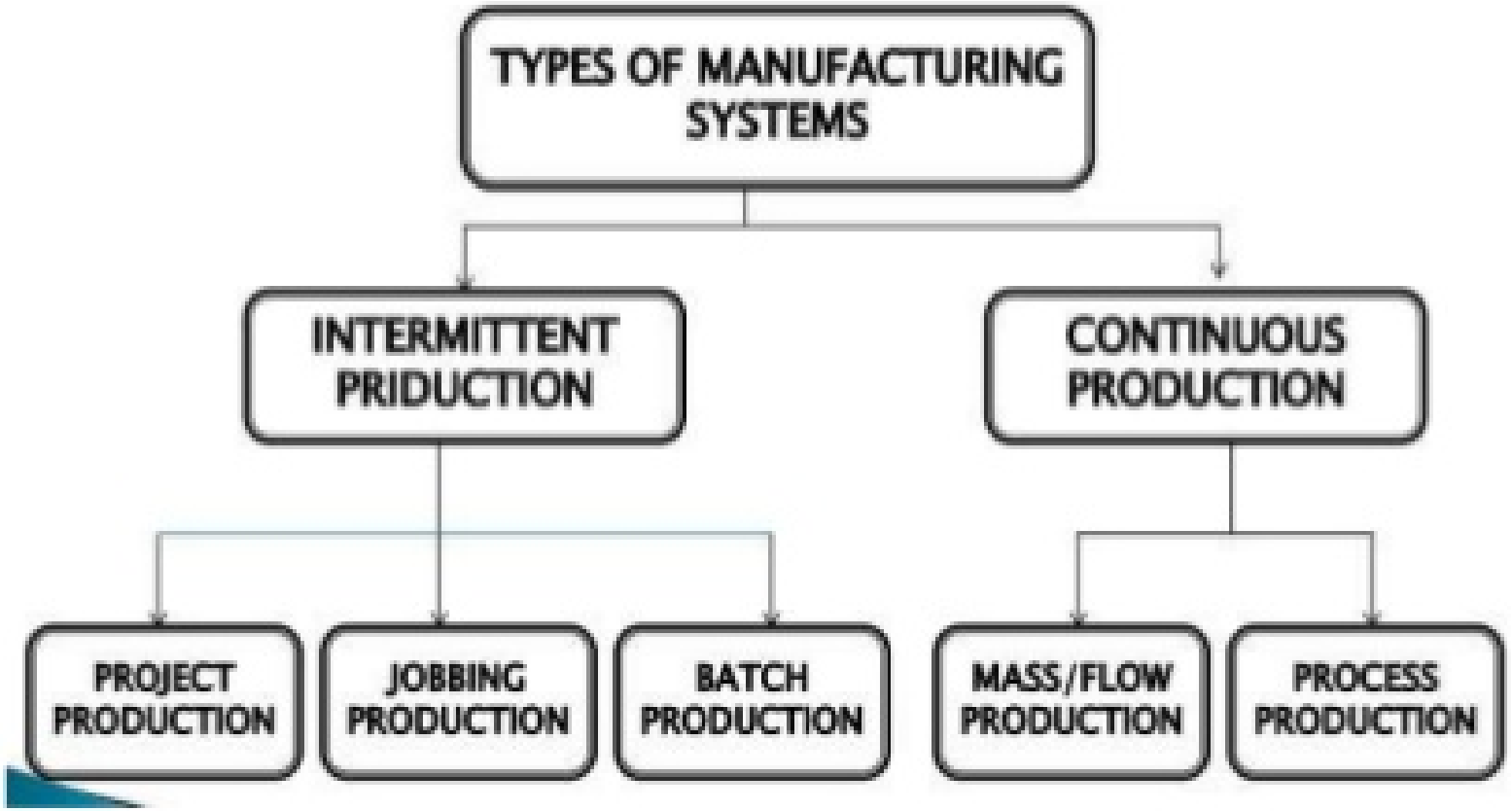
TOPICS TO BE COVERED

- Manufacturing Systems
- Types of Manufacturing Systems
- Fundamentals of Numerical Control(NC).
- Basics components of Numerical Control(NC)
- Classifications of NC
- Comparison of NC and CNC

MANUFACTURING SYSTEM

- The system which is utilized for making some goods/articles by hand or by the help of some kind of machinery is termed as manufacturing system.

Types Of Manufacturing Systems:

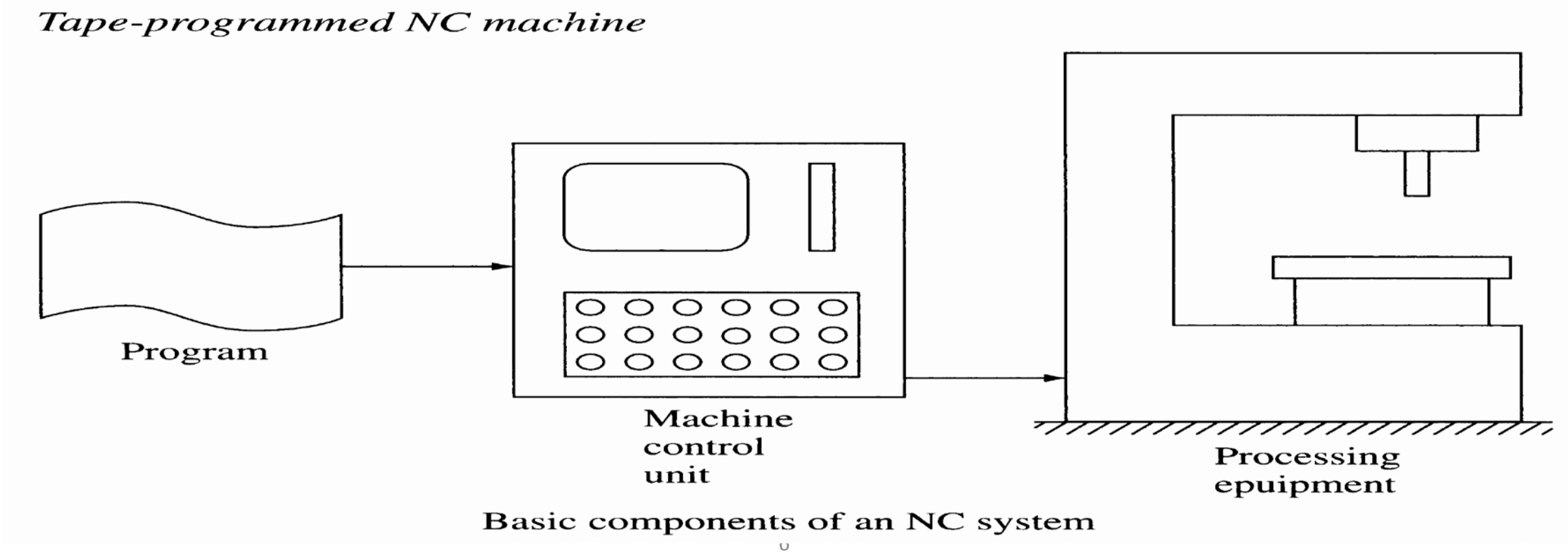


Numerical Control (NC)

- Numerical control (NC) is a form of flexible (programmable) automation in which the process is controlled by numbers, letters, and symbols.
- The electronic industries association (EIA) defined NC as
  - “A system in which actions are controlled by the direct insertion of numerical data at some point. The system must automatically interpret at least some portion of this data.”

Basic Components

- An NC system consists of the machine tools, the part-program, and the machine control unit (MCU).



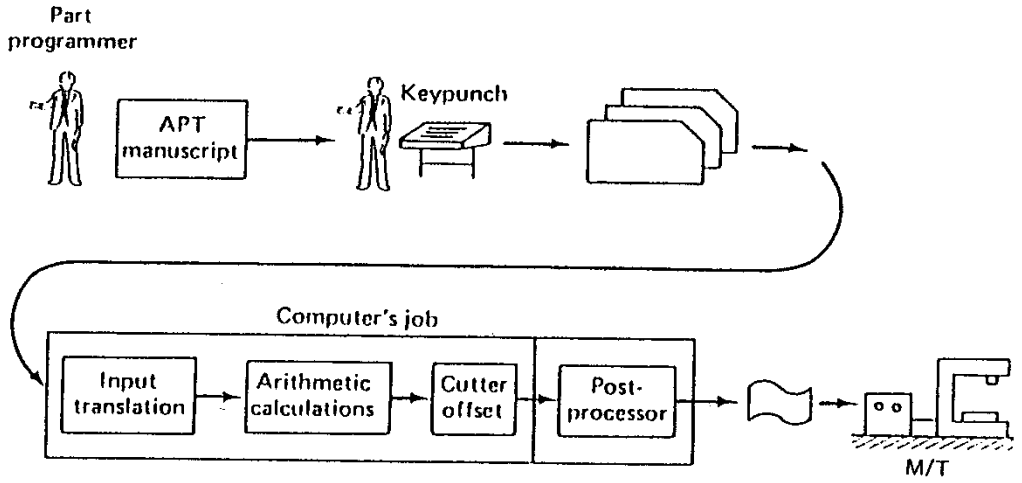
Basic components of an NC system

Machine Tools

- The machine tools perform the useful work.
- A machine tool consists of.
  - A worktable,
  - One or more spindles, motors and controls,
  - Cutting tools,
  - Work fixtures, and.
  - Other auxiliary equipment needed in the machining operation.

- The drive units are either powered by stepping motors (for open-loop control), servomotors (for close-loop control), pneumatic drives, or hydraulic drives.

The Part-program



- The part-program is a collection of all data required to produce the part. It is arranged in the form of blocks of information.
- Each block contains the numerical data required for processing a segment of the work piece.

The Machine Control Unit

- The machine control unit consists of the data processing unit (DPU) and the control loop unit (CLU).
  - The DPU decodes the information contained in the part-program, process it, and provides instructions to the CLU.
  - The CLU operates the drives attached to the machine leadscrews and feedback signals on the actual position and velocity of each one of the axes. The drive units are actuated by voltage pulses.

The Machine Control Unit

- The number of pulses transmitted to each axis is equal to the required incremental motion, and the frequency of these pulses represent the axial velocity.
  - Each incremental motion is called a *basic length unit* (BLU).
  - One pulse is equivalent to 1 BLU.
  - The BLU represents the resolution of the NC machine tool.

Types of NC Systems

Point-to-point (PTP) NC

- The cutting tool is moved relative to the work piece (i.E., Either the cutting tool moves, or the work piece moves) until the cutting tool is at a numerically defined position and then the motion is paused.
- The cutting tool then performs an operation.
- When the operation is completed, the cutting tool moves relative to the work piece until the next point is reached, and the cycle is repeated.
- The simplest example of a PTP NC machine tool is the NC drilling machine.

Straight-cut NC

- Straight-cut system are capable of moving the cutting tool parallel to one of the major axes (X-Y-Z) at a controlled rate suitable for machining.
- It is appropriate for performing milling operations to fabricate work pieces of rectangular configurations.
- Straight-cut NC systems can also perform PTP operations.

Contouring NC

- In contouring (continuous path) operations, the tool is cutting while the axes of motion are moving.
- The axes can be moved simultaneously, at different velocity.
- The path of the cutter is continuously controlled to generate the desired geometry of the work piece.

Computer-assisted NC Programming

1. The computer interprets the instructions in the program into computer-usable form.
2. The computer performs the necessary geometry and trigonometry calculations required to generate the part surface.
3. The part-programmer specifies the part outline as the *tool path*. Since the tool path is at the periphery of the cutter that machining actually takes place, it must be offset by the radius of the cutter.

4. The cutter offset computations in contour part-programming are performed by the computer.
5. Part-programming languages are general-purpose languages. Since NC machine tool systems have different features and capabilities, the computer must take the general instructions and make them specific to a particular machine tool system. This function is called *post processing*.

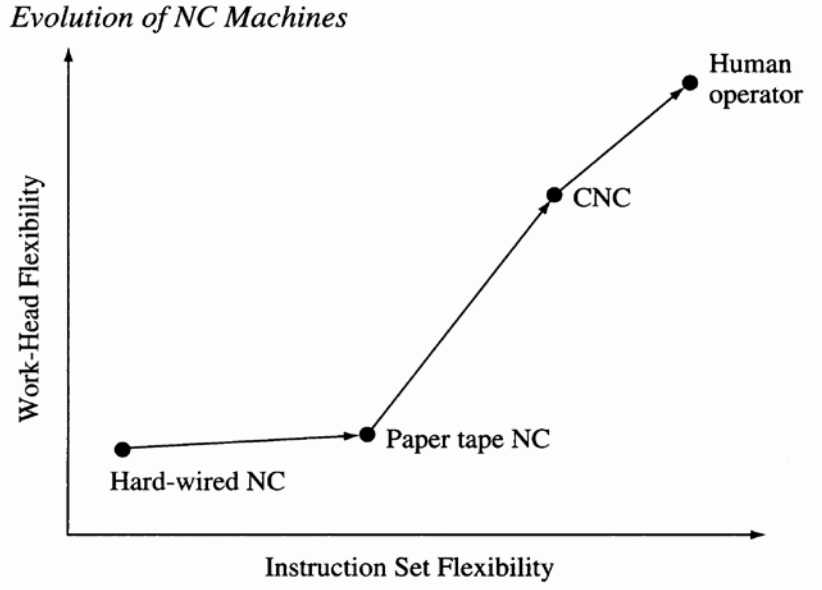
6. After converting all instructions into a detailed set of machine tool motion commands, the computer controls a tape punch device to prepare the tape for the specific NC machine.
7. Graphic proofing techniques provide a visual representation of the cutting tool path.

8. This representation may be a simple two-dimensional plot of the cutter path or a dynamic display of tool motion using computer generated animation.
9. If necessary, part-programs are also verified on the NC station using substitute materials such as light metals, plastics, foams, wood, laminates, and other castable low cost materials used for NC proofing.

Computer Numerical Control (CNC)

- The EIA definition of computer numerical control (CNC).
  - “A numerical control system wherein a dedicated, stored program computer is used to perform some or all of the basic numerical control functions in accordance with control programs stored in the read-write memory of the computer.”

The CNC uses a dedicated microprocessor to perform the MCU functions.

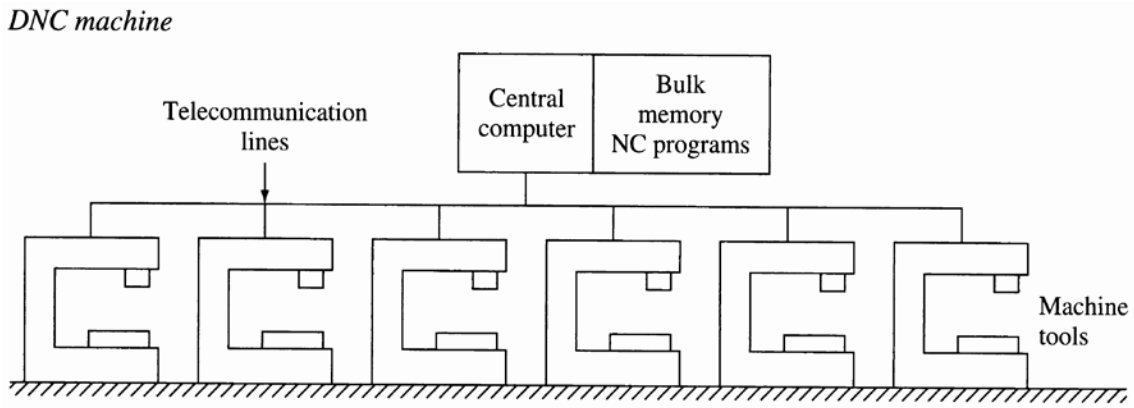


- CNC supports programming features not available in conventional NC systems:
  - Subroutine macros which can be stored in memory and called by the part-program to execute frequently-used cutting sequence.
  - Inch-metric conversions, sophisticated interpolation functions (such as cubic interpolation) can be easily accomplished in CNC.
  - Absolute or incremental positioning (the coordinate systems used in locating the tool relative to the work piece) as well as PTP or contouring mode can be selected.

- The part-program can be edited (correction or optimization of tool path, speeds, and feeds) at the machine site during tape tryout.
- Tool and fixture offsets can be computed and stored.
- Tool path can be verified using graphic display.
- Diagnostics are available to assist maintenance and repair.

Direct Numerical Control (DNC)

- The EIA definition of DNC.
  - “A system connecting a set of numerically controlled machines to a common memory for part program or machine program storage with provision for on-demand distribution of data to machines.”
  - In DNC, several NC machines are directly controlled by a computer, eliminating substantial hardware from the individual controller of each machine tool. The part-program is downloaded to the machines directly (thus omitting the tape reader) from the computer memory.



Points of difference b/w CNC and Conventional Machines

CNC Machine	Conventional Machine
•CNC machines can be used continuously for long intervals and only need to be switched off for occasional maintenance.	•Conventional machines are difficult operate for several hours at a stretch. The operator has to continuously focus on the job at hand.
•CNC machines can produce several products, all similar and dead accurate	•Resemblance of the products formed depends on the skill of the operator. Visible differences may occur
•Less skilled/trained persons can operate the CNC machines.	•Highly skilled operators are required to work on conventional machines
•CNC machines can be updated by using improved software to drive the machines.	•Chances for major improvement in the same conventional machines are very less.
•One person can supervise several CNC machines, and they can be left to work themselves.	•One person cannot operate more than one conventional machine at a time

NC, CNC and DNC

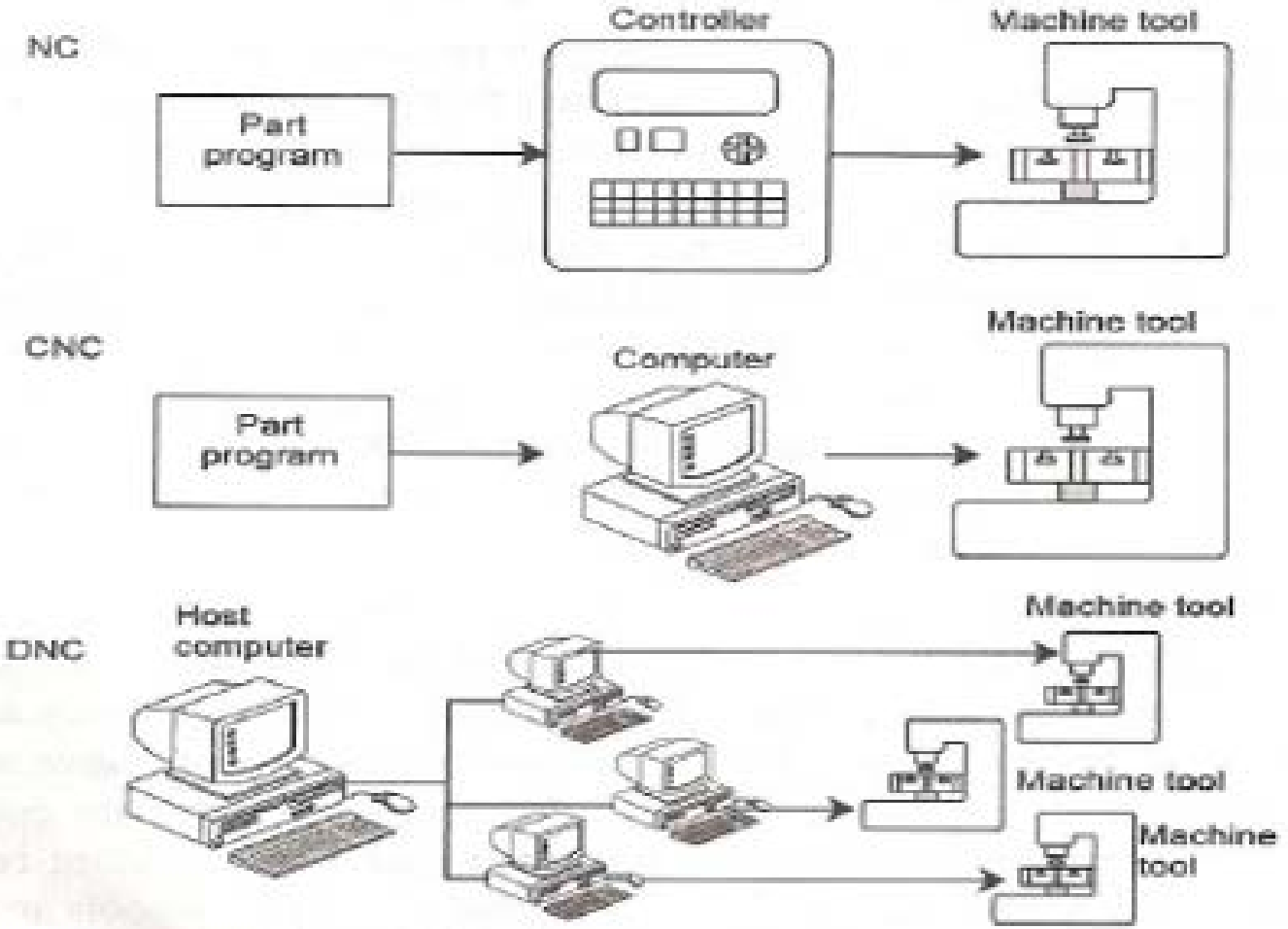


Figure 1.7: NC, CNC, and DNC Systems