Introduction to Numerical Control

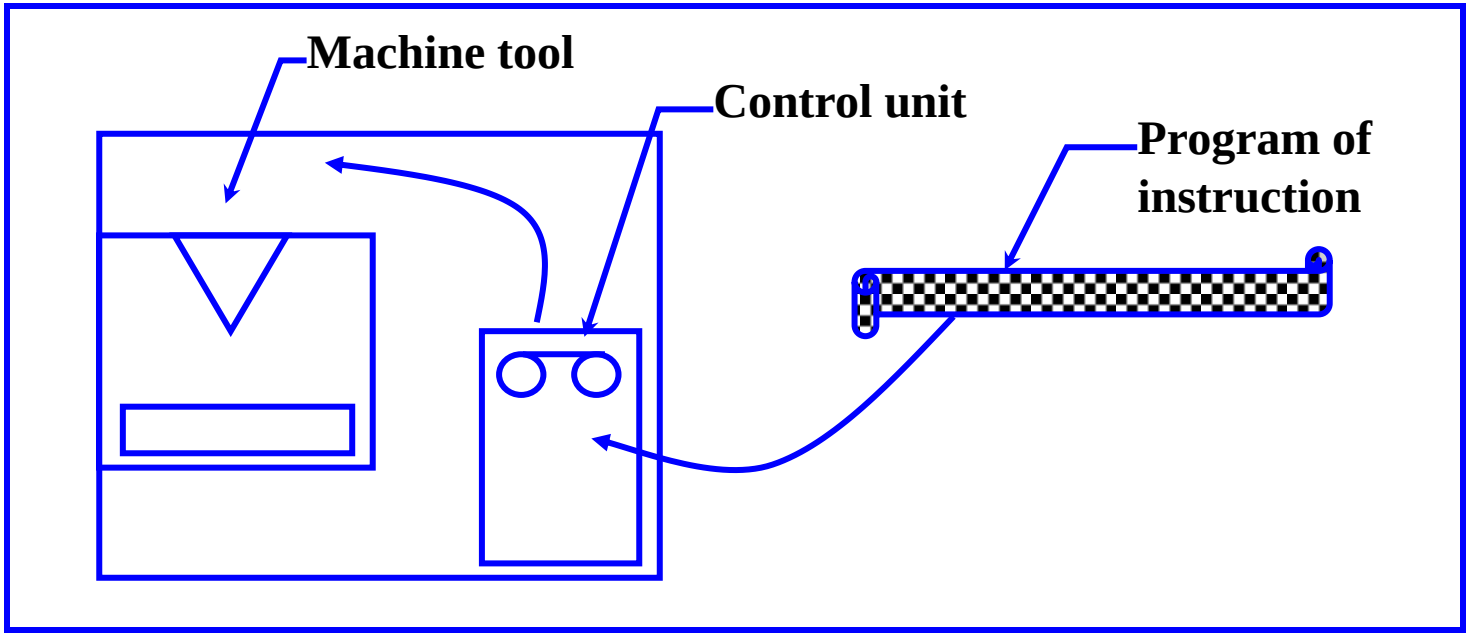
What is numerical control (NC)?

NC has been defined by the Electronic Industries Association (EIA) as" a system in which actions are controlled by the direct insertion of numerical data at some points. The system must automatically interpret at least some portion of this data"

The term 'NC' is used to describe the control of the various functions of a machine using numeric data. In the early age of NC, machines were fed with information by means of the punched tape. An Electro-mechanical tape reader was used to load a machine tape into the controller.

In general there are three basic components of an operational NC (as illustrated in Figure 1):

1. Programme of instruction.
2. A machine control unit.
3. Machine tool.



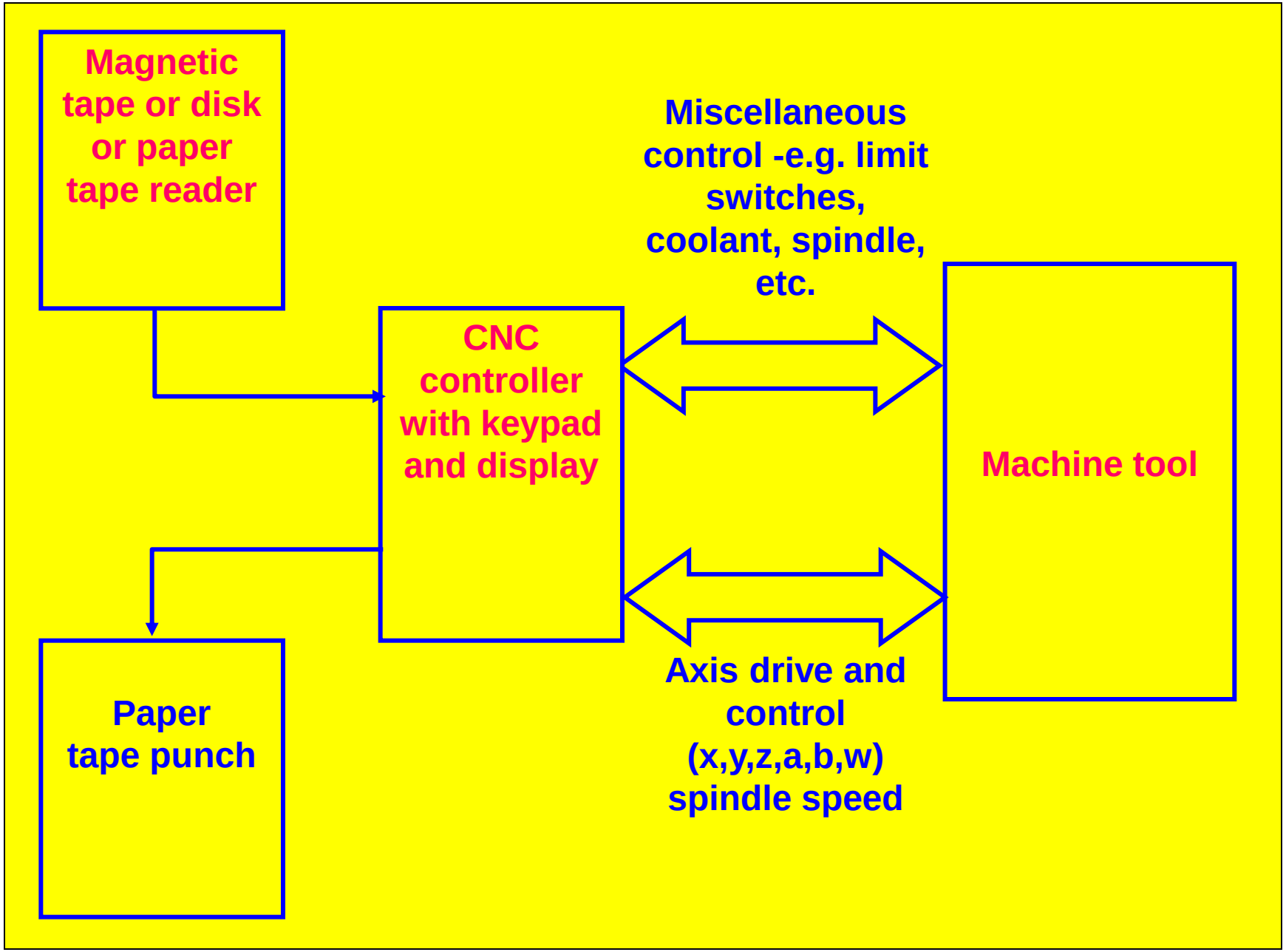
The program of instruction is a numerical or symbolic code that is detailed step-by-step to tell the machine tool what to do.

The controller unit is the unit that reads the programme of instructions and converts it to real movement of a machine tool. Two basic types of control unit are used with NC machines: open-loop control and closed-loop control.

The machine tool performs the mechanical work and deals directly with the part being machined.

Computer Numerical Control (CNC)

CNC refers to a computer that is joined to the NC machine to make the machine versatile. Information can be stored in a memory bank. The programme is read from a storage medium such as the punched tape and retrieved to the memory of the CNC computer. Some CNC machines have a magnetic medium (tape or disk) for storing programs. This gives more flexibility for editing or saving CNC programs. **Figure 2 illustrates the general configuration of CNC.**


Magnetic tape or disk or paper tape reader
Miscellaneous control -e.g. limit switches, coolant, spindle, etc.
CNC controller with keypad and display
Machine tool
Paper tape punch
Axis drive and control (x,y,z,a,b,w) spindle speed

Direct Numerical control (DNC) can be defined as *a set of NC machines that is connected to a main computer* system to establish a direct interface between the DNC computer memory and the machine tools. The tape is not used in the DNC system; hence *a central time-sharing computer is used*. *The basic structure of DNC system is illustrated in Figure 3.*

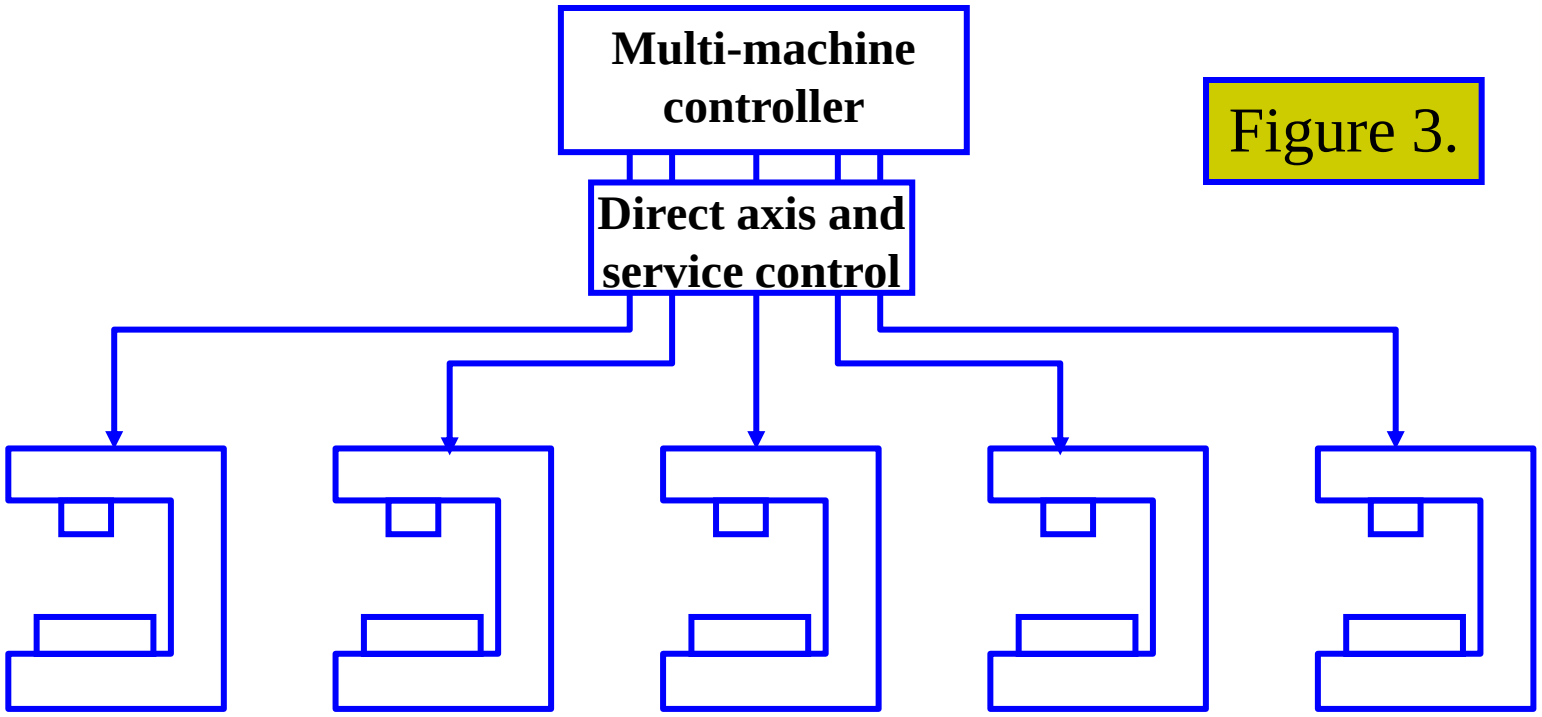
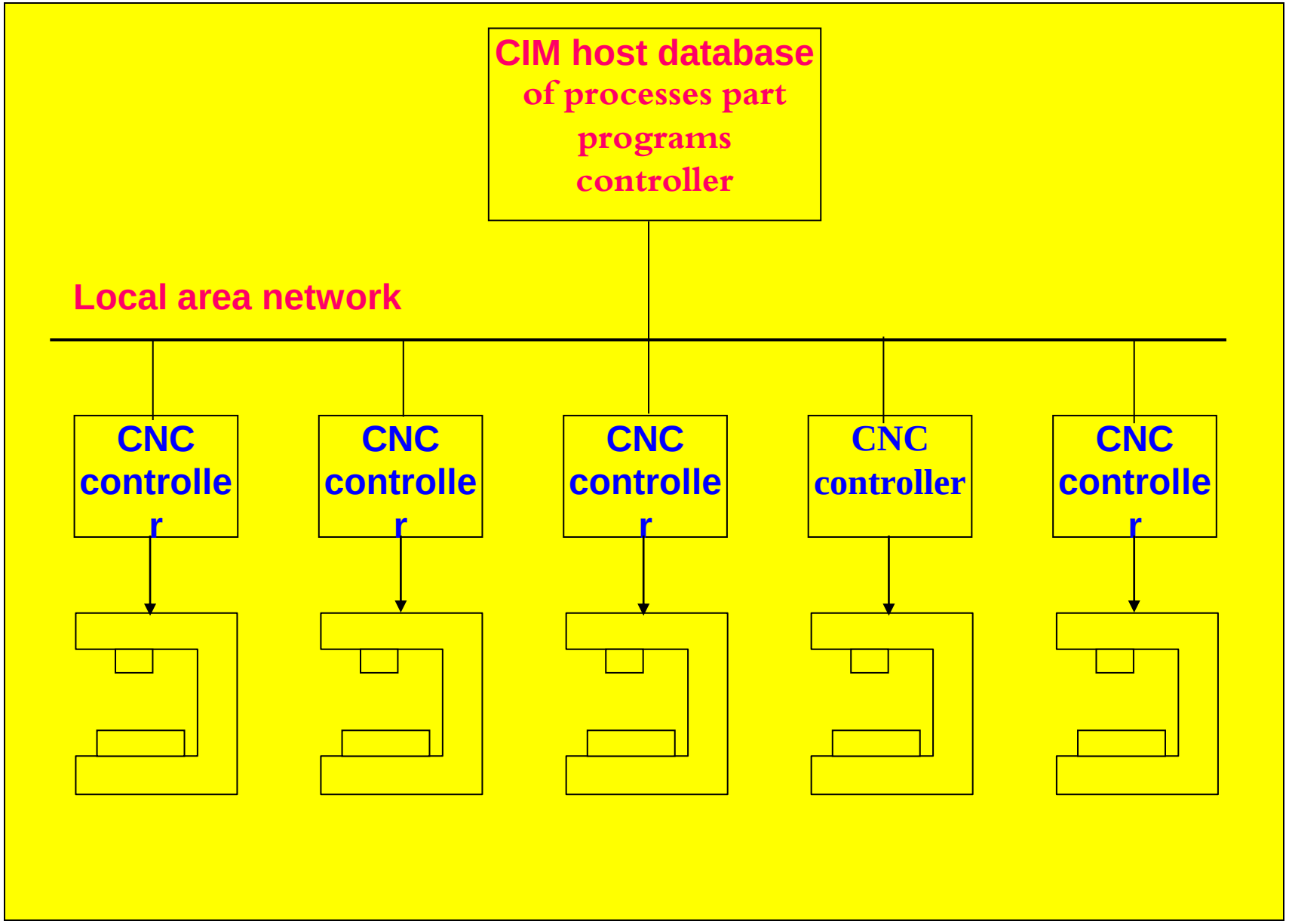


Figure 3.

Distributed Numerical Control

Distributed NC is more advanced than DNC and is widely used in many current applications. The distributed NC uses a local area network but not like that in DNC. It has been indicated that the main difference between DNC and distributed NC is that because modern NC machines have CNC capability, they have memory and therefore computer programs can be downloaded into the memory of a CNC local computer, rather than one block at a time as in DNC systems. Figure 4 illustrates the distributed NC system.


CIM host database
of processes part
programs
controller
Local area network
CNC
controller
CNC
controller
CNC
controller
CNC
controller
CNC
controller

Voice Numerical Control (VNC)

Voice Numerical Control (VNC) is similar to DNC machines but the programmer conveys the information needed to operate the machine by means of computer system. The programmer talks into the computer, and the memory receives the information using a wire. This information can be taken and used to run the machines.

Advantages of CNC

1. Increased productivity.
2. High accuracy and repeatability.
3. Reduced production costs.
4. Reduced indirect operating costs.
5. Facilitation of complex machining operations.
6. Grater flexibility.
7. Improved production planning and control.
8. Lower operator skill requirement.
9. Facilitation of flexible automation.

Limitations of CNC:

1. High initial investment.
2. High maintenance requirement.
3. Not cost-effective for low production cost.

Applications of NC

Machine tool applications:

1. Milling machines.
2. Drilling machines.
3. Boring machines.
4. Turning machines.
5. Grinding machines.
6. Sawing machines.

Non- machine tool applications:

1. Welding machines- flame cutting machines.
2. Press-working machines- assembly machines.
3. Inspection machines- automatic drafting machines

CNC Fundamentals