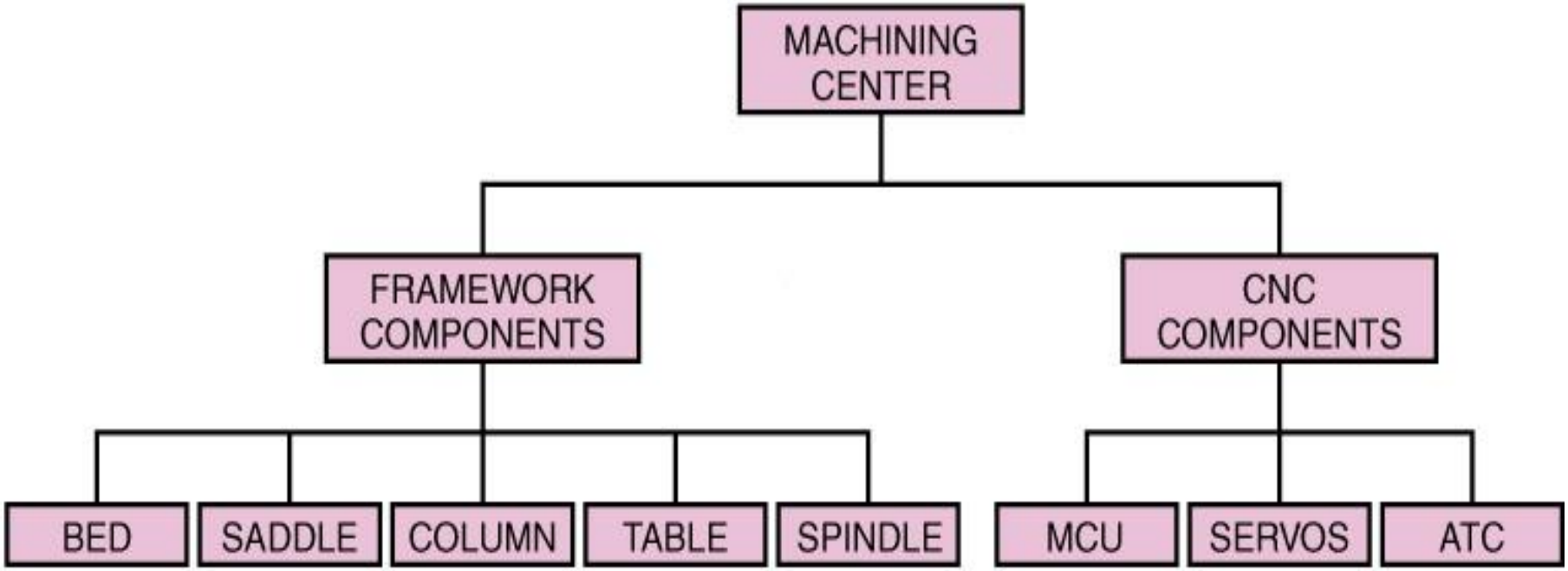
Machining Centers

In late 1960s and early 70s, begin to design machine that would perform several operations and do 90% of machining on one machine.

A single m/c capable of doing a number of opns such as drilling, reaming, tapping, milling and boring. All types of tools are mounted on a drum/chain or egg box type magazine which are put into the spindle by Automatic Tool Changer (ATC Hold up to 200 tools) under the control of tool selection instruction so this m/c to change itself for any above mentioned processes.

In these m/cs, the job needs clamping on the work holding surface only once, then performs a variety of m/cg opns on all the jobs faces except the base.

Primary Components of a Machining Center



Factors to determine type and size

1. Size and weight of largest piece machined
2. Maximum travel of three primary axes
3. Maximum speeds and feeds available
4. Horsepower of spindle
5. Number of tools automatic tool changer can hold

Types of Machining Centers

Three types:

Horizontal: Traveling-column

One or usually two tables where work mounted

-Column and cutter move toward work on one table while operator changes workpiece on other table

Fixed-column

Equipped with pallet (removable table)

-After workpiece machined, pallet and workpiece moved off receiver onto shuttle; shuttle rotated, bringing new pallet into position for shuttle and finished work pallet into position for unloading

Vertical : -Saddle-type construction with sliding bedways that use a sliding vertical head instead of quill movement

-Generally used to machine flat parts held in vise or simple fixture

-Versatility increased by addition of rotary accessories

Universal: Combines features of vertical and horizontal machining centers

-Spindle can be programmed in both vertical and horizontal positions

*Allows for machining all side of a part in one setup

-Useful for small and medium batch parts

-Has additional accessories such as indexible pallets and rotary-tilt tables

Advantages of Universal Machining Centers

-Eliminate handling and waiting time between machines
-Reduced number of fixtures and setups
-Reduced programming time
-Improved product quality
-Less work-in-process (WIP) inventory
-Faster product delivery to customers
-Lower manufacturing costs

Studies show machining center time-
20% milling, 10% boring, and 70% hole-making in average machine cycle,
Cutting time can be as high as 75%

Disadvantages of Universal Machining Centers

-used for batch production
-used most expensive m/c tool
-overall product cost is high
-Costly setup, skilled operators
-Computers, programming knowledge required
-Maintenance is difficult

Conventional m/c layout sys-
All the reqd m/c tools are grouped (turning, grinding, boring, milling and gear hobbing m/c etc) according to the product design in a particular order. Mainly used for batch production. Each m/c is operated by separate operator and work has to be fed continuously to each m/c to achieve its full utilization. The disadvantages of this sys is the high cost of work handling and temporary storage of products.

Layout planning is deciding the best physical arrangement of all resources within a facility.

- Facility resource arrangement can significantly affect productivity
- Two broad categories of operations:
  - Intermittent processing systems – low volume of many different products
  - Continuous processing systems – high volume of a few standardized products

Types of Layouts

- Four basic layout types consisting of:
  - Process layouts – Group similar resources together, job shop and batch production
  - Product layouts – Designed to produce a specific product efficiently, Eg-cement indusries/oil refineries/chemical industries/fertilizer industries etc
  - Hybrid layouts/Group technology – Combine aspects of both process and product layouts
  - Fixed-Position layouts – Product is two large to move; e.g. a ship building site, aircraft, satellite launch etc.

1-Process layout unique characteristics include:

- Resources used are general purpose
- Facilities are less capital intensive
- Facilities are more labor intensive
- Resources have greater flexibility
- Processing
- rates are slower
- Material handling costs are higher
- Scheduling resources & work flow is more complex
- Space requirements are higher

2-Product layout unique characteristics are:

- Resources are specialized
- Facilities are capital intensive
- Processing rates are faster
- Material handling costs are lower
- Space requirements for inventory storage are lower
- Flexibility is low relative to the market

3- Hybrid layouts- Combine elements of both product & process layouts

- **Maintain some of the efficiencies of product layouts**
- **Maintain some of the flexibility of process layouts**

Examples: Cellular/Flexible Manufacturing Systems /Mixed-model Assembly Lines

- **Group technology & manufacturing cells**
- **Grocery stores**

4- Fixed-Position layouts -

- Used when product is large
- Product is difficult or impossible to move, i.e. very large or fixed
- All resources must be brought to the site
- Scheduling of crews and resources is a challenge

Designing Product Layouts

- Designing product layouts requires consideration of:
  - Sequence of tasks to be performed by each workstation
  - Logical order
  - Speed considerations – line balancing

Linked line sys-

The GP/SPM are linked together by a powered belt conveyor. The wpc are transferred from the conveyor and loaded into the m/c to complete opn to be performed on the m/c. now wps is transferred to the next m/c.

This sys is more flexible than the transfer m/c and can easily be changed into straight or curved routes depending upon the wpc.

This sys, production is not interrupted if one m/c breaks down, it is because as each m/c is working as independent unit.

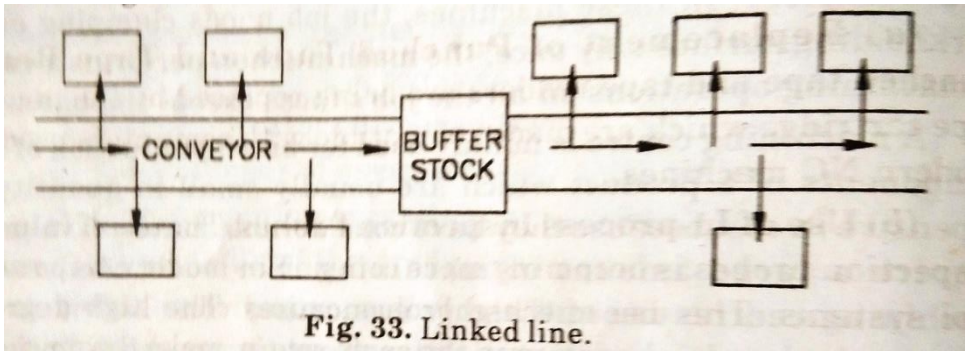


Fig. 33. Linked line.

Unlinked line systems-

General purpose m/cs are laid out in the main opn sequence. The difft m/cs operate at their own rates with buffer stock of components betbeen each m/c. This sys used for batch production of medium component.

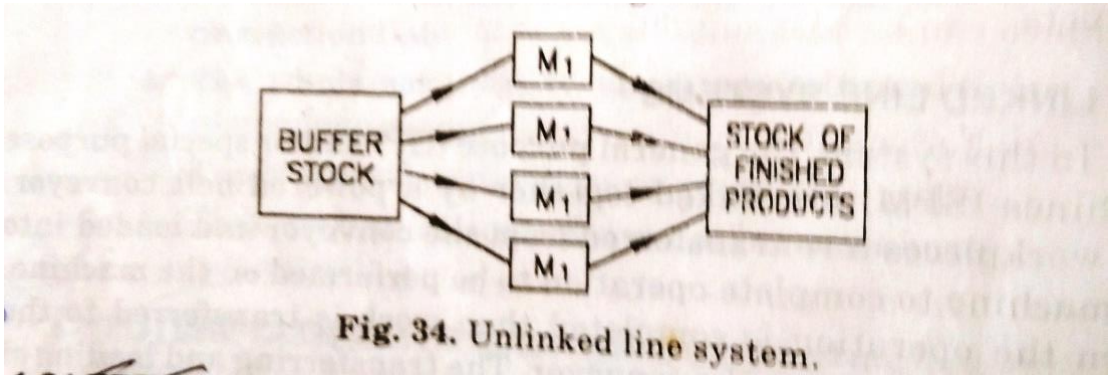


Fig. 34. Unlinked line system.

Other CNC Operations are:-

- CNC Water Jet Cutter
- Drilling
- Sheet metal works (Turret punch)
- Wire bending machines
- Surface grinders
- Cylindrical grinders
- submerged welding
- Glass cutting

Advantages of CNC

- CNC machines can be used continuously
- Batch production with high accuracy
- can be updated by improving the software
- Training in the use of CNCs is available through the use of 'virtual software'.
- Intricate detail machining
- no need to make a prototype or a model
- One person can supervise many CNC machines simultaneously
- saves time

- Easier to program;
- Easy storage of existing programs;
- Easy to change a program
- Avoids human errors
- CNC machines are safe to operate
- Complex geometry is produced as cheaply as simple ones
- Usually generates closer tolerances than manual machines

Disadvantages

- more expensive than manually operated machines

- The CNC machine operator only needs basic training and skills, enough to supervise several machines. In years gone by, engineers needed years of training to operate centre lathes, milling machines and other manually operated machines. This means many of the old skills are been lost.

- Investment in CNC machines can lead to unemployment

i. Costly setup, skilled operators
ii. Computers, programming knowledge required
iii. Maintenance is difficult

CLASSIFICATION OF NC MACHINES

In present era, variety, complexity of geometry, tolerances, skill of personnel and availability of funds by considering all factors, the NC machines are designed according to meet different requirements within the cost constraints. These machines are broadly classified as the following :

(a) Based on feedback control, and (b) Based on control system features.

A control System is a device, or set of devices to manage, command, direct or regulate the behaviour of other device(s) or system(s).