BARS	
S1	0.125	10MM Ø @ 300 SPACING	10MM Ø @ 300 SPACING	10MM Ø @ 200 SPACING	ONE-WAY
S2	0.125	10MM Ø @ 300 SPACING	10MM Ø @ 300 SPACING	10MM Ø @ 150 SPACING	TWO-WAY



## Drafting Roof Framing Plans

The roof framing plan can be created using the roof or floor plan as a base drawing. Upper and lower framing plans are created using the floor plans for the starting points. Two major methods are available to create these drawings. Information can be added to the base drawings and controlled by layers, or information can be added to a separate drawing and referenced to the original. If the roof plan is to be controlled by layers, it is important to remember that the base floor plan is plotted at a scale of  $1/4" = 1'-0"$  and the roof framing plan is usually plotted at a much smaller scale. Because you are

drawing in model space, you are working at full size, but you will need to adjust the line scale and the text scale factors for the appropriate scale on the roof framing plan.

One alternative in creating a roof plan is to place the needed roofing materials using the floor plan as a base. This method can be especially helpful on a complicated stick-frame roof. If the floor plan is used as a base for a roof framing plan, show all of the walls printed in matted lines using grayscale, and show all roofing materials using black lines.

### **Layer Method of Drafting Roof Framing Plans**

1. Once the layout method is selected, add layers to contain materials for the roof plan. For this example, the drawing will be controlled using layers within the base drawing.
2. Give each new layer the prefix of **ROOF FRAM** to make it easy to identify required layers for plotting.
3. Add sub-names for **ANNO**, **DIMS**, **TRUSS**, and **BEAM**. Complete the drawing by working from the roof down to the foundation, and by adding major framing members first, and then working toward smaller members.
4. Draw standard trusses first in the center section of the roof, and then the hip trusses are represented.
5. Finally, draw trusses are drawn at each edge. With all materials represented, dimensions should be placed to locate material limitations, beam locations, and overhang sizes.
6. Provide notation to specify each material and framing member size that has been represented.

### **Drafting Roof Framing Plans using CAD**

A roof framing plan can be drawn using a CAD program following procedures similar to those used for a manual drawing. The drawing can be created in the file containing the floor plan.

1. Start by freezing all floor plan material except the exterior walls, furniture, and skylights.
2. Create layers to contain the roof plan using the **ROOF** prefix. Layer names such as **ROOF WALL**, **ROOF LINE**, **ROOF OUTL**, **ROOF ANNO**, **ROOF DIMN**, or layer names based on the **NCS** should be



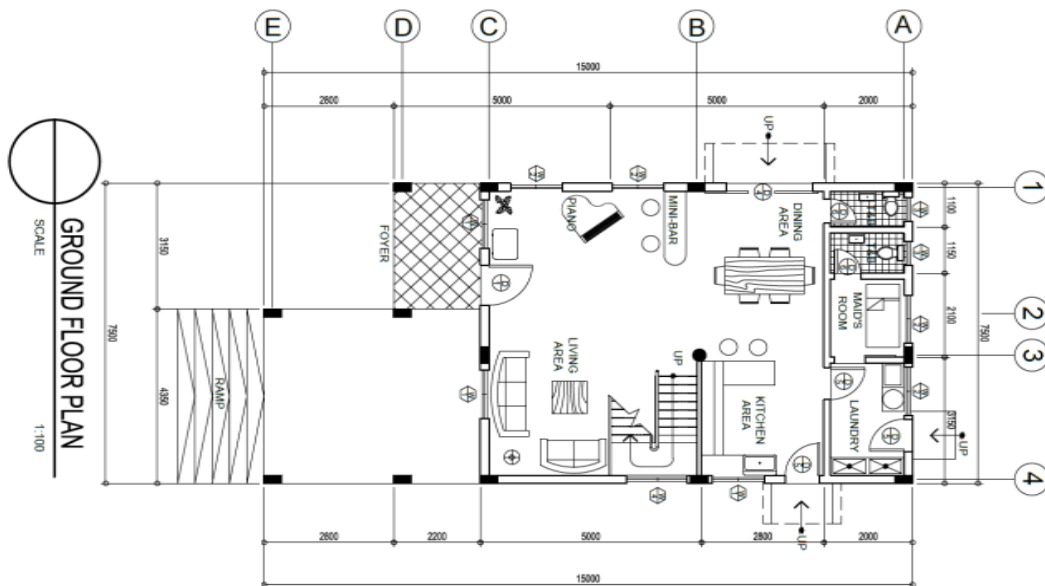
used to keep the roof information separate from the floor plan information and to ease plotting.

3. Draw the outline of the residence on the **ROOF WALL** layer by tracing the outline of the walls on the floor plan, and then freeze the walls of the floor plan.
4. Complete the plan using the appropriate step-by-step process for the required roof type. Using the **OFFSET** command, the lines that represent the walls can be placed to represent the roof outline.
5. Use the **PROPERTIES** command to assign the lines to the appropriate layer, and to assign the required line weight and line type.
6. When the roof plan is completed, a copy can be saved as a **BLOCK** with a title **ROOF**.



### Suggested Activity 2

**Directions:** Select the appropriate CAD tools/commands in drafting the structural roof framing plan of the given floor plan below. Layout your proposal and have it approved by your teacher before you start drawing.

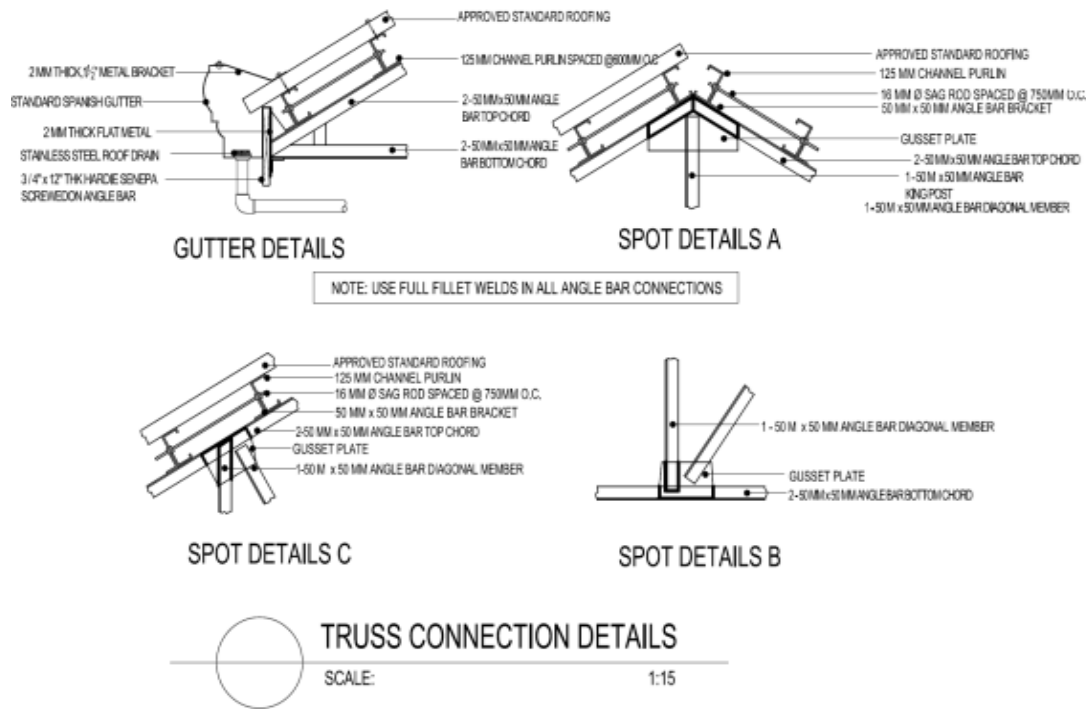




## Reflect and Understand

### Suggested Activity 3

**Directions:** Using CAD, draft the given truss connection details below.

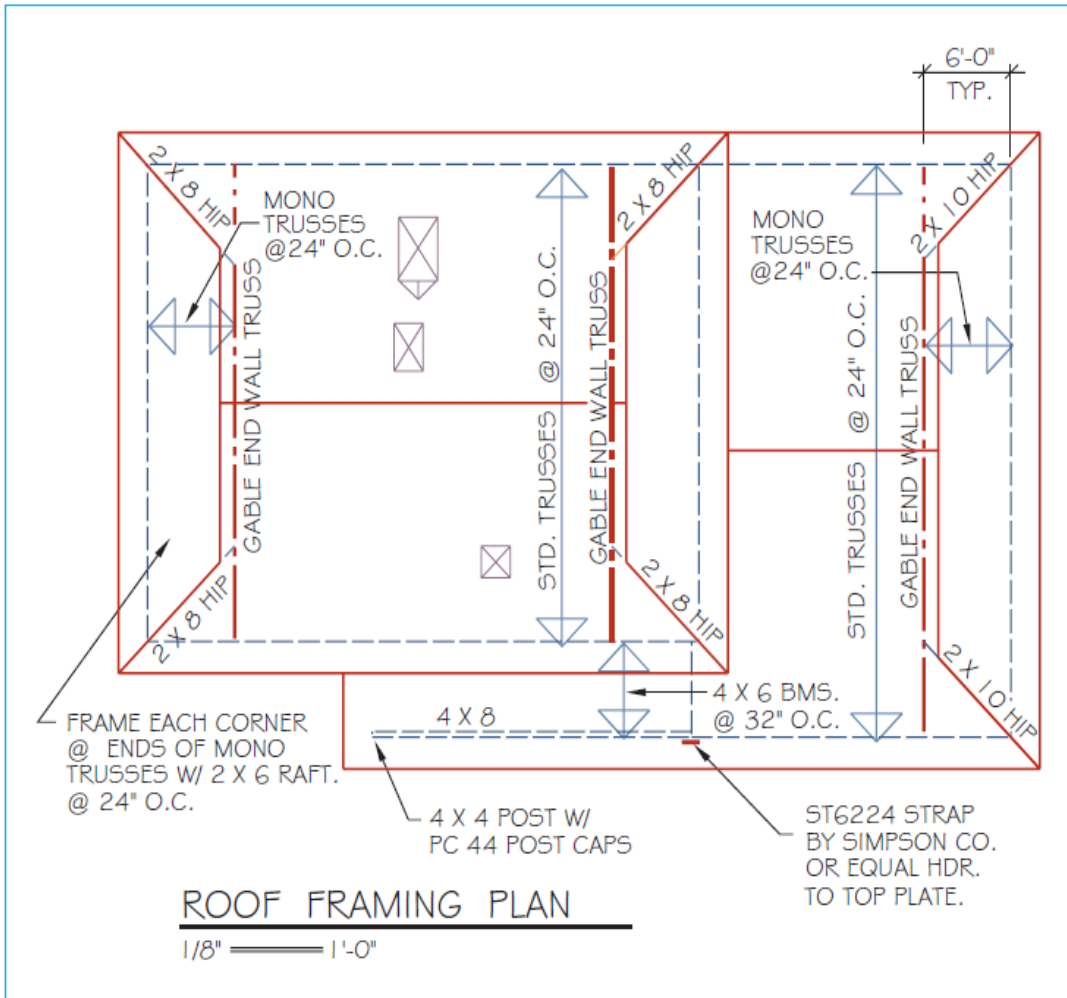


## Transfer

### Suggested Activity 4

**Directions:** Based on the given sample roof framing plan below, perform the following:

1. Draft the structural components of the given roof framing plan.
2. Establish line scales and line weights fit for plotting at 1/8" = 1'-0".
3. Use an architectural font for all text.

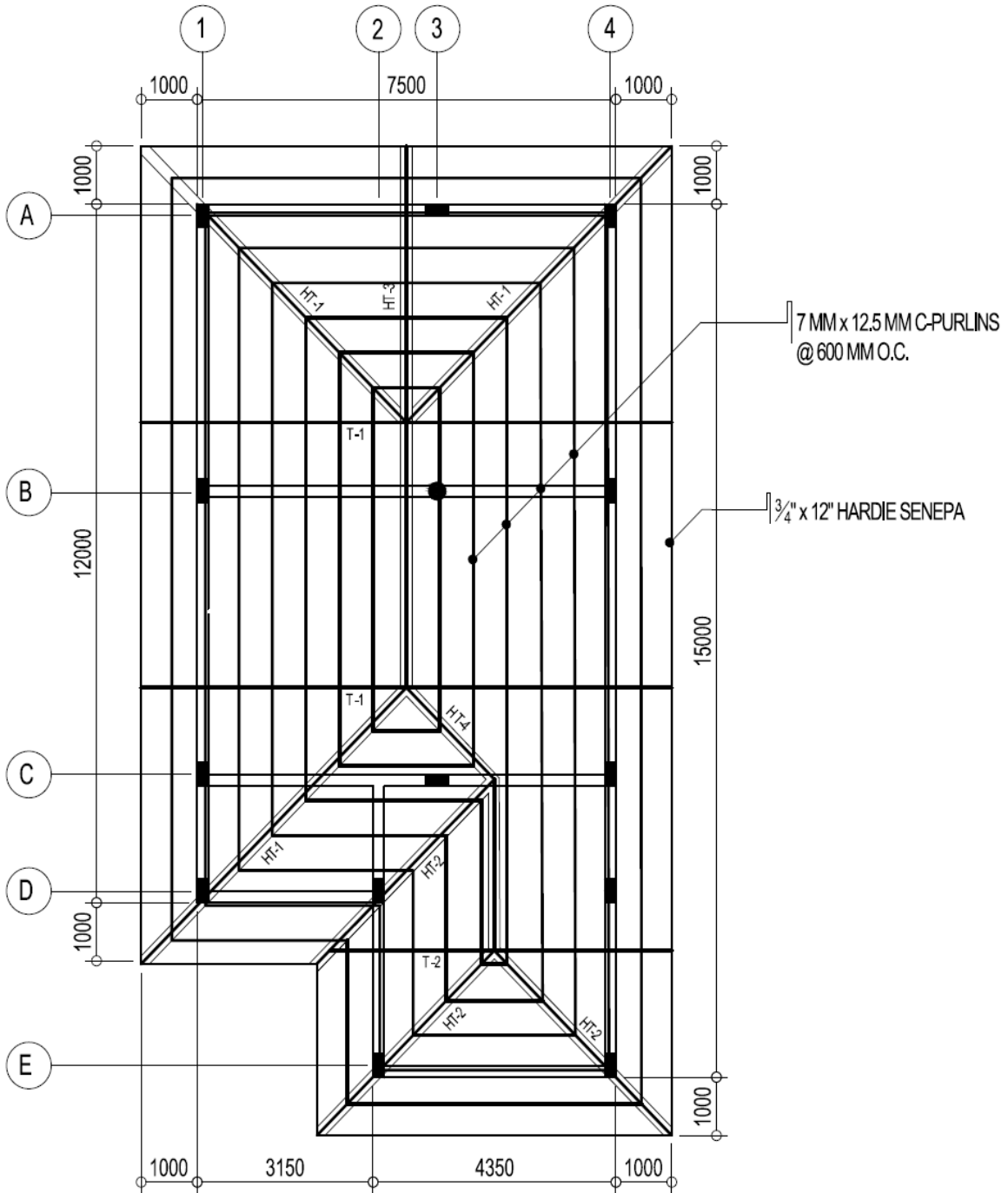


**Sample Roof Framing Plan**



**Summative Assessment: Lesson 2**

**Directions:** Using CAD, select the appropriate tools/commands in drafting the structural roof framing plan and the detailed connections appropriate to the given roof framing plan below.



# ROOF FRAMING PLAN

SCALE: 1:100



## Post-Assessment:

Answer the post assessment test below to determine whether there is significant increase in your understanding of Drafting Structural Layout and Details using Computer-Aided Design (CAD).

**Directions:** Choose the letter of the correct answer. Write your answer in the space provided for each number.

- \_\_\_\_\_ 1. Which circle is drawn with a bow compass?  
A. 360° circle      C. irregular curve  
B. circle template      D. flexible curve
- \_\_\_\_\_ 2. Where do you set your compass to draw a 2 1/2 diameter-circle?  
A. 1.25"      B. 1.50"      C. 2.00"      D. 2.50"
- \_\_\_\_\_ 3. What is the purpose of an erasing shield?  
A. to prevent tearing the drawing media  
B. to avoid erasing nearby lines accidentally  
C. to protect areas that you do not want to erase  
D. all of the above are correct answers to the question
- \_\_\_\_\_ 4. Which of the following is not an advantage of sketching?  
A. refinement of ideas      C. to communicate ideas  
B. to practice drawing      D. to capture ideas
- \_\_\_\_\_ 5. An object is usually shown in more than one view in \_\_\_\_\_ drawing.  
A. a rough sketch      B. a multi-view      C. an isometric      D. an oblique
- \_\_\_\_\_ 6. Concurrent engineering design involves ideation, implementation, and \_\_\_\_\_.  
A. aesthetics      B. creativity      C. life cycle      D. refinement.
- \_\_\_\_\_ 7. What are the three principal views of orthographic drawings?  
A. Isometric, Perspective, Oblique      C. CAD, ISO, ANSI  
B. Top, Front, Side (end)      D. Top, Bottom, Side
- \_\_\_\_\_ 8. When using the TRIM command, which do you select first?  
C. The cutting edges      C. The object to be trimmed  
D. Everything      D. Nothing
- \_\_\_\_\_ 10. How many snap points does an object have?  
C. One      C. Depends upon the object  
D. Two      D. At least four
- \_\_\_\_\_ 11. How many points do you need to define for the rectangle command?  
A. One      B. Two      C. Four      D. None

- \_\_\_\_\_ 12. How many AutoCAD objects are in a rectangle?  
 A. None                      B. One                      C. Four                      D. Eight
- \_\_\_\_\_ 13. If you draw a line at 270 degrees, where does it point to?  
 A. Up                      B. Down                      C. Left                      D. Right
- \_\_\_\_\_ 14. How long will a line be when drawn from 1,4 to 4,4?  
 A. Four units                      C. Three Units  
 B. Eight Units                      D. None of the above
- \_\_\_\_\_ 15. How long will line from 1,4 to @4<5 be?  
 A. Three units                      B. Four units                      C. Five units                      D. 6.4031 units
- \_\_\_\_\_ 16. How many points do you need to draw a line using Absolute Coordinates?  
 A. None                      B. One                      C. Two                      D. Four
- \_\_\_\_\_ 17. When selecting objects, what is selected if you press L?  
 A. Select lines only  
 B. Select the last object created  
 C. Select objects when you move your mouse to the left  
 D. Select the last object you modified
- \_\_\_\_\_ 18. What happen when you click Pressing Shift?  
 A. It allows you to draw a window  
 B. It removes the next selected object from the set  
 C. It automatically deletes the object(s)  
 D. It highlights the selected objects
- \_\_\_\_\_ 19. What does pressing "F" do when selecting objects?  
 A. Allows you to draw a fence                      C. Finishes the selection set  
 B. Limits you to five objects                      D. Allows to find specific text
- \_\_\_\_\_ 20. How do you select the last set of object(s) you selected?  
 A. Type 'L'  
 B. Type 'P'  
 C. Type 'H' to highlight them  
 D. Can't be done
- \_\_\_\_\_ 21. What is the best way of drawing a rectangle?  
 A. By using the Line command  
 B. By using the Rectangle command  
 C. By using the Polyline command  
 D. By using the Multiline command
- \_\_\_\_\_ 22. If you move something four units to the right, what would be the 2nd point of displacement?  
 A. @4,0                      B. @4<0                      C. Neither 1 nor 2                      D. Both 1 and 2

- \_\_\_\_\_ 23. How would you select objects when using the stretch command?
- A. With a crossing window
  - B. Hold the shift key while selecting
  - C. Pick them one by one
  - D. Type 'S'
- \_\_\_\_\_ 24. At what point does a drawing start?
- A. The first point you select
  - B. 0,0
  - C. A random point in space
  - D.10,10
- \_\_\_\_\_ 25. At what point are objects rotated?
- A. Base point
  - B. Bottom right of the object
  - C. Centre of the object
  - D. Origin

**Appendix A.**  
**Assessment Tool: Performance Rubrics**

Name: \_\_\_\_\_ Date: \_\_\_\_\_

Year & Section: \_\_\_\_\_

Criteria	5 points	3 points	1 point
Proficiency	Perform the task with competence and exceptional performance	Perform the task with competence and with standard performance	Perform the task with competence but below standard performance
Method	Followed the given procedure from start to finish, observed correct usage of command tools	Followed the given procedure, noted once incorrect usage of command tools	Followed the given procedure, noted more than once incorrect usage of command tools.
Accuracy	Perform the task with no error	Perform the task with at least 1-2 errors	Perform the task with more than 2 errors
Time Management	Finish the work on/before the given time	Finish the work after the given time	Unable to finish the work

**Rating Scale:**

Points Earned	Numerical Rating	Descriptive Rating
17 – 20	91 – 100	Outstanding
13 – 16	86 – 90	Very Good
9 – 12	81 – 85	Good
5 – 8	76 – 80	Fair
1 - 4	71 – 75	Needs Improvement

Teacher's Comments:

Teacher's Signature: \_\_\_\_\_

Date: \_\_\_\_\_

**Note:** This assessment tool can also be used in the evaluation of the following suggested activities:

- A. Suggested Activity 2 (Transfer), page 100
- B. Summative Assessment Lesson 1, page 101



- C. Suggested Activity 1 (Process), page 104
- D. Suggested Activity 1 (Process), page 107
- E. Suggested Activity 2 (Transfer), page 108
- F. Suggested Activity 1 (Process), page 110
- G. Summative Assessment: Lesson 2, page 112

**Appendix B**  
**Assessment Tool: Performance Rubrics**

Name: \_\_\_\_\_ Date: \_\_\_\_\_

Year & Section: \_\_\_\_\_

<b>Criteria</b>	<b>5 points</b>	<b>3 points</b>	<b>1 point</b>
Line Technique	Application of (all) various lines was used according to standards	At least 3-5 lines were used not according to standards	More than 5 lines were used not according to standards
Accuracy	All measurements and notations needed were accurately done	At least 3-5 measurements and notations needed were inaccurately done	More than 5 measurements and notations needed were inaccurately done
Layout/Proportion	All drawings were drawn proportionately and was layout properly	Layout was good but 1-2 drawing were out of proportion	More than 2 drawings were drawn out of proportion and improperly layout
Time Management	Finish the task ahead of the given time/date	Finish the task on the given time/date	Unable to finish the task on the given time/date

**RATING SCALE:**

<b>Points Earned</b>	<b>Numerical Rating</b>	<b>Descriptive Rating</b>
17 - 20	91-100	Outstanding
13 - 16	86 - 90	Very Good
9 - 12	81 - 85	Good
5 - 8	76 - 80	Fair
1 - 4	71 - 75	Needs Improvement

Content Standard	Performance Standard
The learner demonstrates understanding of concepts and underlying principles in drafting mechanical layout and details using CAD.	The learner independently drafts mechanical layout and details using CAD following the job requirements.

**Quarter IV**

**Time Allotment: 24 hrs.**

## **MODULE 7**

### **DRAFTING MECHANICAL LAYOUT AND DETAILS USING CAD**

#### **Introduction**

The objective of an architectural design is to create an effective environmental system. Structural thinking should be introduced at the early stages in the design process. These will provide buildings and residential dwellings with mechanical and other environmental subsystems to support horizontal and vertical movement of men and materials. It also provides functional heating, ventilating, air conditioning (HVAC) power, water and waste disposal. In addition, acoustical and lighting needs are often influenced by structural design.

The requirements for provisions of heating, ventilation, air conditioning, power, water and waste services can be visualized in the form of a tree diagram. These services usually originate at a centralized location and trace their way horizontally and vertically throughout the structure to serve the activity spaces.

The designer should be well versed with heating, ventilating, air conditioning systems, as well as vertical transportation which include escalators and elevators.

This module familiarizes you on how to locate the machines, raceways, wirings, motors, generations and the like in its proper places.



## Objectives:

Upon completion of this module, you are expected to draft:

- ❖ heating, ventilating, and air conditioning systems according to Mechanical Code;
- ❖ mechanical details of conveyor system; and
- ❖ fire protection system using CAD.

\*\*\*\*\*



At this point, you are heading towards meaningful activities and learning encounters. Complete the succeeding exercises and answer the suggested worksheets to experience lifelong, practical learning that awaits at the end of this module.

*ENJOY YOUR JOURNEY!*

## Pre – Assessment

You will be challenged to recall on your prior knowledge and previous experiences about drafting mechanical layout details. This phase will guide you in assessing yourself by answering questions that relate with the basics of drafting mechanical lay-out and details.

**Multiple Choice:** Choose the letter of the correct answer. Write your answer in the space provided to each number.

- \_\_\_\_\_ 1. It is a water supply pipe that extends vertically to one story or more to carry water to fixtures.  
A. riser                      B. soil pipe                      C. vent pipe                      D. waste pipe
- \_\_\_\_\_ 2. It is a vertical pipe that extends to one or more floors and carries discharge of water closets and other similar fixtures.

\_\_\_\_\_ A. sewer                      B. soil stack                      C. vent stack                      D. waste  
stack

\_\_\_\_\_ 3. It is a sewer used for carrying groundwater, rainwater, surface water, or other non-polluting waste.  
A. storm sewer    B. vent stack    C. sanitary sewer    D. waste stack

\_\_\_\_\_ 4. A fitting with a removable plug that is placed in plumbing drainage pipe lines to allow access for cleaning out the pipe.  
A. cleanout    B. drain                      C. stack                      D. trap

\_\_\_\_\_ 5. A U-shaped pipe below plumbing fixtures that holds water to prevent odor and sewer gas from entering the fixture.  
A. drain                      B. fitting                      C. stack                      D. trap

\_\_\_\_\_ 6. A pipe that carries the discharge of water closets or other similar fixtures.  
A. sewer                      B. soil pipe                      C. vent pipe                      D. waste pipe

\_\_\_\_\_ 7. The portion of a pipe or fitting continuing in a straight line in the direction of flow in which it is connected.  
A. cleanout    B. drain                      C. fitting                      D. run

\_\_\_\_\_ 8. A vertical pipe that runs to one or more floors and carries the discharge of fixtures other than water closets and similar fixtures.  
A. sewer                      B. soil stack                      C. vent stack                      D. waste

stack

\_\_\_\_\_ 9. A fitting that is used to control the flow of fluid or gas.  
A. drain                      B. lavatory                      C. valve                      D. water

closet

\_\_\_\_\_ 10. The pipe installed to ventilate the building drainage system and to prevent drawing liquid out of traps and stopping back pressure.  
A. fitting                      B. riser                      C. soil pipe                      D. vent pipe

\_\_\_\_\_ 11. The inward flow of air through a porous wall or crack.  
A. duct loss    B. infiltration                      C. latent load                      D. R-factor

\_\_\_\_\_ 12. The indoor temperature less the outdoor temperature.  
A. internal heat gain                      C. outdoor temperature  
B. mechanical ventilation                      D. temperature difference

\_\_\_\_\_ 13. Amount of heat loss through mechanical ventilators such as range hood fans or bathroom exhaust fans.  
A. heat transfer multiplier                      C. outdoor temperature  
B. mechanical ventilation                      D. temperature difference

\_\_\_\_\_ 14. Heat loss through ductwork in an unheated space, which has an effect on total heat loss.

- A. duct loss
- B. indoor temperature

- C. internal heat gain
- D. outdoor temperature

- \_\_\_\_\_ 15. A unit of measure determined by the amount of heat required to raise 1 pound of water 1 degree Fahrenheit.
- A. British Thermal Unit
  - B. Degrees Centigrade
  - C. Degrees Fahrenheit
  - D. Degrees Kelvin

### Skills Assessment

**Directions:** Put a check (√) mark that corresponds to your level of competency in performing the skills that relate with drafting mechanical layout and details. Feel free to answer the assessment questionnaire on your notebook.

**Not much** – means that you are not yet competent with the skills stated.

**A little** – means you have skills but not adequate to perform the task.

**A lot** – means that you already possess the desired skills.

Skills in Drafting Mechanical Layout and Details	A lot	A little	Not much
I can draft heating, ventilating and air-conditioning systems according to mechanical codes			
I can indicate signs and symbols according to mechanical layout and detail requirements			
I know how to draw elevator, escalators, dumbwaiter and moving ramp systems according to mechanical codes			
I can draw details of mechanical conveyor system according to mechanical layout and detail requirements			
I know how to draw fire sprinkler system according to fire code			
I know how to draw signs and symbols of fire			

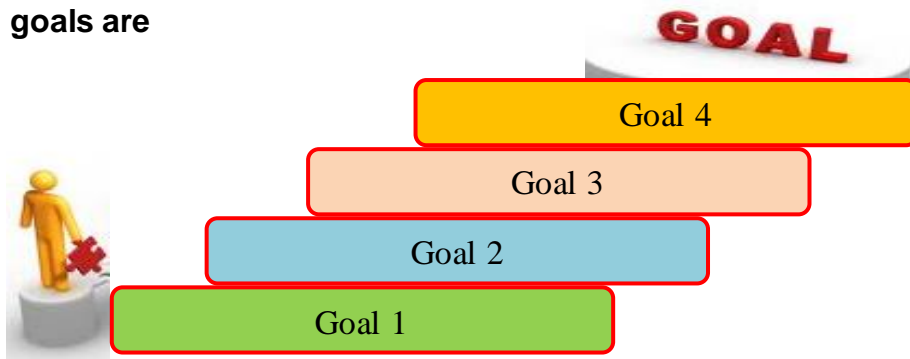
protection system according to fire protection requirement



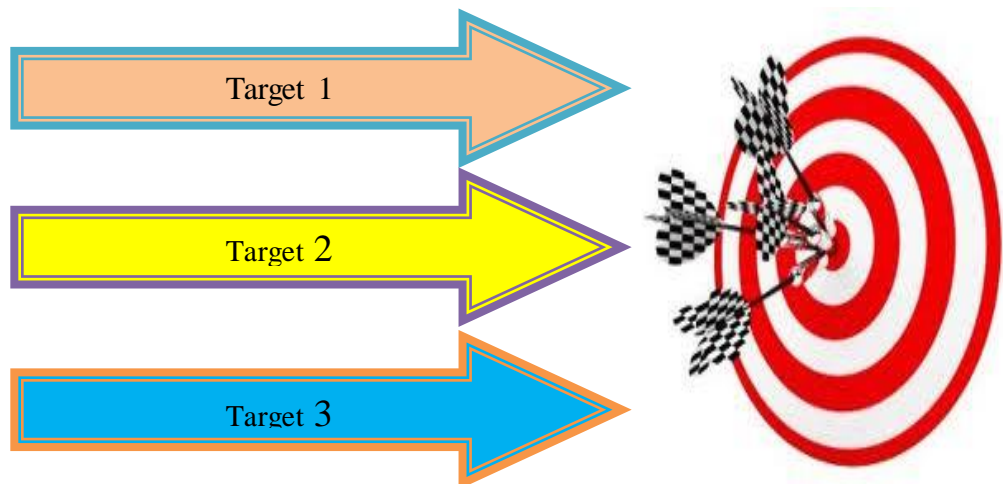
## Learning Goals and Targets

After reading the introduction and carefully answering the pre-assessment skills test, you now have an idea of what you will be dealing in this module. Now, prepare to set your goals and targets for this module by completing the activity below. Write your answer in your notebook.

My goals are



My targets are

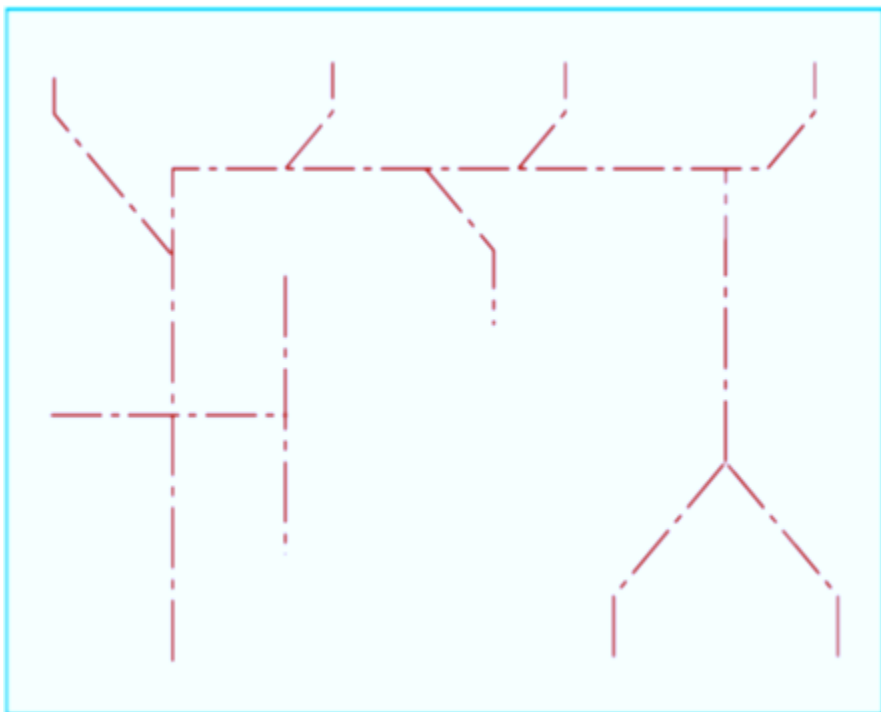




## Lesson 1: Drafting Heating, Ventilating and Air-Conditioning (HVAC) Systems using CAD

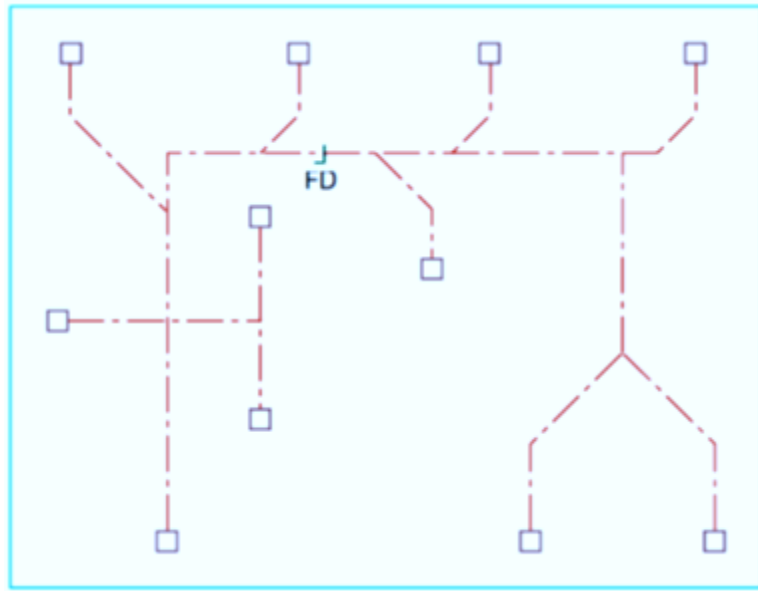
In some HVAC AutoCAD software, you place the duct fittings and then the software automatically sizes ducts in accordance with common mechanical equipment manufacturer specifications. The floor plan is commonly used as a background layer, and the HVAC plan is a separate layer. The following is a sample of the steps that can be used by a draftsman to design and draw an HVAC plan:

1. For the preliminary layout, draw the duct center lines, as shown in below:



## Preliminary Layout of Duct Center Lines

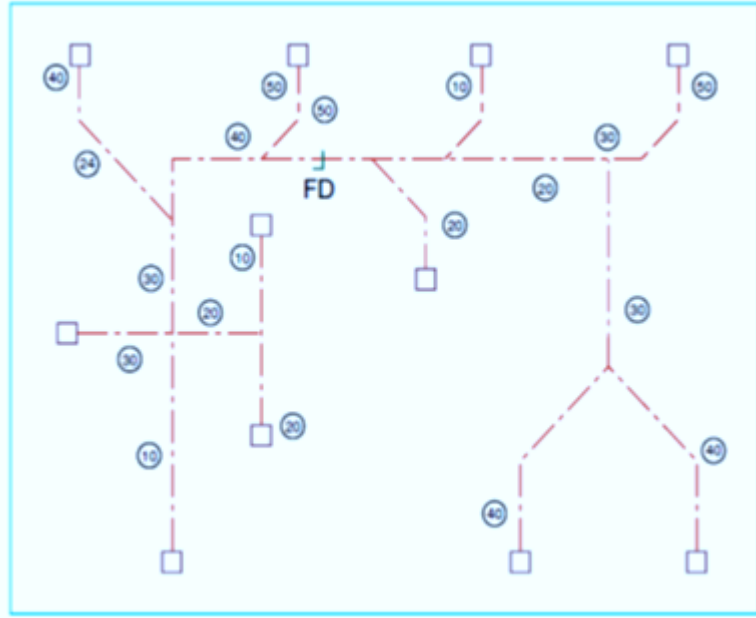
2. Select supply and return registers from a symbol library, and add the symbol to the end of the center lines where appropriate, as shown below.



**Automatic Placing Supply and Return Registers**

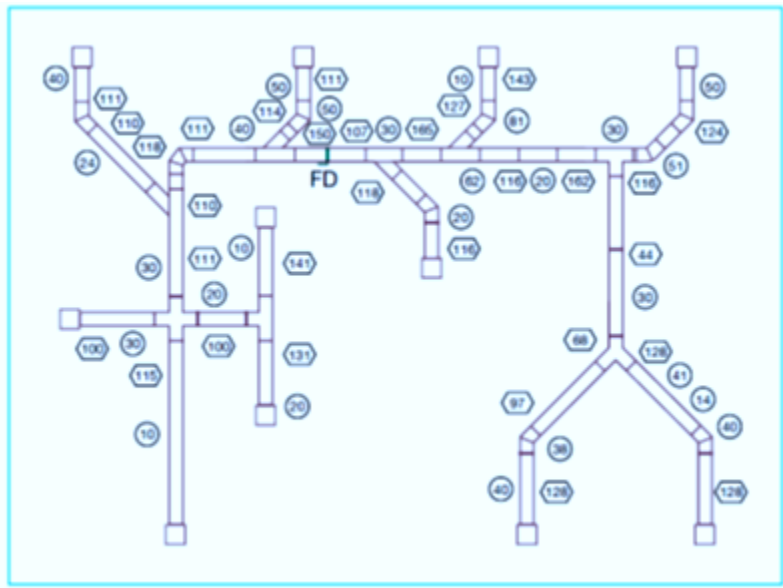
3. Identify the lengths of individual duct runs, and tag each run. Locate fittings by the type of intersection, as shown below.





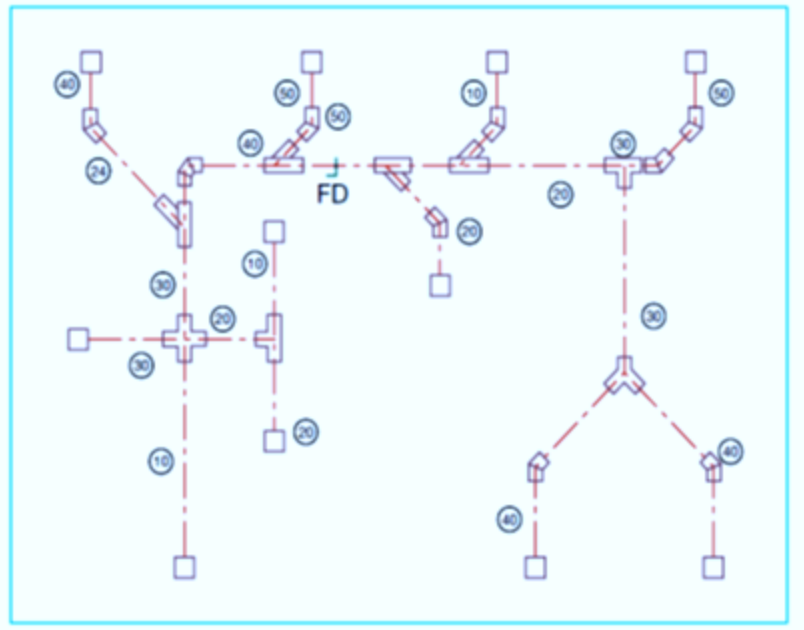
**Fittings located and identified**

While all of this drawing information is added to the layout, gather design information into a file for duct sizing based on specific mechanical manufacturer specifications that you select.



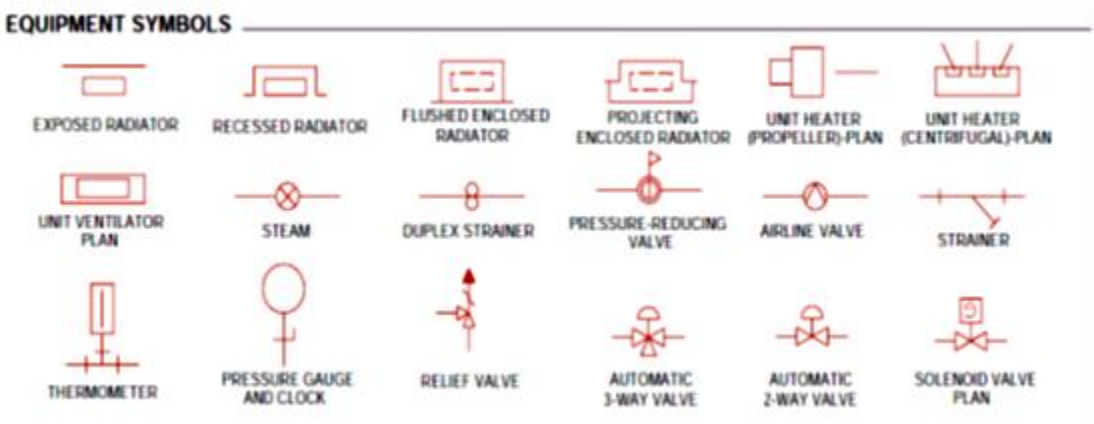
**Complete HVAC AutoCAD Layout**

4. After the fitting location and sizes are determined, transform each fitting into accurate double-line symbols.



**HVAC AutoCAD Layout with Fitting Symbols**

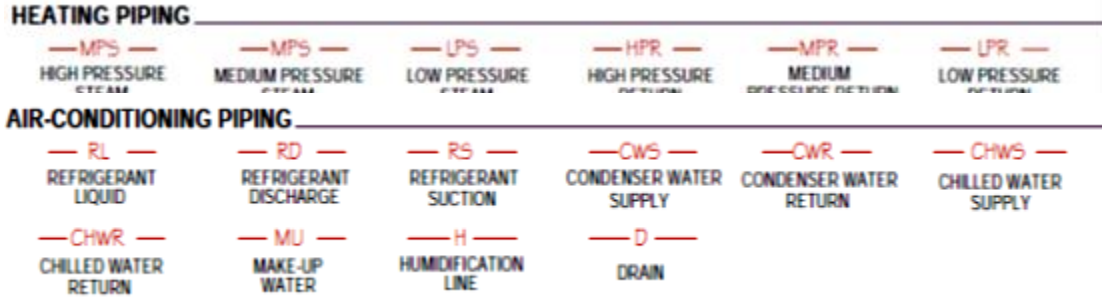
**AutoCAD Mechanical Symbols Library**



**Figure 1. Common HVAC Symbols**

**Simple Heat Loss and Gain Calculations**

Cooling capacity for a room is defined as the heat load in a room that have to be removed in order to achieve a certain room temperature and humidity. The typical design is set to 24°C temperature and 55% RH (*Relative*



Humidity).

Study shows that this combination of temperature and RH is the most conducive for the human body. The unit used to measure heat load is BTU/hr (*British Thermal Unit*). 1 BTU/hr is the heat energy needed to increase 1 pound of water by 1°F.

When choosing an air conditioner, usually a 1 HP (*Horse Power*) equipment is able to remove 9,000 BTU/hr of heat. With better technology, some machines are able to remove 10,000 BTU/hr of heat with the same capacity. The higher the listed BTU/hr, the greater the cooling capacity.

### **Air Conditioning Calculations - Rule Of Thumb**

Calculating the cooling capacity needed for your room is a complicated process as there are many factors to consider. However, there is a simple rule of thumb that you can use to estimate the required cooling capacity for your room. Use this result to compare with the calculation done by the air conditioning contractors for your own checking purposes.



#### **Suggested Activity 1: Compute for a Required Window Air Conditioner Capacity**

**Step 1:** Find the volume of your room in cubic feet. This is done by measuring the length, width and height of the room in feet and multiply all the three dimensions together.

$$\text{Volume} = \text{Width} \times \text{Length} \times \text{Height (cubic feet)}$$

**Step 2:** Multiply this volume by 6.

$$C1 = \text{Volume} \times 6$$

**Step 3:** Estimate the number of people (N) that will usually occupy this room. Each person produces about 500 BTU/hr of heat for normal office-related activity. Multiply this two figures together.

$$C2 = N \times 500 \text{ BTU/hr}$$

**Step 4:** Add C1 and C2 together and you will get a very simplified cooling capacity needed for the room.

Estimated Cooling Capacity needed = C1 + C2 (BTU/hr)

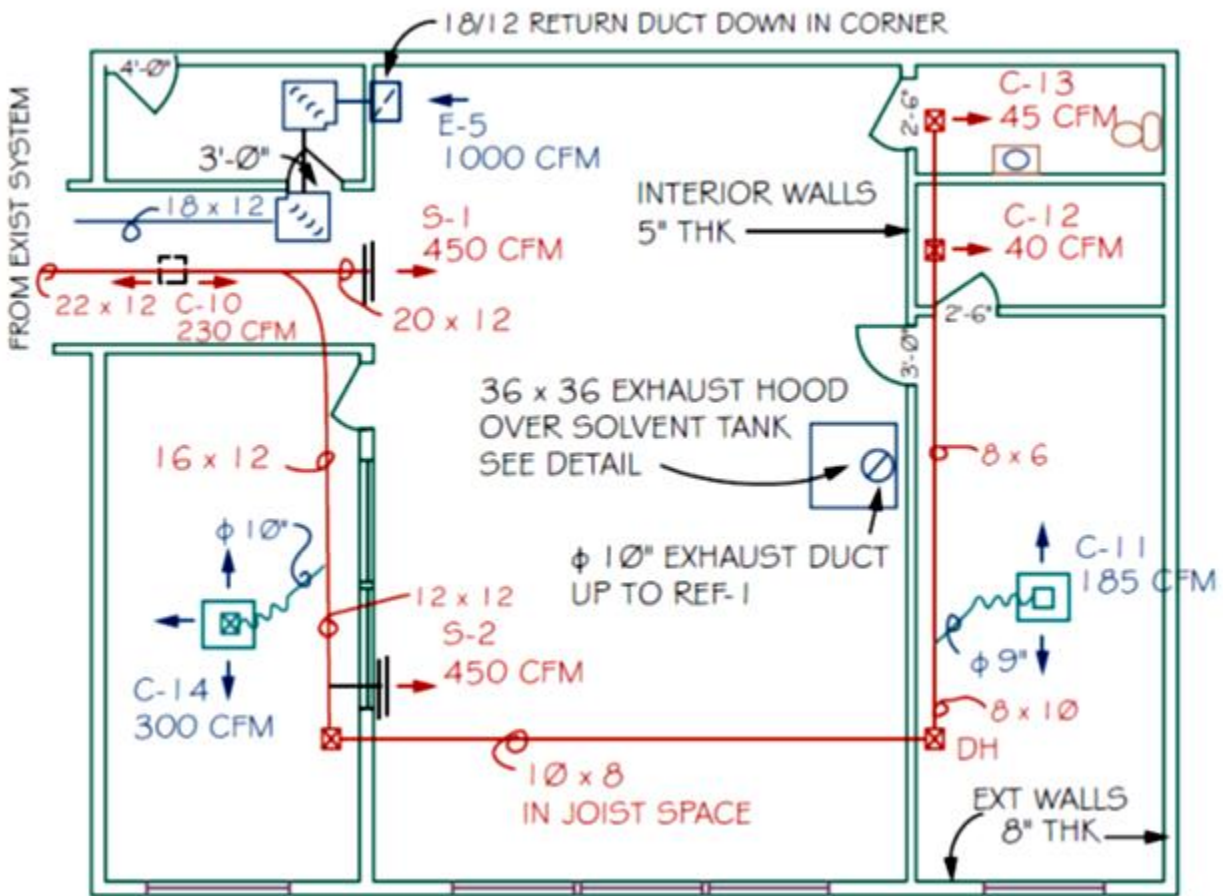


## Reflect and Understand

### Suggested Activity 2: HVAC Plan for a Simple Residential Building

**Directions:** Create an AutoCAD blocks for each of the HVAC Symbols and save in a separate folder to be inserted in the Design Center. Then use the floor plan from previous lessons to draft the HVAC Plan for a Simple Residential Building as shown below.

**Note:** You may indicate the **Simple Heat Loss** and **Gain Calculations** from the given drawing based on the dimensions. Make sure you have considered the outdoor temperature and the number of occupant in the calculations.



HVAC Plan for a Simple Residential Building



**Transfer**

### Suggested Activity 3: Two-Storey HVAC Residential Plan

**Directions:** Create a Two-Storey HVAC Residential Floor Plan from previous floor plans used in this module with **Simple Heat Loss** and **Gain Calculations**



**Know**

TECHNICAL DRAFTING – Grade 10

## Lesson 2: Drafting Mechanical Details of Conveyor Systems using CAD

### Elevator Drawings

Elevators come in several models and sizes. In this activity, you will be drafting a passenger elevator and a residential service elevator. Selecting the model and size depends on several factors such as:

- a. expected number of passengers
- b. number of floors served
- c. budget
- d. speed

One of the main parts of the quoting and design processes is the layout of conveyor systems. While most of the detailed conveyor systems is done with Autodesk Inventor, (a 3D CAD software package), most of the layout are still done in 2D in AutoCAD. It makes sense to use a 2D drafting package as the files are much simpler and smaller in size allowing for easy transfer.



### Steps in Planning Mechanical Details of Conveyor Systems Design and Standards

The following data is for typical industry size elevators. Any size cab is available in  $\frac{1}{4}$ " increments to dimensions A and C or B and D within the maximum and minimum dimensions shown in the diagram below not to exceed 12 SQ. FT. or 15 SQ. FT.

The following specs are to be provided by the General Contractor (GC), except as noted, prior to Elevator Contractor (EC) installing the elevator equipment.

1. Environmental requirements for hoistway:
  - a. The temperature should be maintained between 400 F to 1250 F.
  - b. It should not be exposed to the elements.
  
2. Pit Requirements:
  - a. Substantial level pit floor slab to support 2,700 lbs. impact load.
  - b. Waterproof pit minimum 6" below lowest floor level.

### Suggested Activity 1:

**Directions:** Based on the given information above, formulate at least ten (10) planning guidelines to be considered in drafting Mechanical Details of Conveyor Systems. Be sure to discuss your presentation in class comprehensively.



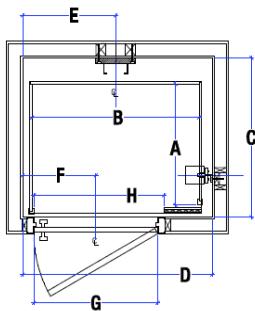
## Reflect and Understand

### Suggested Activity 2:

**Directions:** Draft the sample residential elevator/conveyor plan as shown below.

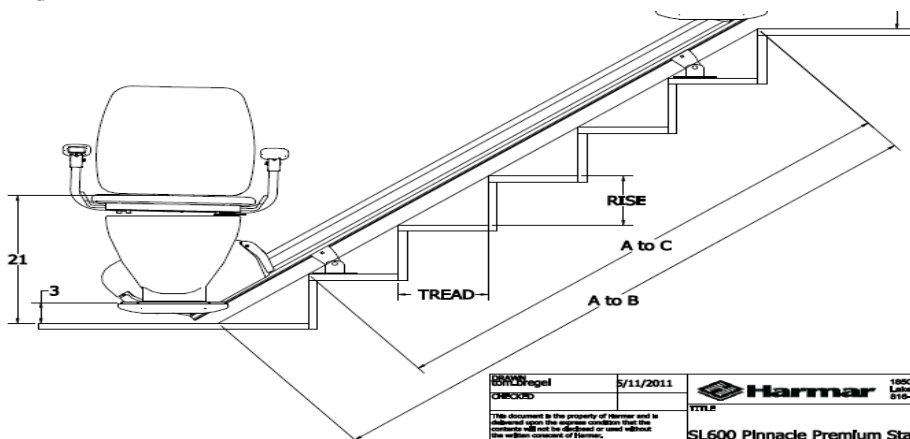


- Applicable to standard size wheelchairs



### CODE 1

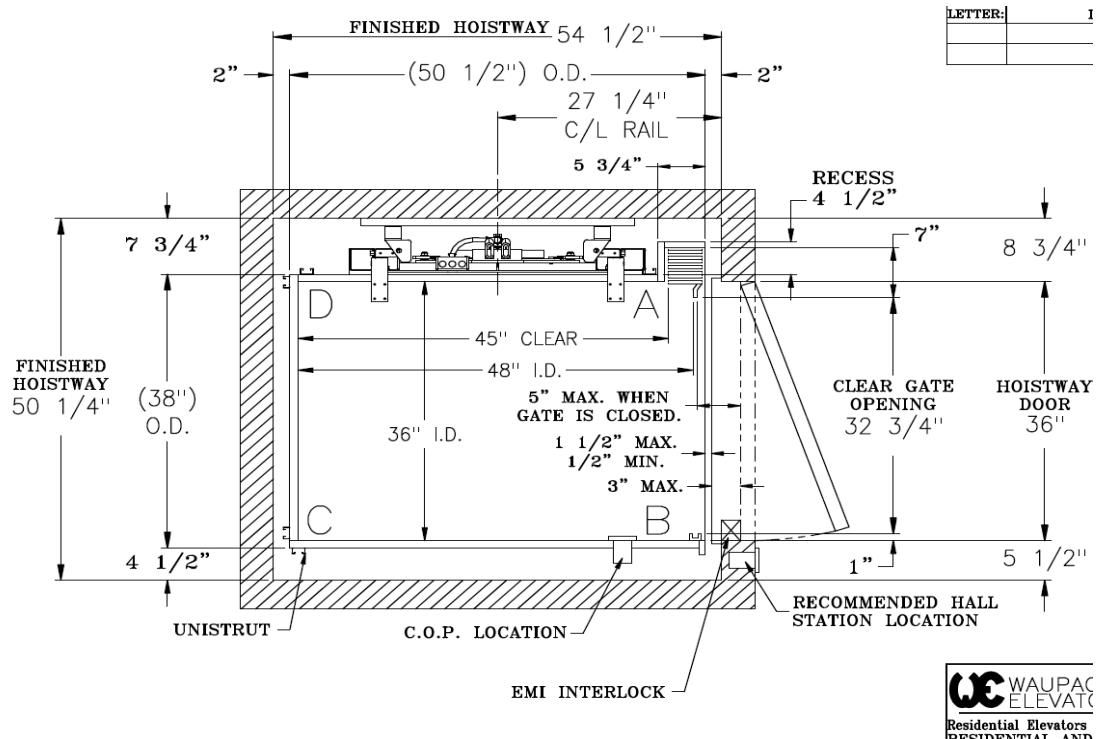
CODE 1	CAR SIZE (O.D.)	A CAR DEPTH (I.D.)	B CAR WIDTH (I.D.)	C SHAFT DEPTH	D SHAFT WIDTH	E CENTER OF RAIL	F CENTER OF DOOR	G DOOR SIZE	H CLEAR OPENING
	38" x 50"	35.75"	48.50"	45.75"	55.00"	27.00"	21.25"	36"	UP TO 38"
	42" x 44"	39.75"	42.50"	49.75"	49.00"	24.00"	21.25"	36"	UP TO 34"





### Suggested Activity 3: Draft Residential Elevator/Conveyor Plan

Directions: Draft the sample residential elevator/conveyor plan as shown below.



## Lesson 3. Drafting Fire Protection Systems using CAD

### Introduction



The protection of residential or building structures from the hazards of fire is one utmost concern of everybody. It is important that there must be a continued citizen's awareness on the destruction brought by fire to life and property. Planners, designers, and builders have their own contributions by making their plans and construction conform to the Fire Code Requirements.

The scope of the lesson on Fire Protection System in building is limited to the following factors and the preparation of plans is through computer-aided drafting.

1. Water and water supply for fire fighting
2. Water pumping system
3. Standpipe and hoses
4. Sprinkler systems

**Requirements for fire safety:**

- a. At least two means of exit in every residential room (such as a doorway or window) should be present.
- b. Exit doors must be at least 0.60 m wide.
- c. Occupied rooms must be accessible.
- d. All door locking devices must be easily disengaged from the inside by quick release catches.
- e. The path of travel from any room to an exit must not be through another room subject to locking.
- f. Passages from sleeping rooms to exits must be at least 0.90 wide.
- g. Stairs must be at least 0.90 m wide.
- h. Every sleeping room must have at least a window which can be easily opened from the inside.
- i. Storm windows, screens, burglar guards must have quick opening devices.
- j. Combustion heaters and stoves must not be located to block escape in case of malfunction.

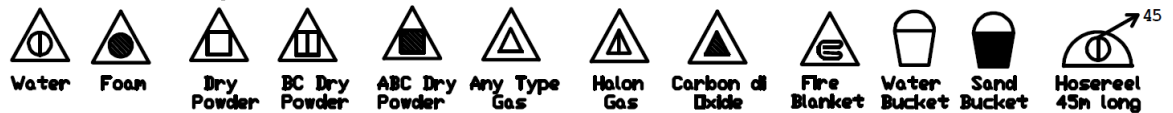


## Suggested Activity 1: AutoCAD blocks for Fire Safety Symbols

**Direction:** Create an AutoCAD blocks for each of the Fire Safety Symbols and save in a separate folder to be inserted in the Design Center.

### Fire Safety Symbols

#### Extinguishers Group 2



#### Fire Alarm Group 4

##### Control Panel 4.1



Any Type



Sounders & Illuminated Signals



Manual Call Point



Detector Any Type



Detector Heat



Detector Smoke



Detector Flame



Detector Beam



Detector Gas

##### Initiating Equipment 4.2

#### Warning Equipment 4.3



Loud Speaker



Manual Sounder



Electronic Sounder



Visual



Telephone



Any Type



Bell

#### Emergency Lighting Group 8



Enclosed



Self Contained



Linear Any Type



Exit Sign Internally Illuminated



Linear Enclosed



Linear Self Contained



## Suggested Activity 2: Draft Fire Safety Protection Systems

**Directions:** Using the floor plan from previous lessons, draft the Fire Safety Protection Systems according to Fire Safety Guidelines and requirements. Be sure to present you work the class.



### Suggested Activity 3

**Directions:** Research and compare with other Fire Safety Protection Plans and come-up with the Best-Practices in creating Fire Safety Protection Plans using AutoCAD. Be able to present your output in the class.

#### Post-Assessment



Answer the post assessment test below to determine whether there is significant increase in your understanding of Drafting Mechanical Layout and Details using CAD.

**Multiple Choice:** Choose the letter of the correct answer. Write your answer in the space provided before each number.

- \_\_\_\_\_ 1. A water supply pipe that extends vertically to one story or more to carry water to fixtures.  
A. riser            B. soil pipe            C. vent pipe            D. waste pipe
- \_\_\_\_\_ 2. A vertical pipe that extends to one or more floors and carries discharge of water closets and other similar fixtures.  
A. sewer            B. soil stack            C. vent stack            D. waste stack
- \_\_\_\_\_ 3. A sewer used for carrying groundwater, rainwater, surface water, or other non-polluting waste.  
A. storm sewer    B. vent stack            C. sanitary sewer    D. waste stack
- \_\_\_\_\_ 4. A fitting with a removable plug that is placed in plumbing drainage pipe lines to allow access for cleaning out the pipe.

- A. cleanout      B. drain      C. stack      D. trap
- \_\_\_\_\_ 5. A U-shaped pipe below plumbing fixtures that holds water to prevent odor and sewer gas from entering the fixture.  
A. drain      B. fitting      C. stack      D. trap
- \_\_\_\_\_ 6. A pipe that carries the discharge of water closets or other similar fixtures.  
A. sewer      B. soil pipe      C. vent pipe      D. waste pipe
- \_\_\_\_\_ 7. The portion of a pipe or fitting continuing in a straight line in the direction of flow in which it is connected.  
A. cleanout      B. drain      C. fitting      D. run
- \_\_\_\_\_ 8. A vertical pipe that runs one or more floors and carries the discharge of fixtures other than water closets and similar fixtures.  
A. sewer      B. soil stack      C. vent stack      D. waste stack
- \_\_\_\_\_ 9. A fitting that is used to control the flow of fluid or gas.  
A. drain      B. lavatory      C. valve      D. water closet
- \_\_\_\_\_ 10. The pipe installed to ventilate the building drainage system and to prevent drawing liquid out of traps and stopping back pressure.  
A. fitting      B. riser      C. soil pipe      D. vent pipe
- \_\_\_\_\_ 11. The inward flow of air through a porous wall or crack.  
A. duct loss      B. infiltration      C. latent load      D. R-factor
- \_\_\_\_\_ 12. The indoor temperature less the outdoor temperature.  
A. internal heat gain      C. outdoor temperature  
B. mechanical ventilation      D. temperature difference
- \_\_\_\_\_ 13. Amount of heat loss through mechanical ventilators such as range hood fans or bathroom exhaust fans.  
A. heat transfer multiplier      C. outdoor temperature  
B. mechanical ventilation      D. temperature difference
- \_\_\_\_\_ 14. Heat loss through ductwork in an unheated space, which has an effect on total heat loss.  
A. duct loss      C. internal heat gain  
B. indoor temperature      D. outdoor temperature
- \_\_\_\_\_ 15. A unit of measure determined by the amount of heat required to raise 1 pound of water 1 degree Fahrenheit.  
A. British Thermal Unit      C. Degrees Fahrenheit  
B. Degrees Centigrade      D. Degrees Kelvin

**Appendix A.**  
**Assessment Tool: Performance Rubrics**

Name: \_\_\_\_\_ Date: \_\_\_\_\_  
 Year & Section: \_\_\_\_\_

<b>Criteria</b>	<b>5 points</b>	<b>3 points</b>	<b>1 point</b>
<b>Proficiency</b>	Perform the task with competence and exceptional performance	Perform the task with competence and with standard performance	Perform the task with competence but below standard performance
<b>Method</b>	Followed the given procedure from start to finish, observed correct usage of command tools	Followed the given procedure, noted once incorrect usage of command tools	Followed the given procedure, noted more than once incorrect usage of command tools.
<b>Accuracy</b>	Perform the task with no error	Perform the task with at least 1-2 errors	Perform the task with more than 2 errors
<b>Time Management</b>	Finish the work on/before the given time	Finish the work after the given time	Unable to finish the work

**Rating Scale:**

<b>Points Earned</b>	<b>Numerical Rating</b>	<b>Descriptive Rating</b>
17 – 20	91 – 100	Outstanding
13 – 16	86 – 90	Very Good
9 – 12	81 – 85	Good
5 – 8	76 – 80	Fair
1 - 4	71 - 75	Needs Improvement
<b>Teacher's Comments:</b>		

Teacher's Signature: \_\_\_\_\_ Date: \_\_\_\_\_

**Note:** This assessment tool can also be used in the evaluation of the following suggested activities:

- A. Suggested Activity 2 (Reflect and Understand), page 153
- B. Suggested Activity 3 (Transfer), page 154
- C. Suggested Activity 2 (Reflect and Understand), page 156
- D. Suggested Activity 3 (Transfer), page 157
- E. Suggested Activity 1 (Process), page 158
- F. Suggested Activity 3 (Transfer), page 159

**Appendix B.  
Product Scoring Rubrics**

Name: \_\_\_\_\_  
Year & Section: \_\_\_\_\_

Date: \_\_\_\_\_  
Teacher: \_\_\_\_\_

Criteria	5 points	3 points	1 point
<b>Accuracy</b>	All computations and/or solutions were accurately done	At least 1 to 2 computations and/or solutions were inaccurately done	More than 3 computations and/or solutions were inaccurately done
<b>CAD Application (Appropriateness of tools/commands used)</b>	Selection of CAD tools/commands was appropriate	At least one CAD tools/commands was used inappropriately	More two CAD tools/commands were used inappropriately
<b>Time Management</b>	Finished the task 10 minute before the given time	Finished the task on time	Unable to finished the given task

**Rating Scale:**

Points Earned	Numerical Rating	Descriptive Rating
12 – 15	91 – 100	Very Good
8 – 11	86 – 90	Good
4 – 7	81 – 85	Fair
1 - 3	75 – 80	Needs Improvement

**Teacher's Comments:**

Teacher's Signature: \_\_\_\_\_ Date: \_\_\_\_\_

**Note:** This assessment tool can also be used in the evaluation of the following suggested activities:

- A. Suggested Activity 1 (Process), pages 155-156
- B. Suggested Activity 2 (Reflect and Understand), page 159