Title

AN INDUSTRIAL INTERNSHIP TRAINING REPORT

Submitted by

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21BEC0992

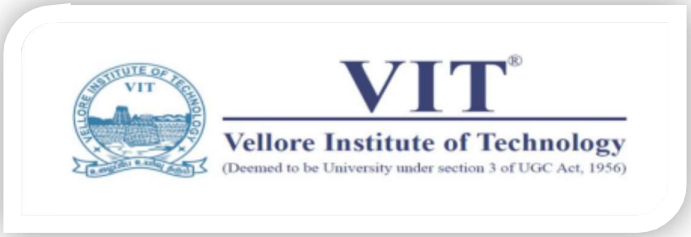
BECE399J – SUMMER INDUSTRIAL INTERNSHIP

in partial fulfillment for the award of the degree of

BACHELOR OF TECHNOLOGY

in

ELECTRONICS AND COMMUNICATION ENGINEERING



School of Electronics Engineering

DECLARATION BY THE CANDIDATE

I hereby declare that the Industrial Internship Report entitled "AN INDUSTRIAL INTERNSHIP TRAINING REPORT" submitted by me to VIT University, Vellore in partial fulfillment of the requirement for the award of the degree of Bachelor of Technology in Electronics and Communication Engineering is a record of bonafide industrial training undertaken by me under the supervision of Raghavachari N. I further declare that the work reported in this report has not been submitted and will not be submitted, either in part or in full, for the award of any other degree or diploma in this institute or any other institute or university.

Vellore

Signature of the Candidate

Date:

ACKNOWLEDGEMENT

The student is free to acknowledge all those he/she feels to acknowledge on the basis of the guidance and help provided during the implementation of the project

M.MANIKANTA

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LIST OF SYMBOLS AND ABBREVIATIONS

NC: Numerical control

CNC: Computer Numerical control

PLC: Programmable logic controller

INTRODUCTION

1.1 About the Company

BHEL is the largest engineering and manufacturing enterprise in India in the energy related/infrastructure sector today. BHEL was established more than 40 years ago when the first plant was set up in Bhopal ushering in the indigenous Heavy Electrical Equipment industry in India, a dream which has been more than realized with a well-recognized track record of performance. It has been earning profits continuously since 1971-72 and achieved a sales turnover of Rs.7482.2 crores with a profit before tax of Rs.802.4 crores in 2002-2003.

BHEL caters to core sectors of the Indian Economy viz., power Generation & Transmission, Industry, Transportation, Telecommunication, Renewable Energy, Defense, etc. The wide network of BHEL's 14 manufacturing divisions, four Power Sector regional centers, eight service centers and 18 regional offices and a large number of Project Sites spread all over India and abroad enables the Company to promptly serve its customers and provide them with suitable products, systems and services-efficiently and at competitive prices. BHEL has already attained ISO 9001:2000 version quality standard certification for quality management. BHEL has secured ISO 14001 certification for environmental management systems and OHSAS – 18001 certification for occupational health and safety management systems for its major units/divisions.

Power Generation

Power Generation Sector comprises of thermal, gas, hydro and nuclear power plant business. As of 31.3.2003 BHEL-supplied sets account for nearly 68,854 MW or 65% of the total installed capacity of 106,216MW in the country, as against Nil till 1969-70.

BHEL has proven turnkey capabilities for executing power projects from concept to commissioning. It possesses the technology and capability to produce

thermal sets with super critical parameters up to 1000MW unit rating and gas turbine-generator sets of up to 250 MW unit rating. Co-generation and combined – cycle plants have been introduced to achieve higher plant efficiencies. To make efficient use of high-ash-content coal available in India, BHEL also supplies circulating fluidized bed combustion boilers for thermal plants.

The Company manufactures220/235/500MW nuclear turbine generator sets. Custom-made hydro sets of Francis, Pelton and Kaplan types for different head-discharge combinations are also engineered and manufactured by BHEL.

Transmission & Distribution (T&D)

BHEL offers wide-ranging products and systems for T&D applications. Products manufactured include: power transformers, instrument transformers, series shunt-reactors, capacitor banks, vacuum & SF6 circuit breakers, gas-insulated switchgears, energy meters, SCADA systems and insulators.

A strong engineering base enables the Company to undertake turnkey delivery of substations upto 400 kV level, series compensation systems (for increasing power transfer capability of transmission lines and improving system stability and voltage regulation), shunt compensation systems (for power factor and voltage improvement) and HVDC systems (for economic transfer of bulk power). BHEL has indigenously developed the state-of-the-art controlled shunt reactor (for reactive power management on long transmission lines). Presently, a 400 kV FACTS (Flexible AC Transmission System) project is under execution. The Company undertakes comprehensive projects to reduce ATC losses in distribution systems.

Industries

BHEL is a major contributor of equipment and systems to industries: cement, sugar, fertilizer, refineries, petrochemicals, paper, oil and gas, metallurgical and other process industries. The range of system & equipment supplied includes: captive power plants, co-generations plants, DG power plants, industrial steam turbines,

industrial boilers and auxiliaries, waste heat recovery boilers, gas turbines, heat exchangers and pressure vessels, centrifugal compressors, electrical machines, pumps, valves, seamless steel tubes, electrostatic precipitations, fabric filters, reactors, fluidised bed combustion

Boilers, chemical recovery boilers, process controls and material handling systems. The Company has commenced manufacture of large desalination plants to help augment the supply of drinking water to people.

Transportation

BHEL is involved in the development, design, engineering, marketing production, installation, maintenance and after-sales service of rolling stock and traction propulsion system. In the area of 350HP to 3100HP, both for mainline and shunting duty applications. BHELis also producing rolling stock for special applications viz., overhead equipment cars, Special well wagons, Rail-cum-road vehicle etc. Besides traction propulsion systems for in-house use, BHEL manufactures traction propulsion systems for other rolling stock producers of electric locomotives, diesel-electric locomotiveselectrical multiple units and metro cars. The electric and diesel traction equipment on Indian Railways are largely powered by electrical propulsion systems produced by BHEL. BHEL also undertakes retrofitting and overhauling of rolling stock. In the area of urban transportation systems, BHEL is also diversifying in the area of port handling equipment and pipelines transportation system.

Telecommunication

BHEL also caters to telecommunication Sector by way of small, medium and large switching systems.

Renewable Energy

Technologies that can be BHEL for exploiting non-conventional and renewable sources of energy include: wind electric generators, solar photovoltaic systems, stand-alone & grid-interactive solar power plants, solar heating systems, solar lanterns and battery-powered road vehicles. The Company has taken up R&D efforts for development of multi-junction amorphous silicon solar cells and fuel cells based systems.

Oil and Gas

BHEL is a major contributor to the Oil and Gas sector industry in the country. BHEL's product range includes Deep Drilling Oil Rigs, Mobile Rigs, Work Over Rigs, Well Heads and X-Mas Trees (of upto 10000 psi ratings), Choke and Kill Manifolds, Full Bore Gate Valves, Mud Valves, Mudline Suspension System, Casing Support System, Sub-Sea Well Heads, Block Valves, Seamless Pipes, Motors, Compressors, Heat Exchangers, etc. BHEL is the single largest supplier of Well Heads, X-Mas Trees and Oil Rigs to ONGC and OIL.

International Operations

BHEL is one of the largest exporters of engineering products and services from India, ranking among the major power plant equipment suppliers in the world.

Over the years, BHEL has established its references in about 60 countries around the world. These references almost encompass the entire product range of BHEL, covering turnkey power projects of thermal, hydro and gas-based types, substation projects, rehabilitation projects, besides a wide variety of products – like, transformers, valves, well-head equipment, insulators, switchgears, heat exchangers, castings and forgings, centrifugal compressors, photovoltaic cell and panels, etc. The Company has been successful in meeting the ever increasing customers' requirements in terms of complexity of the works as well as the technological, quality and other requirements. BHEL possesses the requisite flexibility to interface and complement with international companies for large projects by supplying complementary equipment and meeting their production needs for intermediate as well as finished products

Technology Upgradation, Research & Development

To remain competitive and meet customers' expectations, BHEL lays great emphasis on the continuous upgradation of products and related technologies and development of new products. The company has upgraded its products to contemporary levels through continuous in-house efforts as well as through acquisition of new technologies from leading engineering organizations of the world.

The Corporate R&D Division of Hyderabad, spread over a 140 acre complex, leads BHEL's research efforts in a number of areas of importance to BHEL's product range. BHEL's investment in R&D is amongst the largest in the corporate sector in India. Products developed in-house in the last five years contributed to over 7% to the revenues in 2002-2003.

The company is also engaged in research in futuristic areas such as application of super-conducting materials in power generation and industry and fuel cells for distributed, environment friendly power generation.

Human Resource Development Institute

BHEL has envisioned to becoming "A world class innovative, competitive and profitable engineering enterprise, providing total business solutions." For realising this vision, continuous development and growth of the 47,000 strong highly skilled and motivated people making the Organisation, is the only 'mantra'.

Human Resource Development Institute (HRDI), the Corporate Training Institute of the company, in association with the Advanced Technical Education Centre (ATEC) in Hyderabad and the HRD Centre at the units is responsible for the total human resource development of the company. Further, Competency Development/Assessment Centre for the Senior Executives is taken up by the HRDI.

Health, Safety and Environment Management

BHEL, as an integral part of business performance and in its endeavor of becoming a world-class organisation and sharing the growing global concern on issues related to Environment, Occupational Health and Safety, is committed to protecting Environment in and around its own establishment, and providing safe and healthy working environment to all its employees.

For fulfilling these obligations, Corporate Policies have been formulated as:

- Compliance with applicable Environmental Legislation/Regulation;
- Continual improvement in Environment Management Systems to protect our natural environment and control pollution;
- Promotion of activities for conservation of resources by Environment Management;
- Enhancement of Environmental Awareness amongst employees, customers and suppliers.

Occupational Health and Safety Policy

- Compliance with applicable Legislation and Regulations;
- Setting objectives and targets to eliminate/control/minimise risks due to Occupational and Safety Hazards;
- Appropriate structured training of employees on Occupational Health and Safety (OH&S) aspects;
- Formulation and maintenance of OH&S Management programs for continual improvement;
- Periodic review of OH&S Management System to ensure its continuing suitability, adequacy and effectiveness;
- Communication of OH&S Policy to all employees and interested parties.

The major units of BHEL have already earned international recognition by implementation of ISO 14001 Environmental Management system and OHSAS 18001 Occupational Health and Safety Management System.

In pursuit of these policy requirements, BHEL will continuously strive to improve work practices in the light of advances made in technology and new understandings in Occupational Health, Safety and Environmental Science.

Participation in the "Global Compact" of the United Nations

The "Global Compact" is a partnership between the United Nations, the business community international labour and NGOs. It provides a forum for them to work together and improve corporate practices through co-operation rather than confrontation.

BHEL has joined the Global Compact" of United Nations and has committed to support it and the set of core values enshrined in its principles

1.2 About the In-Plant Training

Development of NC/CNC machines is considered as an outstanding contribution to machine tool engineering. It is definitely a step in automation of the machining processes with a flexibility which makes the technology more versatile and widens the range of application. NC technology merely incorporates the automation of machine tool with the aid of modern electronics.

NC MACHINES

Numerical control is defined as a form of programmable automation in which the process is controlled by numbers, letters and symbols. A machine tool is said to be numerically controlled if it operates in a semiautomatic or automatic cycle as per instructions transmitted to it in a coded form. In numerical control, the numbers form a program of instructions designed for a particular work part or job. When the job changes, the program of instructions is changed. This technology has been applied to a wide variety of operations including turning, milling, sheet metal working, welding, inspection etc.

CNC SYSTEMS

2.1 Introduction to CNC Systems

In case of computer numerical control machine tools, a dedicated computer is used to perform all basic NC functions. The complete part program to produce a component is input and stored in the computer memory and the information for each operation is fed to the machine tools. The part programs can be stored in the memory of the computer and used in future. CNC machine tools are widely used due to many new control features available on these machines.

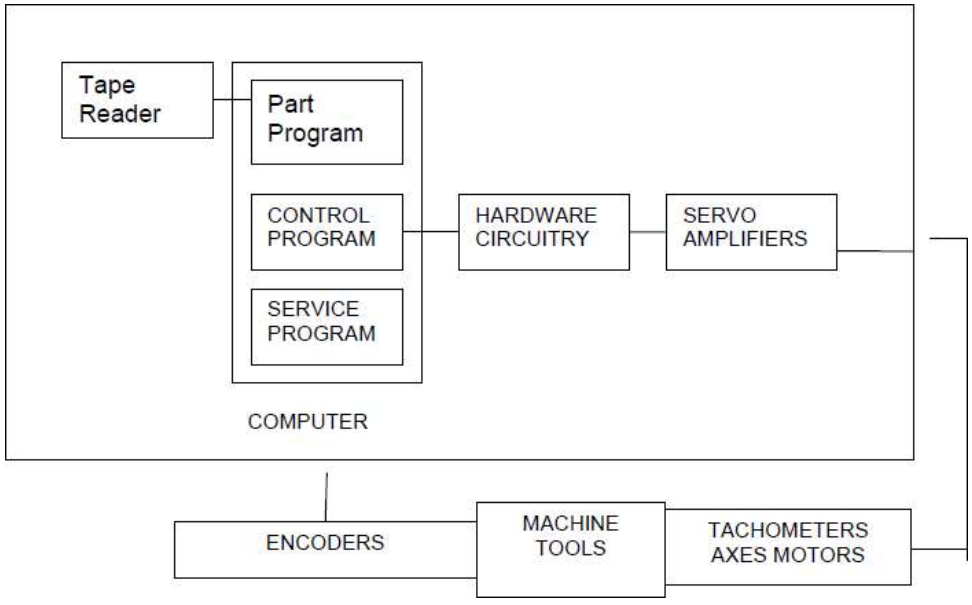

Figure 2.1 Schematic diagram of a CNC system

2.2 Principal Characteristics of NC/CNC System

The basic features of NC/CNC system.

(i) Machine tool
(ii) Control unit
(iii) Input data
(iv)Measuring system
(v) Accuracy
(vi)Auxiliary functions

(i) Machine Tool

The major information is the type of machine (i.e. Vertical milling machine, Horizontal milling machine etc.) and it must be followed by additional information such as.

Number of machine axes.

Maximum allowable travelling dimensions of each axis.

Maximum spindle power.

Range of speeds and feeds.

Constant possibilities.

Static Dynamic characteristics.

(ii) Machine Control Unit

Basic information includes

Number of motion control channels.

Type of control structure - Analog or Digital

Type of system - Point to point, Straight line, Continuous path, contouring.

Type of interpolation - Linear, Circular, Parabolic or Combination of these.

Maximum feed rate.

(iii) Input Data

Input data includes information about the control medium, information about computer programs should also be given. Knowledge of the following must be provided.

Control medium: perforated tape, magnetic tape, etc.

Capability of manual handling of input data

Type of dimensional programming: Absolute, Incremental or both etc.

Number of digits in each dimensional word etc.

Input resolution Information about programming methods and

languagesList of Preparatory (G) & Miscellaneous (M) functions

Tool changing codes

Speed and Feed range codes

Tape reader type - Mechanical or photo electric etc.

Tape code - ISO, EIA

Recommended order of words in a block & number of digits in each word

Use of algebraic signs.

(iv) Measuring System

Features of the measuring system

Method of coupling the measuring element

Absolute or Incremental measurement

Type of element - Encoder, Resolver, Inductosyn etc.

(v) Accuracy

Positioning accuracy: Difference between required and actual position of machine slide.

Contour accuracy:Gain in a contouring system

Repeatability: Difference between accuracy on repeating the Operation.

(vi) Auxiliary Information

Floating Zero, Zero offsets, Fixed Zero

Backlash take-up circuit. Compensation capabilities for length and radius of tool Provision for mirror images, scaling etc.

2.2. NC/CNC System Classification

a. Based on feedbackcontrol

b. Based on control system features.

a. Classification based on Feedback control system

Based on feedback control, the NC/CNC systems are classified as Open loop & Closed loop control systems.

(i) Open loop control system

Machine tool control in which there is no provision to compare the actual position of the cutting tool or work piece with the input command value are called open loop systems. In open loop system the actual displacement of the slide may vary with change in external condition and due to wear of the components of the drive mechanism. Open loop systems are less expensive than closed loop systems due to the absence of monitoring devices as shown in figure 2.2 and their maintenance is not complicated.

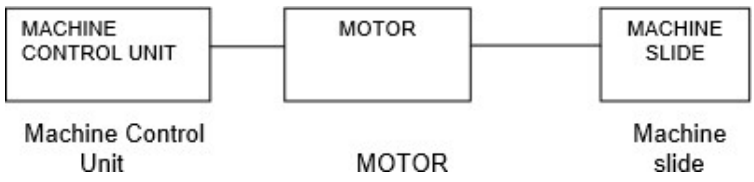

Figure 2.2 Block diagram of open loop system

(ii) Closed loop control system

In a closed loop control system, the actual output from the system i.e. actual displacement of the machine slide is compared with the input signal. The closed loop systems are characterised by the presence of feedback devices in the system. In the closed loop control system, the displacement can be achieved to a very high degree of accuracy because a measuring or monitoring device is used to determine the displacement of the slide.

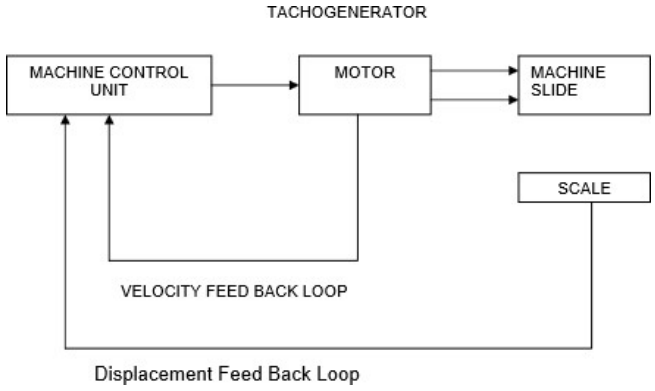

Figure 2.3 Block diagram of Closed loop system

b.Classification Based On Control System Feature

Based on control system feature, the NC/CNC control systems are classified as

(i) Point to point control system
(ii) Straight line control system
(iii)Continuous path / contouring control system

(i) Point to point control system

In point to point control system, control requires to position the machine tool slides to the pre-determined coordinate point. The tool moves to the predetermined position in the shortest possible time. This control system is suitable for the drilling, boring, tapping, punching and jig boring machines.

(ii) Straight line control system

In straight line control system, in addition to point to point control, control to machine along a straight line at controlled feed rate is provided. This is suitable for straight line milling and turning operations.

(iii) Continuous path / contouring controlsystem

In contouring control, several axes can be simultaneously controlled. This enables machining of various contours / profiles.

2.3 Main Elements of CNC Machines

To enable electronic automation with high rate of metal removal at optimum cutting conditions, maintaining high repetitive accuracies with utmost safety to the operator and the machine, CNC machines are specially designed.

The main elements of CNC machines are:

i. Machine structure

ii. Guide ways

iii. Spindle bearings & mounting

iv. Drive units

v. Mech. Power transmission

vi.Position feedback elements / systems

vii. Additional accessories / equipment

viii. Control software

ix. Chip removal system

x. Safety features

i. Machine structure

Structures are designed to withstand static, dynamic & thermal loads providing high stiffness, rigidity & damping properties. The material used is generally mechanite cast iron / special casting with nickel & copper elements. Welded structures aso in wide usage.

ii. Guide ways

Guide ways are designed to reduce/ eliminate friction, providing high, precision. This is achieved through aerostatic / hydrostatic guide ways, Tyco way bearing. LM guide ways and the surfaces of counter guides coated with PTFE (Poly Tetra Ethylene) etc.

iii. Spindle bearings & mounting

Designed for high accuracies, stiffness, stability and to minimise torsional strain providing high rpm range.

iv. Drive units

AC/ DC servo motors and drive systems with infinitely variable speed and high response are used.

V. Mech. Power transmission

Specially designed with minimum gear transmission and isolated to reduce thermal effects, etc. Sliding friction is converted to rolling friction by re-circulating ball screws with nuts arrangement etc. Providing precision movement eliminating backlash, stick-slip etc.

vi. Position feedback elements / systems

Linear / rotary transducers, tacho generators etc., are provided for precise control of the movements of the machine slides etc.

vii. Additional accessories / equipment

Level of automation depends on the accessories/equipment and further enhance the optimum utilization of the CNC machine. The equipment's such as Automatic tool changer, Automatic attachment changers, Work changers, Electronic probes, Tool monitoring system etc.

viii. Control software

Automation level & optimum utilization of the CNC machine depends on features provided in the control system. Such as Simultaneous control of no. of axes. Compensation functions, Mirror image, Scaling etc.

ix. Chip removal system

Efficient chip removal system eliminates thermal effects & thus improves the quality of cutting and the job being machined.

x. Safety

Suitable covers for guide-ways etc., and electronic interlocks for the safety of the operating personnel and machine are provided.

2.4 Advantages of CNC Machine

- Flexibility
- Small batch size
- Reduced work-in-process inventory
- Reduced tooling
- Reduced lead time
- Reliable operation
- Repetitive quality
- Reduced scrap rate
- Optimum machine utilization
- Increased operational safety
- Reduction in manufacturing costs
- Short response time to implement design change

PROGRAMMABLE LOGIC CONTROLLER (PLC)

3.1 PLC

The word PLC stands for Programmable Logic Controllers. . PLC normally consists of a standard hardware built by one manufacturer but used by different Original Equipment Manufacturers (OEM) to achieve the own sequence by programming. These have replaced the relay logic for the following applications.

1. Elevators
2. Washing machines
3. Process control
4. Special purpose machines
5. General purpose machines
6. Transfer lines

As the name suggests these are field programmable and more flexible than the normal relay logic which were being used. Time spent for the modification of the sequence will also be less since the modification is a software modification and not hardware modification. Also PLC provide enhanced functions. These functions include counters, timers and Analog inputs and outputs. Counters and timers are available both in hardware version and software version. PLCs reduce the hardware connections since the actual logic is software, thus enhancing the reliability of the system it is also easy to connect peripherals like Computers, etc., for communication, data storage and display.

PLCs play a vital role in CNC machines as window between the CNC control and the machine. This enables the machine builder to configure his own logic so that the required machine functions can be achieved. This type of window concept allows the system to have standard hardware configuration standardization of the hardware results in improved reliability.

Ladder diagram is one of the methods used to program the PLC's. Thus this is nothing but the Program written by the OEM to control the sequence as per his requirement.

3.2 Hardware Configuration of a Standard PLC

All the PLC systems consists of a Power supply, CPU, input & output Circuits as shown in figure 3.1. These may be part of one unit or can be in modular form. In this description a PLC with back and module arrangement has been considered. Some of the PLC's will in addition provide counter modules, timer modules and analog Input and Output modules. These are mounted on a rack as shown below.

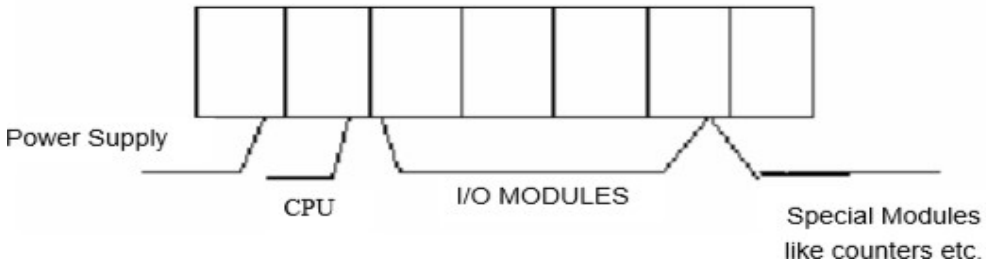

Figure 3.1 Block diagram of PLC

3.3 Functions of Different Modules in aPLC

(i) Power Supply Module

This module normally receives 110V/220V single-phase supply as its input and converts the same into the required voltages for PLC functioning like 24V, DC, 15V DC etc., sometimes this unit also generates the 24V DC supply required for the Inputs.

(ii) CPU (Central Processing Unit)

* Processor
* Operating System
* ALU
* RAM for program memory, timers, counters, Relays, System data.
* Serial port

* Plug in memory module. Processor is the actual control equipment which works based on the operating system. As per the operating system it calls the control programmed in a specified manner and executes the same.

(iii)Operating System

Operating system is the executive program written by the PLC manufacturer which directs the functioning of CPU.

(iv) ALU (Arithmetic Logic Unit)

ALU is used for processing the data which is byte long and word long.

(v) RAM

RAM stores the control program written by PLC user. It also contains data such as timer, counter, system data and working RAM area for holding the results of the logic

.

(vi) Serial Port

Serial port is meant for communication with peripheral devices such as Computer. Printer etc.

(vii) Plug in Memory

Module Plug in memory module is used to store the control programd and associated data in non-volatile memory.

(viii) Input / Output modulesCards

Depending on the marketing requirement various combination of I/O cards are supplied by the manufacturers. They are listed below.

Digital Input Card

* Input voltage 24V DC, 38V DC, 110V AC, 220V Dc.
* Number of Inputs per card or per connector - 8/16/24/32/40/48.
* Current consumption will be normally within 20 milli ampere.
* Also the inputs may have electrical isolation to take care of electrical noise.
* Normally these input units have built in delay to take care of the contact bouncing of the limit switches.

Digital Output card.

* Input voltage 24V DC, 38V DC, 110V AC, 220V Dc.
* Number of Inputs per card or per connector - 8/16/24/32
* Current rating - 200 mA/500 mA/1A/2A
* Built-in protection - Available in higher current modules.

3.4 Programming PLC's

All PLC's need a control program which is written by OEM. This program can be written in different languages. They are.

(i) Statement List
(ii) Ladder diagram
(iii)Control flow chart

(i) Statement List. Language used in this case is Boolean language. Here each instruction in PLC is written as one statement along with the data shown below.

- Load Io. (Limit switch 1)
- And I1 (Limit switch 2)
- And not I2 (Limit switch 3)
- Write O1 (Solenoid 1)

In the above case 'I' stands for Input and 'O' stands for output.

This equation informs the PLC that it limit switch 1 and 2 are closed and if limit switch 3 is not operated then switch on Solenoid 1. To achieve the same function in case of a relay logic, the normal open contacts of limit switch 1 and 2 and NC contact of limit switch 3 were connected in series with coil of Solenoid 1 by wires.

(ii) Ladder Diagram

This is a symbolic representation of the control program in the normal relay logic form using signals of the limit switches. If the logic in statement list is written as ladder it will look as given below. This diagram appears as though the limit switches have been connected physically.Figure 3.2 explains a ladder logic diagram of a network.

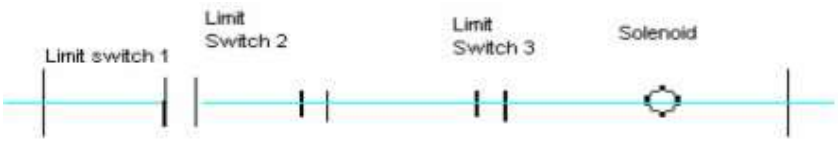

Figure 3.2 Ladder diagram

(iii) Control Flow Chart

In this type of programming the actual logic is written with electronic symbols as shown in figure3.3

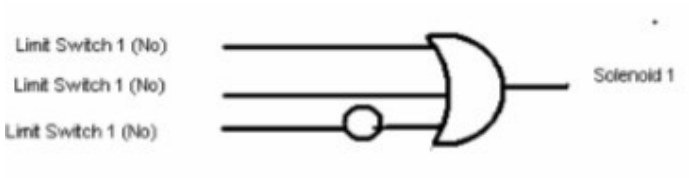

Figure 3.3Control flow chart

In all the cases the same required sequence is represented in different formats.

Control Program

This represents the complete sequence of operation written by the OEM. This consists many networks as shown in the ladder diagram. The CPU starts reading the control program from network 1 till the end of the control program in a sequential order and the time taken to read the complete control program is called the scan time. Scanning principle is specific to each PLC and the manuals must be referred to know the details.

Signals used in Control program

Every control program is based on the following information.

- Each limit switch, push buttons, etc., are connected to the inputs of the PLC. Each input will have it's identify for writing the logic.
- Each Solenoid, contactors, relays etc., are connected to outputs of the PLC. Each output also will have an individual identity for while writing the logic.
- Internal relays are provided in all the PLC for storing the results of the logic. Internal relays can be both volatile and non-volatile type (Retaining the status during the power off).
- Software timers and counters which can be used in the logic are also provided

CNC MACHINES

4.1 CNC Lathes

Figure4.1-CNC lathe

CNC (computer numeric control) lathes remain electrically powered machines that are used to create such symmetrical objects as table legs and baseball bats. The operator programs a task into the lathe and the machine carries out the task on a workload.

Function

According to CNC Information, CNC lathes rotate a workload along an axis and remove material from the workload with each pass. Workloads that are modified by CNC lathes emerge with symmetrical and cylindrical shapes. CNC lathes can be programmed to create an unlimited number of shapes and designs into objects.

Components

CNC lathes are comprised of several integral components. The foundation of a CNC lathe is referred to as its bed. The machine's chuck features jaws that hold workloads in place. A spindle allows for workload rotation. Other key components include a headstock, tailstock and a series of gears. CNC Information claims that many CNC lathes utilize tools that are constructed out of carbide to grind or cut a workload.

Safety

To prevent workload chips and debris from flying about a workspace, CNC lathes employ shields that are either fixed or removable depending on the manufacturer. Employing eye goggles is a further safety measure that CNC operators may choose to employ even if shields are in place. Proper safety measures and correct operational procedures are typically listed in a CNC lathe's instructional manual.

Advantages of CNC Lathe Machines

The CNC lathe turns raw material, which can be metal, plastic, or wood among others, and uses a computer to guide a tool to cut shapes and profiles. The CNC lathe greatly reduces human error overall and can lead to a more productive and efficient manufacturing environment. Although initial costs are high with CNC lathes, they will quickly pay for themselves with their speed and accuracy.

Accuracy

Because the cutting tools are controlled by a computer, you can within .0001 inches as long as your tooling is sharp and the conditions of the spinning material on the lathe are set to optimize the cutting process.

Speed

CNC lathes are not only accurate but can be run very fast. This leads to increased efficiency and more parts per hour. Because CNC lathes often have 12 or more tools in a turret, they can change to another tool rather quickly.

4.2 CNC Milling

CNC Milling, or Computer Numerically Controlled milling (CNC) is the process of machining physical objects from 2D or 3D digital information, which is imported from CAD or other design programs converted to a specific language understood by the machine.

Figure 4.2 CNC MILLING machine

The process of CNC Milling is a 2-Step Procedure.

Step 1: Toolpathing

- Toolpathing is the process of translating a 2D or 3D computer model into a series of "paths" for the CNC mill bit to follow as it excavates the model from a block raw material

Step 2: Machining

- Machining involves translating the toolpaths into commands to small stepper motors in the milling machine that move the head incrementally in the X, Y and Z directions.

Advantages of CNC Milling

- Very good for one-off or geometrically simple objects
- Virtually any material can be milled with a proper cutter, therefore costs are low
- Complex parts can be milled with high detail
- Tolerances of 0.001" to 0.003" are possible
- Weights of parts from a few grams to up to 100 lbs

Disadvantages of CNC Milling

- A more reduced set of features possible
- Certain features are not possible, including internal shapes or parts
- Size limitations depend on the actual CNC machine used
- More material waste than casting type processes
- Quite slow

4.3 CNC Flame Cutting

Provides a very efficient and accurate method for preparing component shapes prior to fabricating a part. Individual component drawings in DXF format are first imported into a nesting software to generate an optimum layout on the available raw material. Once the cutting plan is finalised, the layout is transferred to the CNC Flame Cutting machine which will rapidly cut all the individual parts from the loaded plate using a completely automated Oxy/Fuel flame cutting head. Cutting and machining allowances as well as single bevels if any may be specified ahead of time. Dimensional accuracy as well as cut surface finish are far superior to manual methods and this directly translates to fast fabrication and machining.

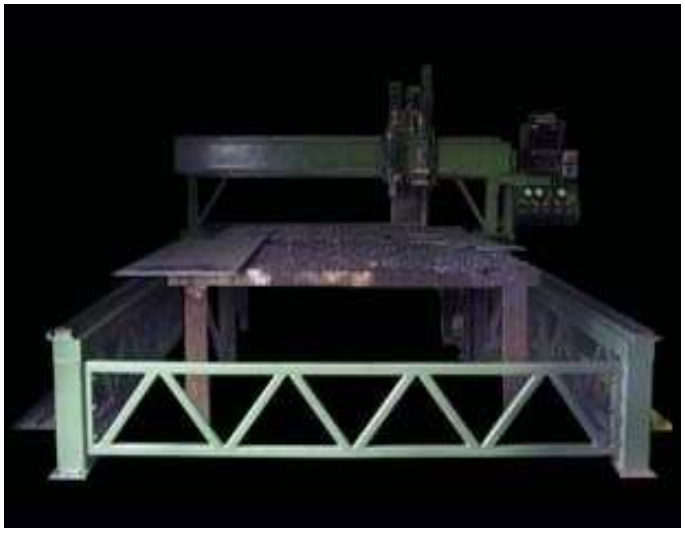

Figure 4.3 CNC Flame cutting machine

Description

Gas used: Oxy-acetylene

Material handled: mild steel

Cutting thickness: up to 220mm

Cutting speed: vary according to work piece thickness

Specifications

Table 4.1 Specifications of CNC flame cutting machines

Materials	Mild Steel, Low Carbon Steel
Max Job Length	14,000 mm
Max Job Width	3,000 mm
Max Job Thickness	150 mm
Min Job Thickness	5 mm
Max Job Weight	5,000 kg
Cutting Tolerance	0.5 mm over 5,000 mm, 1.0 mm over 14,000 mm
Bevelling	Single Bevel upto 45 deg

Applications

1. Machinery Parts
2. Developed Sections
3. Sign making
4. Ship building panels and frames
5. Large module gear wheels and sprockets
6. Any profile cut part required for fabrication

4.4. Application of PLC in CNC Systems

PLC in case of a CNC is meant for the machine tool builder who can connect all the peripherals on machine to the inputs and outputs. Normally PLC in case of CNC is integrated into the system and hence may not have a separate CPU as shown in case of only a PLC. Also it is possible to connect any general PLC to a CNC system and write the logic as desired to achieve the functions. Block diagram of a CNC machine is given below for reference.

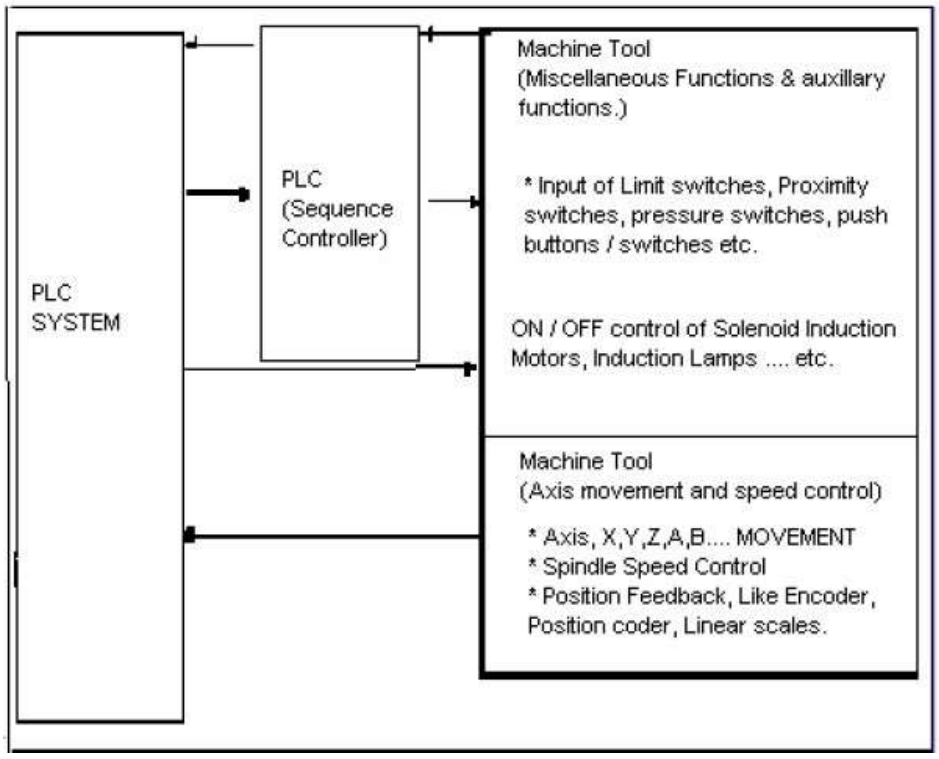

Figure 4.4 CNC system configuration

(i) Data Transfer from CNC to PLC

As discussed earlier functions like ATC, APC, Coolant chip conveyer etc. are controlled by the PLC. These functions should be transferred the CNC to PLC. Addi- tionally signals like machine healthy, machine position data etc. may be needed in the PLC for providing the interlocks to ensure safety of the machine and the operator. Since the PLC is normally integrated with the system with either the same CPU or a Microprocessor, this data transfer becomes easy.

(ii) Data Transfer from PLC to CNC

CNC machine has combined operation of axes movement, spindle control, and PLC control functions like ATC/APC. Hence PLC being the window between the machine and CNC has to provide the data to the CNC regarding interlocks required before spindle or an axis can start. Also an operator should be able to decide the functions required by the machine. Safety requirements of the machine need to be informed to the CNC control. These signals form part of the communication from PLC to CNC.

(iii) Input from machine to PLC.

All machine signals are connected to inputs available with the PLC of the CNC systems.

(iv) Outputs from PLC to machine.

- Machine control like relays, solenoids, lamps are driven using the outputs.
- In addition to the above signals which are a must for working of the CNC machines. PLCs use with CNC systems provide certain special facilities as listed below.

(v) Scanning

PLC in case of CNC also works based on the control programme. However in most of the controls two scanning systems are provided. These are listed below.

1. Interrupt Scanning or Short term scanning.
2. Normal scanning of the signals.

During interrupt scanning or short scanning time the status of the signals from the machine is read immediately on observing the change of the signals. During normal

scanning the I/O data is transferred at the beginning other the scanning of the program.

All the details given here deal in general about the PLC used in any CNC SYSTEM. However it is always necessary to refer to the manufacturers manuals for complete details.

4.5 Role of PLC in CNC Systems

(i) Machine tool functions controlled by PLC are

- Miscellaneous Functions
- Spindle Functions
- Tool Functions

(ii) Inputs to PLC are

- Switching Elements on the Machine
- Switches / Push Buttons on control panel
- M, S, & T codes in Part program

(iii) Outputs controlled by PLC can be

- Contactors
- Solenoid Valves
- Electro-Magnetic Clutches
- Lamps, etc.

(iv) Types of PLCs in CNC systems

- Integrated
- External

CONCLUSION

5.1 Conclusion

Latest CNC machines are very sophisticated and costly equipment. Their accuracy and production capability will be greatly reduced it they are not properly maintained. Use of diagnostic tasks and pinpoint troubled areas. Remote diagnostic features of CNC system greatly reduce the diagnostic communication systems for computer controlled machine tools further simplifies the task of maintenance personnel.