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# CNC Machines – A Boon for Manufacturing Industries and Backbone of Cellular Manufacturing Systems

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### ABSTRACT

The concept of CNC (Computer Numerical Control) in machine tool evolved at the Massachusetts Institute of Technology (MIT), USA between the year 1947 to 1952 for the manufacture of complex & accurate helicopter blades. Since then, this technology has been applied to many different types of machines & machine tools. Now a days the CNC machines have found adoption of by many industries. They have become virtually indispensable in many manufacturing industries because of their many advantages and easy management & reliability. In the face of stiff competition, higher cost of labour & higher rejection of parts, CNC machines proved to be a boon for any manufacturing industry, be it a metal cutting industry, metal forming industry & any other manufacturing industry. Now a days no industrialist can think of putting up an industry without CNC machines, such are their importance & advantages. Talking of Cellular Manufacturing Systems, where a cell of machine tools & other facilities like job movement arrangement etc are created to process a machine part or component from the input of raw material to the finished part. One cannot think of designing such a cell without any CNC machine. CNC machines are part & parcel of Cellular Manufacturing Systems. Rather, they form the backbone of Cellular Manufacturing Systems.

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### 1.0 Introduction

#### Definition of CNC:

CNC means Computerized Numerical Control, It is such a technology where machine tool movements are controlled with the help of computers by using alpha numerical codes. The operation of CNC machines needs CNC part programs. These programs are prepared using alpha numeric codes which contain various informations like job dimensions, shapes, tolerances, machine operating parameters like speed, feed, depth of cut. It also contains information i.e coded instruction to the CNC machines when to start & stop coolants, when to dwell & various other parameters. In CNC machines the various machine slides are moved using recirculating ball screws & servomotors. The motion commands are given to the CNC machines using alphanumeric codes. These as machine then interprets the various commands and operate accordingly. The motion command that is given to the machine is then compared to the actual movement of the machine & if there is any discrepancy, the same is corrected by the CNC system & the accurate positioning is obtained.

#### What is CNC?

#### ChattoPadhyay [7] defines CNC as follows:

Computer Numerical Control (CNC) is the the process of having a computer control of the operation of a machine. This would include the table motions, the spindle speed, and various other machining functions. Having the computer control the machine is accomplished by a program that is written using NC code. CNC is a technology, which permits automatic operation of a machine tool or process through a

series of coded instructions consisting of numbers, letters and other symbols.

#### According to Electronics Industries Alliance of USA (EIA) the definition of CNC is as follows:-

“A system in which actions are controlled by direct insertion of numerical data at some point. The system must automatically interpret at least some portion of this data”. The data required to produce a part is called Part-Program.

#### According to HMT, India [4]

#### 1.1 Suitability of CNC Machines:

- Accuracy - high
- Number of operations per component – many
- Complexity of operations – high
- Repetition of batches – often.
- Labor cost of component – high
- Skill required by the operator for setting – high
- Ratio of non cutting time to cutting time – high
- Variety of components to be produced – more
- Time lag between operations - high
- Cost of special tooling involved – high
- Design changes – frequent
- Setup & dimensions to be maintained – many
- Precision involved in component – high
- Non-uniform cutting conditions – required

#### 1.2 Types of CNC Machines:

- CNC turning machines
- CNC milling machines
- CNC turn-mill centers
- CNC machining centers
- CNC turret punches

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- CNC laser cutting machines
- CNC floor borers
- CNC drilling machines
- CNC flame cutting machines
- CNC bending machines
- CNC press brakes
- CNC wire cut electric discharge machines (EDMs)
- CNC 3 – dimensional coordinate measuring machines (CMMs)

### 1.3 Advantages of Numeric Control:

- Higher productivity in small production
- Lower cost of machining
- Higher repetitive accuracy
- Requirement of lesser skill for their operation
- Can switch over to different jobs in minimum time
- Increased machine utilization, lesser inspection time
- Greater quality control
- Mid tolerances can be achieved for all dimensions
- Eliminates rework & scrap
- Saving in jigs & fixtures, cost of machining
- Change in design can be easily incorporated, as it is the part-Program, which requires change.
- Reduced inventory
- Reduced floor space
- Low requirement of skilled manpower
- Optimum utilization of machine capacity
- Operations are faster as it is possible to perform many operations on a single machine.
- Cutting technology stored in the form of a part program
- Development work can be done faster
- Cost accounting & production planning & control becomes very precise

### 1.4 Advantage of CNC over Conventional

- Reduced work handling
- Reduced number of tooling (inventory)
- Automation
- Reduced cycle time
- Reduced paper work
- Repeatability with same accuracy
- Design freedom and flexibility of design changes
- Comfort to operators
- Better tool Management and less cost of operation
- Freedom from regrinding the tool

### 1.5 Functions performed by NC machines:

- Movement of Machine slides.
- Turning the spindle ON/OFF
- Changing the cutting tool
- Indexing a part
- Turning the coolant ON/OFF
- Tool changing, Probe control

## II. Two Main Types of CNC Machines

The simplest form of CNC machine is a CNC Lathe. Figure 1 shows a CNC Lathe where there are only two axes of movement that is there are two individual movements. The movements are made possible with the help of recirculating ball screws & servomotors. Cylindrical shaped jobs can be machined on CNC lathes having various contours, threads, tapers etc. Electric motor shafts & other shaft like jobs are machined on CNC lathes.

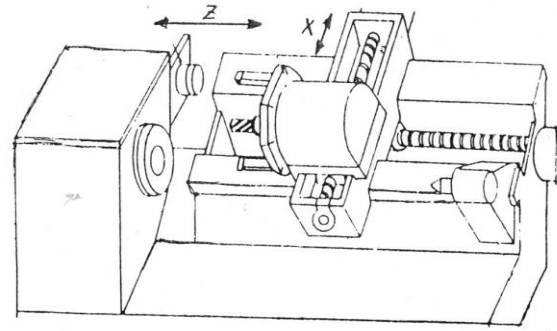
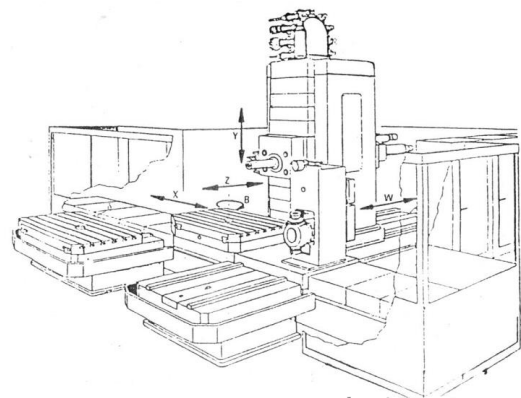


Fig. 1

Figure 2, shows a CNC machining Centre. In such a machine many different types of operations can be carried out on the same machine. In this machine, there are many axes of movements that is there are many independent motions like X, Y, Z, W etc. Apart from this, this machine is equipped with two automatic pallet changers (APC) & an automatic tool changer ATC which can store & change a number of cutting tools as per the command of the CNC program. The Automatic Pallet Changer makes it possible to set – up the next job on the CNC machine, while one job is, under machining on the CNC machine. This saves a lot of job set-up time. The Automatic Tool Changer can store a number of cutting tools. Wherever a particular cutting tool needs change, the same is made possible by the use of a robotic tool change arm. Prismatic components like DC Motor Magnet Frames are machined on such a CNC Horizontal Machining Centre(HMC). Apart from cutting tools stored in the Automatic Tool Changer, various other attachments like right angle milling heads can also be mounted on such a machine as and when required for carrying out the various machining operations.



Nancy Hyer & Urban Wemmerlov (2001) [5] defines Cellular Manufacturing as below:-

III. Cellular Manufacturing is an approach in which equipment and work stations necessary to produce a product are arranged closely together to facilitate small lot continuous flow production. The goal is to have the necessary flexibility to produce a variety of low demand products while maintaining the same productivity obtained with a large scale production system. Figure 3, shows shows a typical Cellular Manufacturing System for the machining of DC Motor shafts.

From the Cellular Manufacturing layout shown in figure 3, it is evident that a number of CNC Machines are used in such a system. In fact, one cannot think of a Cellular Manufacturing System without the application of CNC machines.

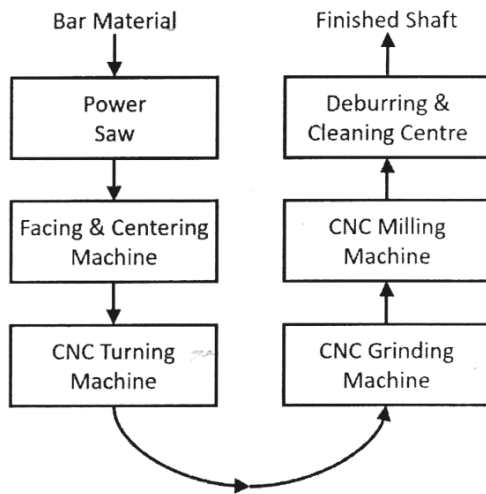


Figure 3: U-Shaped Cellular Layout for Shafts

#### IV. Conclusions

Thus, we observe that Computerized Numerical Control Machines (CNC machines) have become indispensable to industries particularly to metal cutting industries because of a number of advantages they offer. Also, at this age, one cannot imagine designing a Cellular Manufacturing System ignoring CNC machines. CNC machines, thus, have become a part & parcel to various manufacturing industries & also to the Cellular Manufacturing System. These machines have proven to be a boon to the manufacturing industries & they play an important role in Cellular Manufacturing System. Hence we can say that CNC machines form the backbone of Cellular Manufacturing System.

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procurement of CNC machines & designing shop layout & formulating specification of CNC machines to be procured. The authors also wish to thank RKDF University for giving permission for presenting this paper. Lastly, the authors acknowledge with thanks the contributions of various persons directly or indirectly associated with the preparation of this paper.

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