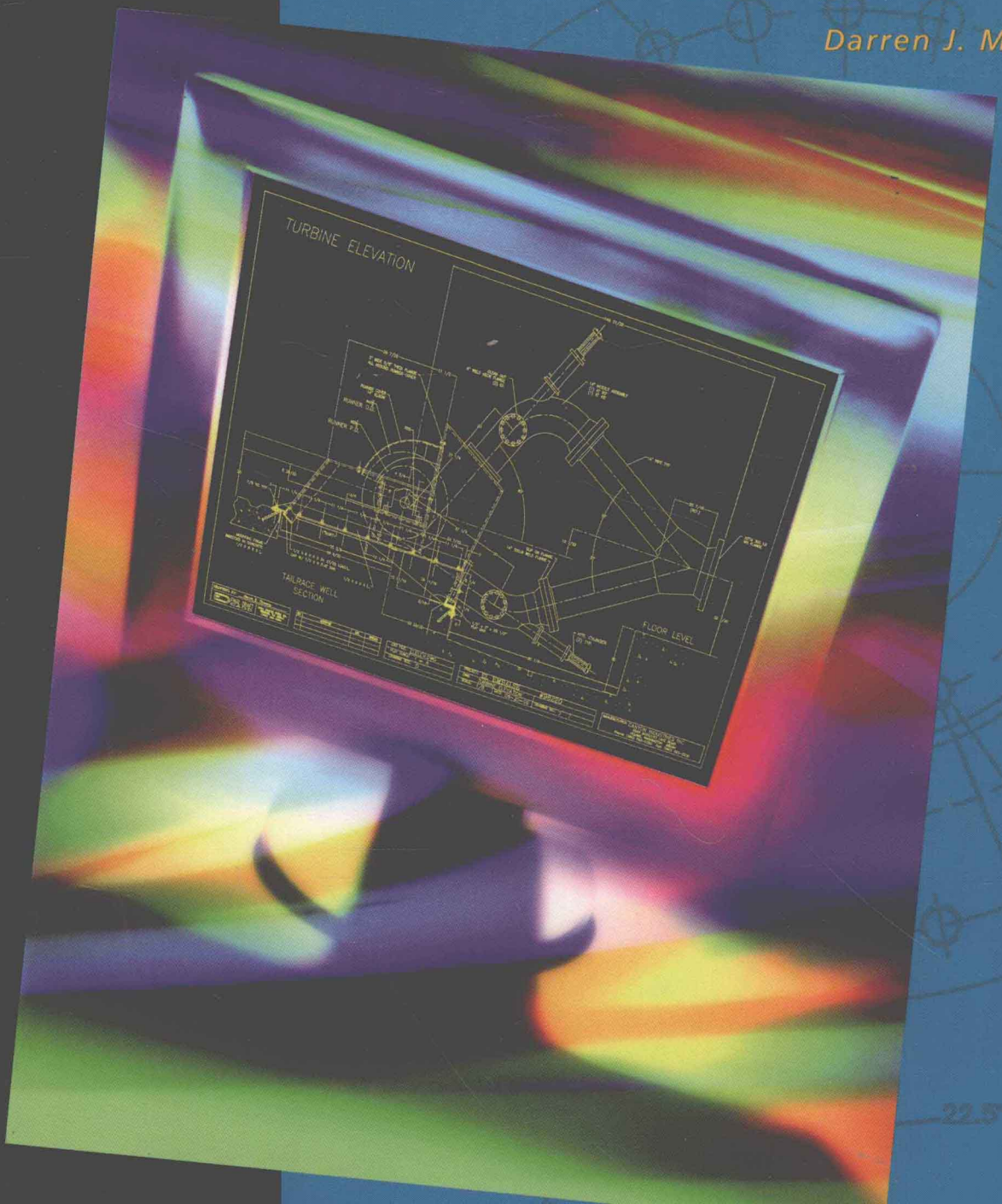
Project-Based AutoCAD®

Darren J. Manning



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Darren J. Manning

Glencoe

New York, New York Columbus, Ohio Chicago, Illinois Peoria, Illinois Woodland Hills, California

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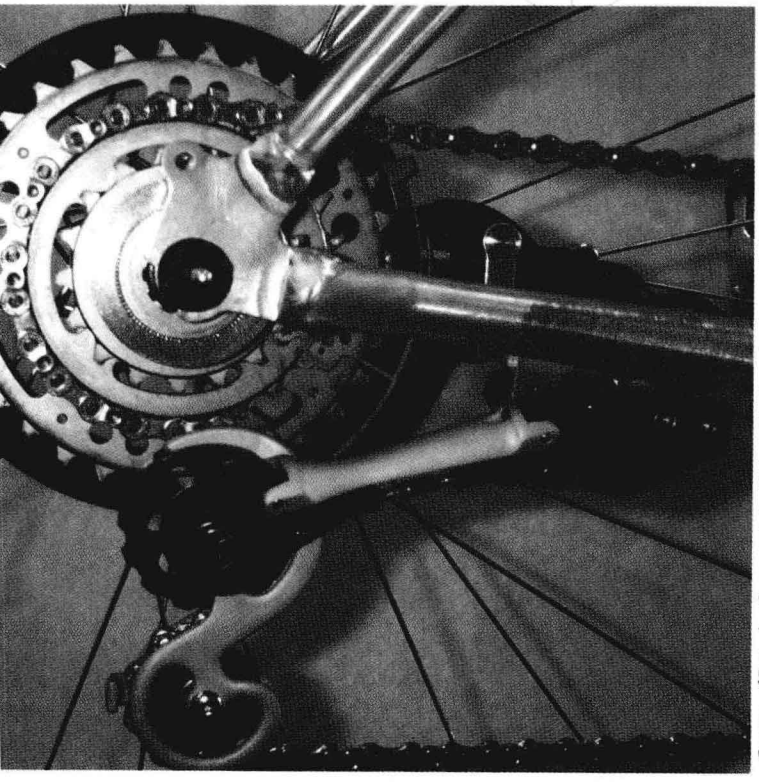

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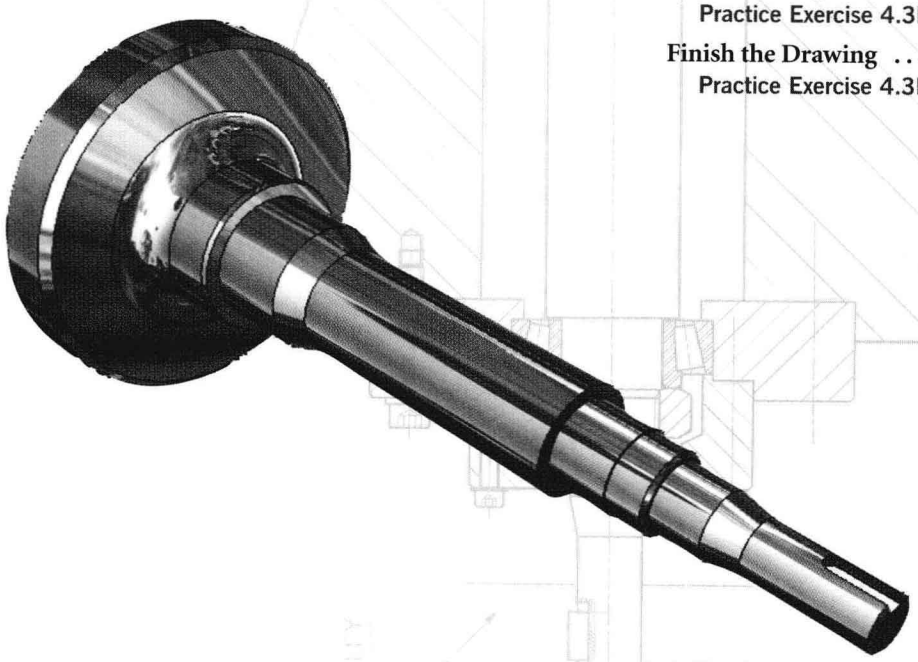

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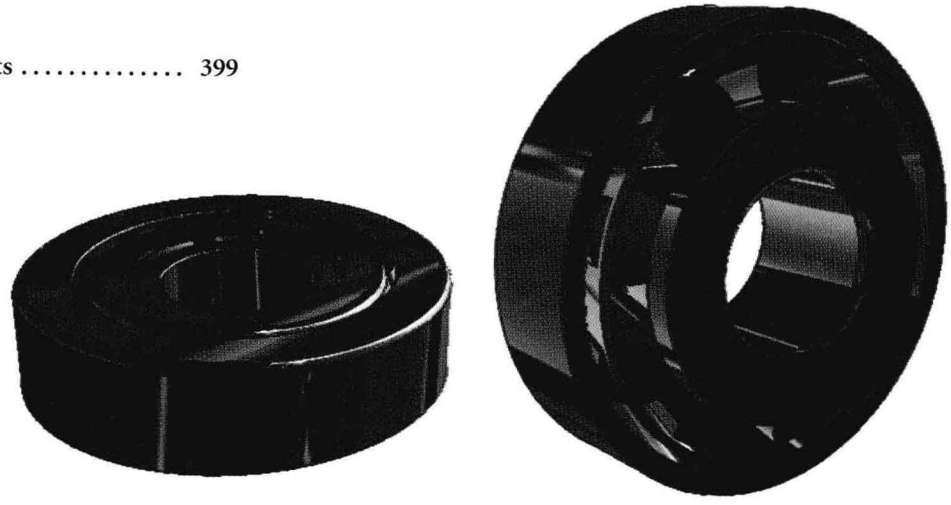


Before you begin . . .

Project-Based AutoCAD approaches CAD from the drafter's perspective. Instead of trying to include all of the many commands and options available in the AutoCAD software, this textbook focuses on how the drafter might use AutoCAD on the job.

Real-World Projects

Each of the four projects in this book demonstrates a different aspect of drafting in the real world. Project 1 concentrates on the development of working drawings for a mechanical assembly. Project 2 recreates the process of documenting a prototype field assembly. Project 3 introduces 3D modeling and the concepts of CAD/CAM and CNC. The concept drawing in Project 4 demonstrates the process of designing and developing a new concept to fill a market need.

The Importance of Drafting Standards

Drafting skill and knowledge of drafting standards are extremely important in any drafting job. Although *Project-Based AutoCAD* includes some drafting instruction, its primary focus is on using AutoCAD to accomplish real-world drafting projects. As you work on these projects, it is vital that you follow established drafting guidelines. If you are not familiar with the specifications in ASME Y14 and the ADDA guidelines, you should endeavor to learn them well.

Drafting Today

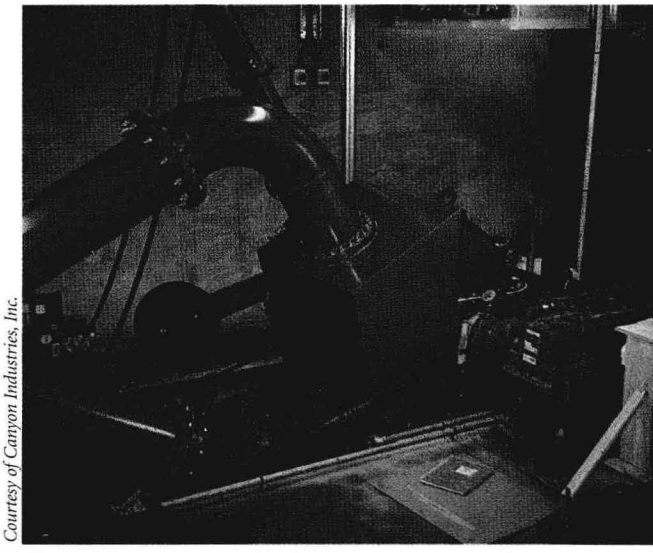
In today's world, it is not enough simply to learn how to use AutoCAD, nor is it enough to know the drafting standards. You must be able to apply drafting standards correctly and use AutoCAD or other CAD software efficiently to accomplish the drawings and models that drafters are called upon to create.

PROJECT 1

Hydroelectric Turbine Nozzle Assembly

When you have completed this project, you should be able to:

- Identify the parameters of a two-dimensional design assignment.
- Use a predefined ANSI template to prepare an AutoCAD drawing file for use with an entire set of technical drawings.
- Create a reference assembly drawing.
- Use an assembly drawing as the basis for a cross-section detail.
- Apply weld symbols appropriately to a working drawing.
- Identify parts of the assembly that need dimension details and create them accordingly.
- Dimension a detail drawing using geometric dimensioning and tolerancing (GD&T).



Courtesy of Canyon Industries, Inc.

***Fig. 1.1** A finished hydroelectric turbine assembly installed in a powerhouse.*

Introduction

Two-dimensional (2D) CAD drawings are often used by manufacturers to define new designs and ideas in detail so that they can be manufactured to very specific requirements. In this project, you will create a set of working drawings for a nozzle assembly that controls the flow of water into the housing of a hydroelectric turbine.

Before you begin the actual drawings, you will need to become familiar with the concepts behind power generation and hydroelectric turbines. You must understand the function of the nozzle assembly and how it fits into the overall turbine design. Knowing these details will help you design the nozzle assembly to fit the customer's needs. Then you will create a complete set of working drawings to describe the nozzle assembly for the manufacturer. Your drawings will guide the manufacture and assembly of the nozzle in the hydroelectric turbine and will provide the basis for quality control checks. Your drawings must therefore be both precise and accurate.

SECTION 1.1 Design Parameters

The guidelines by which a new design is created are known as **design parameters**. To define the parameters of a design problem, you must first know something about how the finished product will be used. In this project, courtesy of Canyon Industries, the assignment is to create a set of working drawings for the nozzle assembly of a hydroelectric turbine. What must you find out before you can begin planning the design?

A good starting point is to explore the environment in which the nozzle assembly will be used. Also, you should gather information from the customer and from engineers to determine exactly what function the nozzle assembly is expected to perform, and under what physical conditions. The purpose of this section is to familiarize you with the basic concepts so that you can begin planning the design and forming strategies to solve the design problem.

Section Objectives

- Explore the uses of hydroelectric turbines in power generation.
- Identify the function of the nozzle assembly.
- Brainstorm design elements that will meet the functional needs.
- Plan the necessary drawings and specifications.

Key Terms

- design parameters
- flow
- head
- hydroelectric turbine
- nozzle
- runner

Initial Research

How do you go about finding out the background information you will need to complete a design assignment? You have several resources at your disposal. First, you should meet with the customer, by appointment if necessary. Ask very specific questions about the assignment. For the nozzle assembly, for example, you might ask the following questions:

- Exactly what is the nozzle assembly expected to do?
- To what specific physical conditions will the nozzle assembly be subjected? What are the extremes of cold and hot temperatures, humidity, etc.?
- What equipment will interface with the nozzle assembly?
- Are there any specific material requirements due to the equipment interfaces?

If you are completely unfamiliar with the type of product to be designed, you should also look for background information about the product in general. The Internet is one convenient common source of background information. For the nozzle assembly project, use a search engine with keywords such as *hydroelectricity*, *power generation*, and *turbine*. When you find information that might help you in the project, save it and read it carefully. **Caution:** When using materials from the Internet and other external sources, be sure to read critically. Compare the information with that from your customer. If any discrepancies arise, ask the customer for clarification. Information from the customer should always take precedence over information from third-party sources. This is important because information from external sources may refer to a slightly different system or setup, or it may reflect the laws or regulations of another state or country.

For this project, you will not be able to sit down with the customer to discuss the project at length. Therefore, much of the background information you would ordinarily obtain from the customer is summarized in this section. However, it is important for the designer/drafter to understand how to

Practice Exercise 1.1A

The purpose of this exercise is to practice finding and using various resources for background material that may be useful as you design a new product. The steps outlined below are general in nature. Take the time to work through each step. The information resources you discover may be useful not only throughout your work in this textbook, but also as you accept and work on design projects for employers.

1. List the most likely sources of information. For a given project, these may include some or all of the following:
   - The customer's public relations department
   - The customer's engineering department and/or the person who hired you
   - The Internet, using megasearch engines
   - Textbooks and reference books
   - For local customers and projects, local libraries, university libraries, newspapers, and sometimes even museums (for pertinent historical, political, and other information)

   The last two items in step 1 are the most likely sources of information for this project. Keep in mind that available sources may vary from project to project.
2. Follow up each likely source. In this case, your followup should consist of a minimum of calling local libraries/museums and performing a thorough Internet search.
3. Gather and organize the information that you have obtained. Compare the information provided in this textbook with the information you found using other sources. Clear up any questions that arise.
4. Document your findings and summarize them on paper to help orient yourself to the design task before you begin planning the drawings.

find and use background information. Practice Exercise 1.1A will guide you through a typical search for background information for a new project.

Background: Hydroelectric Turbines

The nozzle assembly to be designed in this project will control the flow of water to the turbines in a hydroelectric dam. A **hydroelectric turbine** is a type of rotary engine that consists of a series of curved vanes connected to a central shaft. Running water, usually from a river, is directed toward the vanes by one or more **nozzles**. As the water runs over the vanes, it moves them in the direction of the curvature of the vanes. As the vanes move, they cause the central shaft to rotate. In this way, the turbine transforms the energy of the moving water into mechanical energy. The shaft can be connected to a power generator to produce electrical energy.

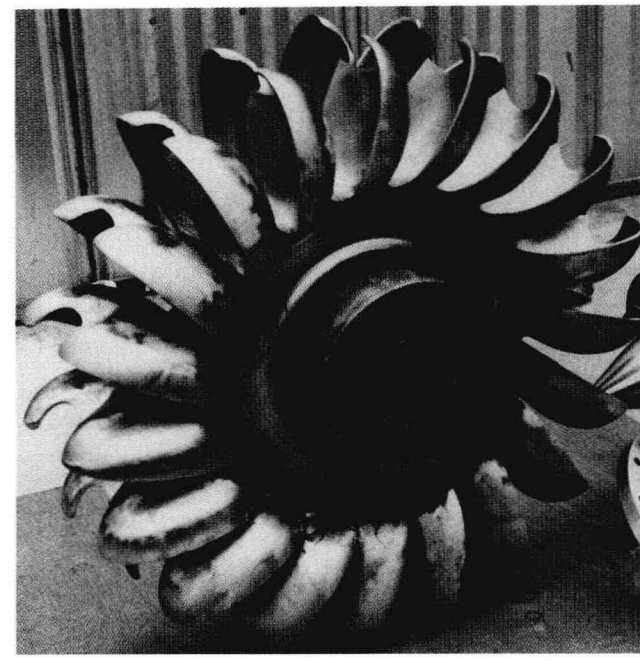
Canyon Industries is a major manufacturer of utility-grade hydroelectric systems for power generation, energy recovery projects, and other uses. The company designs and manufactures each system to specific site requirements, which increases the general efficiency of the systems. This customization process requires a large amount of custom drafting for each job undertaken.

Turbine efficiency is extremely important to the overall operation of a hydroelectric system. The turbine must be designed to use the available water source to produce the greatest possible amount of energy.

The turbines used in the Canyon Industries systems are designed to be used with a water source that has a high head and/or high flow. **Head** is defined as the total of vertical feet over which the water falls, and **flow** is the quantity of water by volume. These two factors determine the water power that can be converted into radial, or rotary, power by the turbine. The volume of water is critical to the nozzle assembly design.

The nozzle assembly in this project will be used with a turbine that is based on the Pelton water wheel, which was developed in 1878 by Lester Allen Pelton for use in California gold mines. The original Pelton wheel used the gravitational force of falling water to turn curved "buckets." In today's version, water is funneled into a pressurized pipeline with a narrow nozzle at one end. The water sprays out of the nozzle and

into the turbine housing under force. When the water strikes the double-cupped buckets, the impact causes the wheel to rotate with a high rate of efficiency. Fig. 1.1.1.



Courtesy of Canyon Industries, Inc.

Fig. 1.1.1 ***A modern Pelton wheel of the type used by Canyon Industries.***

Nozzle Assembly

In creating the working drawings for the nozzle assembly, it will help you to understand exactly how the assembly fits in the system as a whole. The assembly elevation in Fig. 1.1.2 shows the complete system. In this drawing, the nozzle assembly is shown on the right, behind the turbine housing. The couplings in the center of the drawing show how the shaft is connected to the generator on the left.

The turbine to be used in this project is a double-nozzle Pelton hydroelectric turbine. In the double-nozzle design, two nozzles feed water to the turbine housing. Fig. 1.1.3. The use of two nozzles allows a smaller Pelton wheel (also called a **runner**), to be used with a given water flow. It also increases the rotational speed of the runner, which increases efficiency. The force of the water causes the runner to turn a shaft that

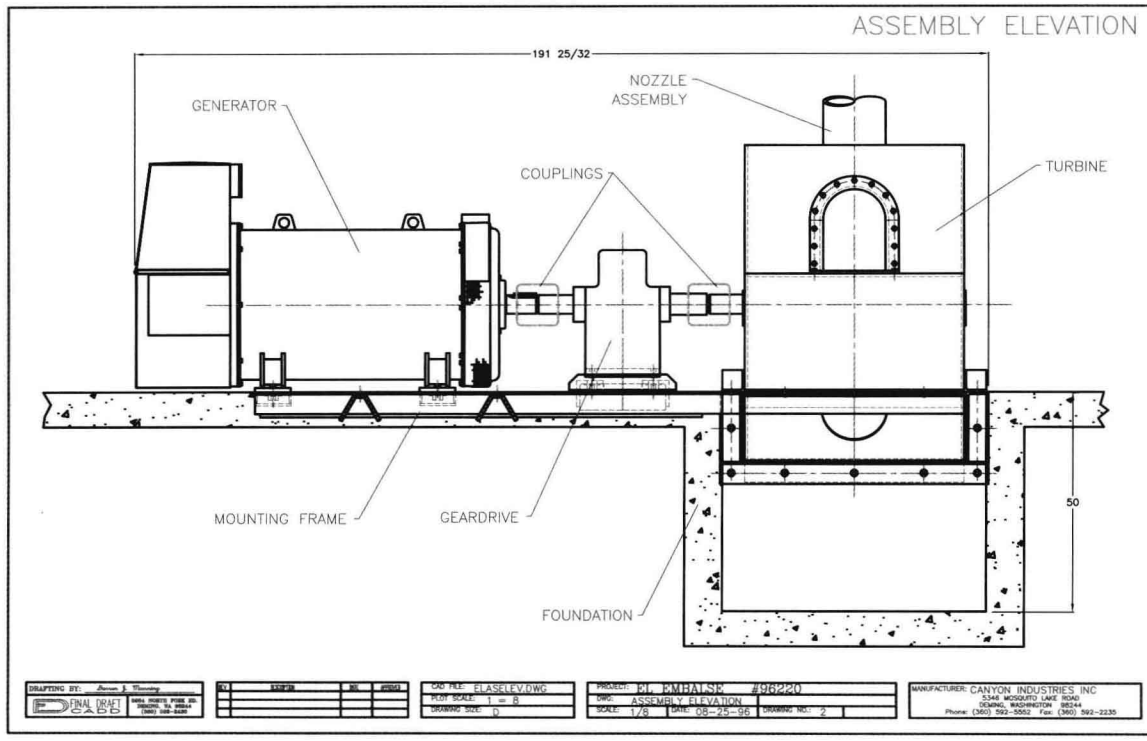


Fig. 1.1.2 ***The hydroelectric system for which the nozzle assembly is designed.***

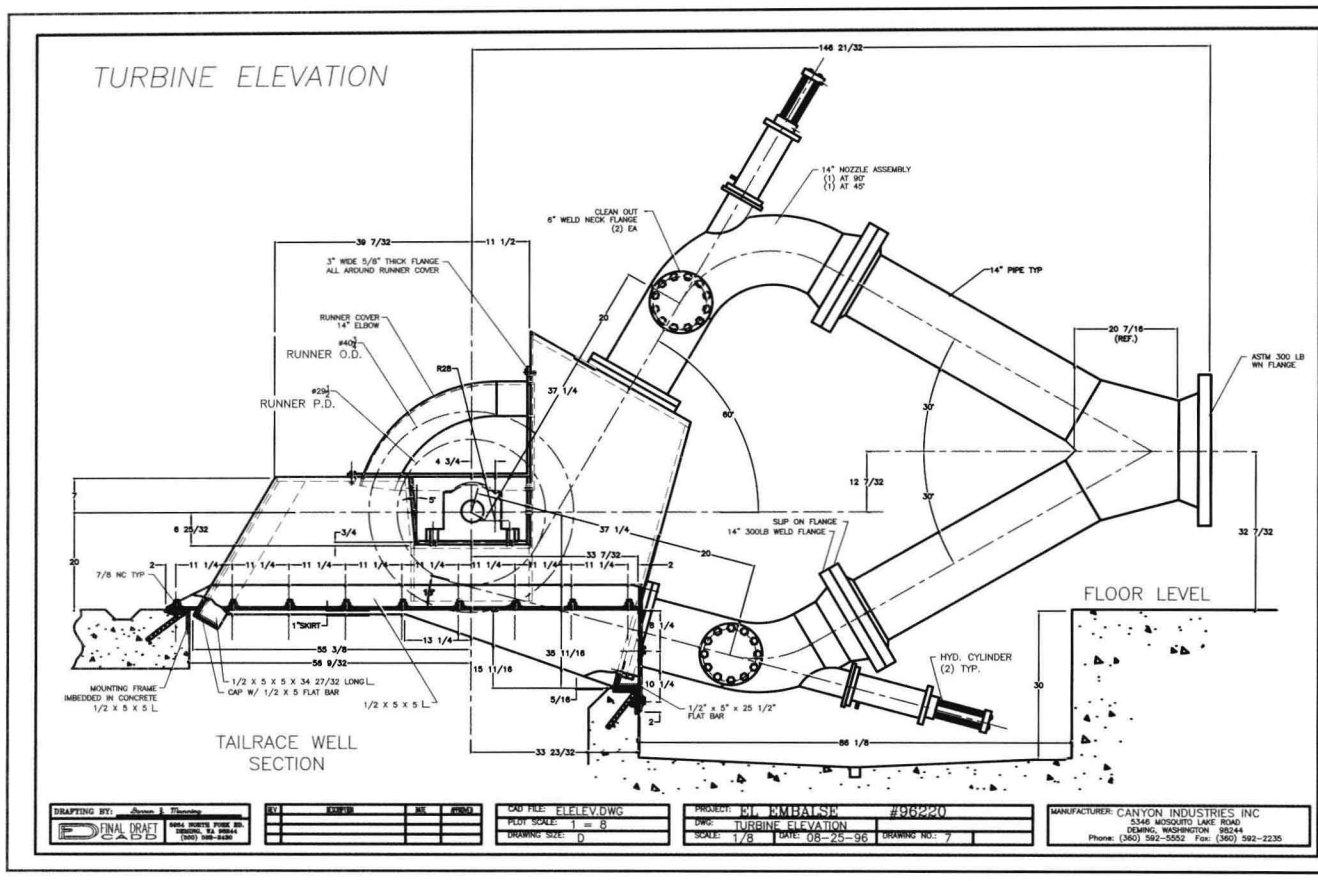


Fig. 1.1.3 ***A double-nozzle hydroelectric turbine system consists of upper and lower nozzle assemblies that feed the water to the turbine.***

is connected to a generator, which converts the mechanical energy into electricity. The nozzle is designed so that the outlet can be opened and closed by operating a hydraulic cylinder. This also allows precise opening of the nozzle to regulate the flow of water into the turbine housing.

Project Parameters

In this project, we will concentrate on creating a set of working drawings for the lower nozzle assembly. The purposes of the drawings include:

- showing the overall construction of the nozzle assembly
- showing how the nozzle assembly interfaces with the main turbine housing and with other assemblies in the turbine
- assisting with cost estimation
- providing a basis for ordering materials
- providing information needed for engineering validation and approval

Some manufacturers do not break down their drawings into detailed parts. In these situations, the design department works closely with the manufacturing departments to provide necessary information as needed to create each part. However, it is common for the detail parts of an assembly to be contracted to independent manufacturers. If this method is used, both the designers and the manufacturers must comply with the same set of guidelines and standards.

This project is intended to guide you through the process of creating a partial nozzle assembly for use by an independent manufacturer. The nozzle assembly will need to be broken down into enough detail so that all the information is available for the manufacturer to produce the assembly. By the time you have finished this project, you will have created the following drawings:

- assembly drawing of the lower nozzle assembly, including a detail section and a parts list
- bell housing detail drawing

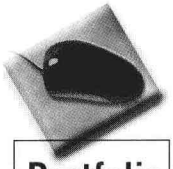
SECTION 1.1 Review

Review Questions

1. Explain why it is important for the designer/drafter to obtain background information before beginning a new project.
2. List at least three ways to obtain background information about an assigned project.
3. Explain the basic operation of a hydroelectric turbine.
4. What is the purpose of the nozzle assembly for which you will create working drawings in this project?
5. Explain the advantages of having two nozzles to supply water to the turbine housing.
6. What is another name for the Pelton hydroelectric turbine used in this project?

Practice Problems

1. XYZ Corporation has hired you to design and create a complete set of working drawings for a cell phone for use in various rugged terrains, including mountains and deserts. Make a list of the information you will need before you can begin this project. Perform a search for background information using all available resources. Record the resources and the information you obtained from each. Summarize your findings.
2. Research various kinds of turbines that could be used in a hydroelectric power generation system. Sketch each type of turbine. Next to each sketch, list the advantages and disadvantages of using the turbine for the application discussed in this section.



Portfolio Project

Needle Valve

Design and develop the drawings for a needle valve for an industrial chemical manufacturer. Needle valves provide an alternative for controlling the flow of a liquid or gas through a hydraulic system. The valve you design will control the flow of acetic acid into a mixing chamber. It must meet the following specifications:

- The valve must provide both precise flow (metering) control and complete shutoff capability.
- Maximum flow through the valve will be 8 gallons per minute (GPM).
- Maximum operating pressure will be 4,000 pounds per square inch (PSI).

Research various types of needle valves. Decide what characteristics the valve must have to meet the customer's requirements. Operate on the assumption that none of the needle valves currently on the market meet the customer's requirements exactly, so this cannot be a purchased part, and you cannot copy a design from another source. Characteristics must include the size of the valve and its orifice, a method of controlling flow, and the material from which the valve should be manufactured.

Document your research by recording the sources you use for reference and the information you found at each source. List the types of drawings that will be required to complete this portfolio assignment.