


Computer Numerical Control (Part-1)

6ME1A: Computer Integrated Manufacturing Systems

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1

1

Syllabus

Unit-I

Introduction to CIM: Overview of Production Systems, the product cycle, Automation in Production Systems, computer's role in manufacturing, sources and types of data used in manufacturing. The Beginning of CAM: Historical Background.

Numerical Control (NC): Basic components of an NC system, coordinate system and motions control systems. Computer Numerical Control (CNC): features of CNC, machine control unit, CNC software. Direct Numerical Control and Distributed Numerical Control. Applications, advantages and disadvantages of NC. Adaptive control of machining system.

Unit-II

NC Part programming: Manual and computer assisted part programming, Part programming with APT. NC part programming using CAD/CAM software. NC cutter path verification.

2

2

Outcomes

- Basic concept of CNC machines
- Appropriateness of CNC machines
- Advantages, disadvantages and applications of CNC machines

3

3

Contents

- Introduction
- Historical Perspective
- Computer numerical control
- Where is NC most appropriate?
- Advantages CNC machine tools
- Disadvantages CNC machine tools

4

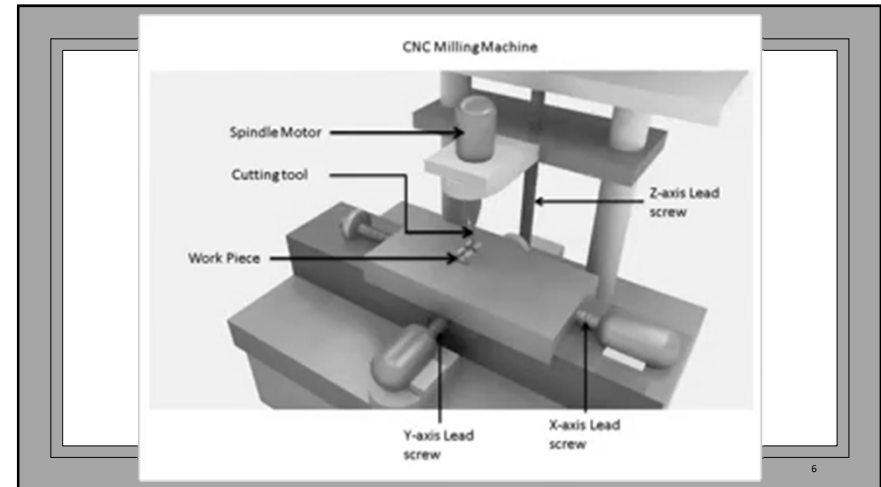
4

Terminologies used in Automation

- ▶ FMS (Flexible Manufacturing System)
- ▶ CAPP (Computer Aided Process Plan)
- ▶ CAD (Computer Aided Design/Drafting)
- ▶ CAM (Computer Aided Manufacturing)
- ▶ CIM (Computer Integrated Manufacturing)
- ▶ CAE (Computer Aided Engineering)
- ▶ RPT (Rapid Prototype Technology)

5

5



6

6

Introduction

- ▶ The word NC which stands for Numerical Control refer to control of a machine or a process using symbolic codes consisting of characters and numerals.
- ▶ The word CNC stands for Computer Numerical Control and came into existence in seventies when microprocessors and microcomputers replaced integrated circuit (IC) based controls used for NC machines.

7

7

Historical Perspective

- ▶ The concept of NC was proposed in the late 1940s by John Parsons who recommended a method of automatic machine control that would guide a milling cutter to produce a curvilinear motion in order to generate smooth profiles on the work-pieces.
- ▶ In 1949, the U.S Air Force awarded Parsons a contract to develop new type of machine tool that would be able to speed up production methods.
- ▶ Parsons sub-contracted the Massachusetts Institute of Technology (MIT) to develop a practical implementation of his concept. Scientists and engineers at M.I.T built a control system for a two axis milling machine that used a perforated paper tape as the input media. By 1955, these machines were available to industries with some small modifications.

8

8

Computer Numerical Control

- ▶ Computer numerical control (CNC) is the numerical control system in which a dedicated computer is built into the control to perform basic and advanced NC functions.
- ▶ CNC controls are also referred to as soft-wired NC systems because most of their control functions are implemented by the control software programs.
- ▶ CNC is a computer assisted process to control general purpose machines from instructions generated by a processor and stored in a memory system.
- ▶ The computer allows for the following: storage of additional programs, program editing, running of program from memory, machine and control diagnostics, special routines, inch/metric, incremental/absolute switch ability.

9

9

Computer Numerical Control

- ▶ CNC machines can be used as standalone units or in a network of machines such as flexible machine centers.
- ▶ The controller uses a permanent resident program called an executive program to process the codes into the electrical pulses that control the machine.
- ▶ In any CNC machine, executive program resides in ROM and all the NC codes in RAM. The information in ROM is written into the electronic chips and cannot be erased and they become active whenever the machine is on.
- ▶ The contents in RAM are lost when the controller is turned off. Some use special type of RAM called CMOS memory, which retains its contents even when the power is turned off.

10

10

Where is NC most appropriate?

- Parts are processed frequently and in small to mediums for sizes.
- Part geometry is complex.
- Close tolerances must be held on the work part.
- Many operations must be performed on the part in its processing.
- Much metal needs to be removed.
- Engineering design changes are likely.
- It is an expensive part where mistakes in processing would be costly.
- Parts require 100% inspection.

11

11

Advantages CNC machine tools

- ▶ CNC machines can be used continuously and only need to be switched off for occasional maintenance.
- ▶ These machines require less skilled people to operate unlike manual lathes / milling machines etc.
- ▶ CNC machines can be updated by improving the software used to drive the machines.
- ▶ Training for the use of CNC machines can be done through the use of 'virtual software'.

12

12

Advantages CNC machine tools

- ▶ The manufacturing process can be simulated virtually and no need to make a prototype or a model. This saves time and money.
- ▶ Once programmed, these machines can be left and do not require any human intervention, except for work loading and unloading.
- ▶ These machines can manufacture several components to the required accuracy without any fatigue as in the case of manually operated machines.
- ▶ Savings in time that could be achieved with the CNCs are quite significant.

13

13

Advantages CNC machine tools

High flexibility	Increased productivity
Reduced scrap rate	Consistent quality
Reliable operation	Shorter cycle time
Reduced manpower	Better safety
High accuracy	Reduced Non-productive time

14

14

Disadvantages CNC machine tools

- ▶ CNC machines are generally more expensive than manually operated machines.
- ▶ The CNC machine operator only needs basic training and skills, enough to supervise several machines.
- ▶ Increase in electrical maintenance, high initial investment and high per hour operating costs than the traditional systems.
- ▶ Fewer workers are required to operate CNC machines compared to manually operated machines. Investment in CNC machines can lead to unemployment.

15

15

Applications of NC/CNC machine tools

CNC was initially applied to metal working machinery: Mills, Drills, boring machines, punch presses etc. and now expanded to robotics, grinders, welding machinery, EDM's, flame cutters and also for inspection equipment etc.

The machines controlled by CNC can be classified into the following categories: CNC mills and machining centers.

- CNC lathes and turning centers
- CNC EDM
- CNC grinding machines
- CNC cutting machines (laser, plasma, electron, or flame)
- CNC fabrication machines (sheet metal punch press, bending machine, or press brake)
- CNC welding machines
- CNC coordinate measuring machines

16

16



17