IAT 3 Solution

Computer Integrated Manufacturing (15ME62) **6^{TH} SEMESTER**

1) METHODS OF WORKPART TRANSPORT The transfer mechanism of the automated flow line must not only move the partially completed workparts or assemblies between adjacent stations, it must also orient and locate the parts in the correct position for processing at each station. The general methods of transporting workpieces on flow lines can be classified into the following three categories:

1. Continuous transfer

2. Intermittent or synchronous transfer

3. Asynchronous or power-and-free transfer

a) **Continuous transfer**: With the continuous method of transfer, the workparts are moved continuously at Constant speed. This requires the workheads to move during processing in order to maintain continuous registration with the workpart. For some types of operations, this movement of the workheads during processing is not feasible. It would be difficult, for example, to use this type of system on a machining transfer line because of inertia problems due to the size and weight of the workheads. In other cases, continuous transfer would be very practical. Examples of its use are in beverage bottling operations, packaging, manual assembly operations where the human operator can move with the moving flow line, and relatively simple automatic assembly tasks. In some bottling operations, for instance, the bottles are transported around a continuously rotating drum. Beverage is discharged into the moving bottles by spouts located at the drum's periphery. The advantage of this application is that the liquid beverage is kept moving at a steady speed and hence there are no inertia problems. Continuous transfer systems are relatively easy to design and fabricate and can achieve a high rate of production.

b) **Intermittent transfer:** As the name suggests, in this method the workpieces are transported with an intermittent or discontinuous motion. The workstations are fixed in position and the parts are moved between stations and then registered at the proper locations for processing. All workparts are transported at the same time and, for this reason, the term "synchronous transfer system" is also used to describe this method of workpart transport.

c) **Asynchronous transfer**: This system of transfer, also referred to as a "power-and-free system," allows each workpart to move to the next station when processing at the current station has been completed. Each part moves independently of other parts. Hence, some parts are being processed on the line at the same time that others are being transported between stations. Asynchronous transfer systems offer the opportunity for greater flexibility than do the other two systems, and this flexibility can be a great advantage in certain circumstances. In-process storage of workparts can be incorporated into the asynchronous systems with relative ease. Power-and-free systems can also compensate for line balancing problems where there are significant differences in process times between stations. Parallel stations or several series stations can be used for the longer operations, and single stations can be used for the shorter operations. Therefore, the average production rates can be approximately equalized. Asynchronous lines are often used where there are one or more manually operated.

2) Controlling an automated flow line is a complex problem, owing to the sheer number of sequential steps that must be carried out. There are three main functions that are utilized to control the operation of an automatic transfer system. The first of these is an operational requirement, the second is a safety requirement, and the third is dedicated to improving quality.

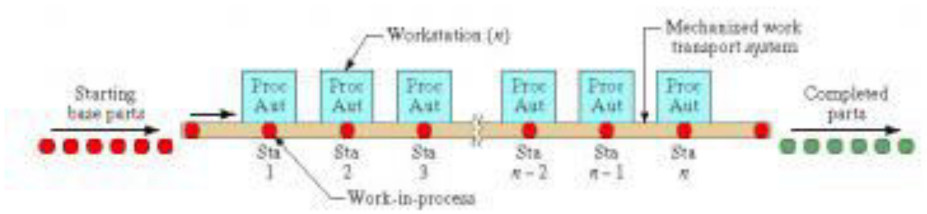
1. **Sequence control**. The purpose of this function is to coordinate the sequence of actions of the transfer system and its workstations. The various activities of the automated flow line must be carried out with split-second timing and accuracy. On a metal machining transfer line, for example, the work parts must be transported, located, and clamped in place before the work heads can begin to feed. Sequence control is basic to the operation of the flow line.
2. **Safety monitoring**. This function ensures that the transfer system does not operate in an unsafe or hazardous condition. Sensing devices may be added to make certain that the cutting tool status is satisfactory to continue to process the work part in the case of a machining-type transfer line. Other checks might include monitoring certain critical steps in the sequence control function to make sure that these steps have all been performed and in the correct order. Hydraulic or air pressures might also be checked if these are crucial to the operation of automated flow lines.
3. **Quality monitoring**. The third control function is to monitor certain quality attributes of the work part. Its purpose is to identify and possibly reject defective work parts and assemblies. The inspection devices required to perform quality monitoring are sometimes incorporated into existing processing stations. In other cases, separate stations are included in the line for the sole purpose of inspecting the work part.

- **Instantaneous control**. This mode of control stops the operation of the flow line immediately when a malfunction is detected. It is relatively simple, inexpensive, and trouble-free. Diagnostic features are often added to the system to aid in identifying the location and cause of the trouble to the operator so that repairs can be quickly made. However, stopping the machine results in loss of production from the entire line, and this is the system's biggest drawback.
- **Memory control**. In contrast to instantaneous control, the memory system is designed to keep the machine operating. It works to control quality and/or

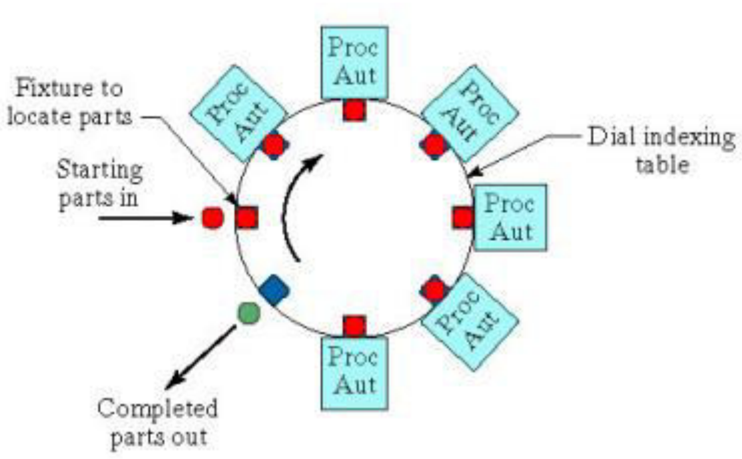
protect the machine by preventing subsequent stations from processing the particular work part and by segregating the part as defective at the end of the line. The premise upon which memory-type control is based is that the failures which occur at the stations will be random and infrequent. If, however, the station failures result from cause (a work head that has gone out of alignment, for example) and tend to repeat, the memory system will not improve production but, rather, degrade it. The flow line will continue to operate, with the consequence that bad parts will continue to be produced. For this reason, a counter is sometimes used so that if a failure occurs at the same station for two or three consecutive cycles, the memory logic will cause the machine to stop for repairs.

3)

- **In-line type**: The in-line configuration consists of a sequence of workstations in a more-or-less straight-line arrangement. The flow of work can take a few 90° turns, either for work piece reorientation, factory layout limitations, or other reasons, and still qualify as a straight-line configuration. A common pattern of work flow, for example, is a rectangular shape, which would allow the same operator to load the starting workpieces and unload the finished workpieces.



- **Rotary type** :In the rotary configuration, the work parts are indexed around a circular table or dial. The work stations are stationary and usually located around the outside periphery of the dial. The parts ride on the rotating table and are registered or positioned, in turn, at each station for its processing or assembly operation.



- **Segmented In-Line Type:** The segmented in-line configuration consists of two or more straight-line arrangement which are usually perpendicular to each other with L-Shaped or U-shaped or Rectangular shaped. The flow of work can take a few 90° turns, either for workpieces reorientation, factory layout limitations, or other reasons, and still qualify as a straight-line configuration.

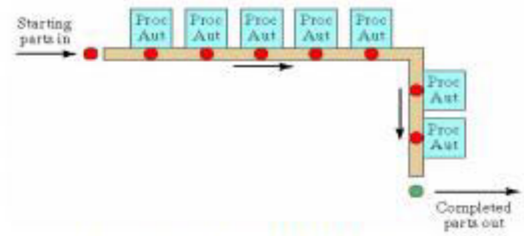


Figure 5 L-shaped configuration

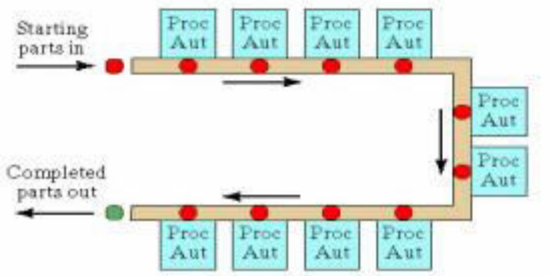
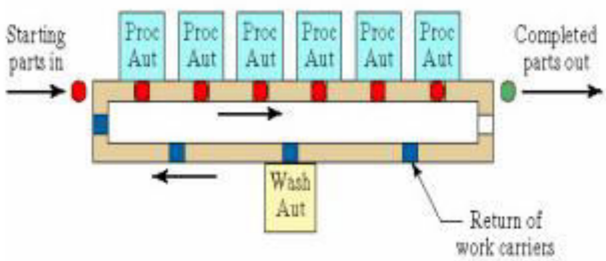


Figure 6 U-shaped configuration



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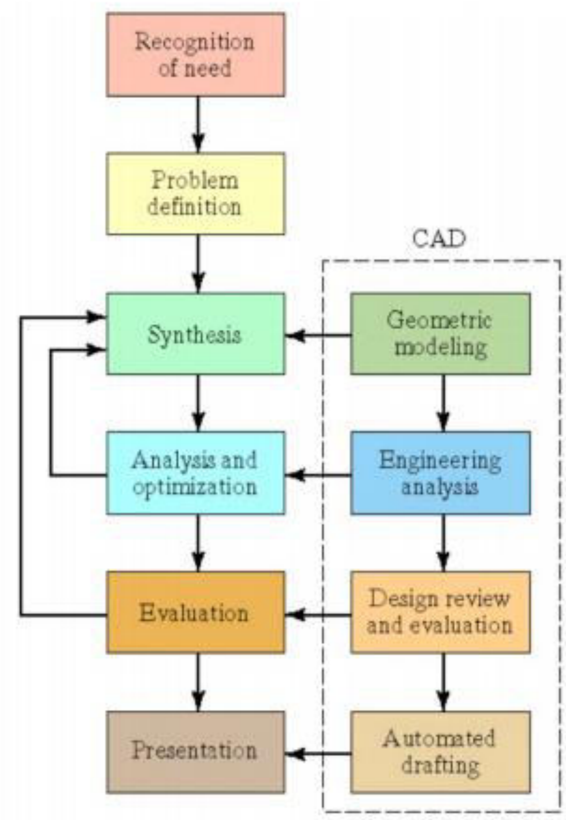


Recognition of need—this involves the realisation that a problem or need exists that may be solved by design. This may mean identifying some deficiency in a current machine design by an engineer, or perceiving some new product opportunity by a salesperson. Problem definition—this involves a thorough specification of the item to be designed. Specifications include physical characteristics, function, cost, quality, and operating performance.

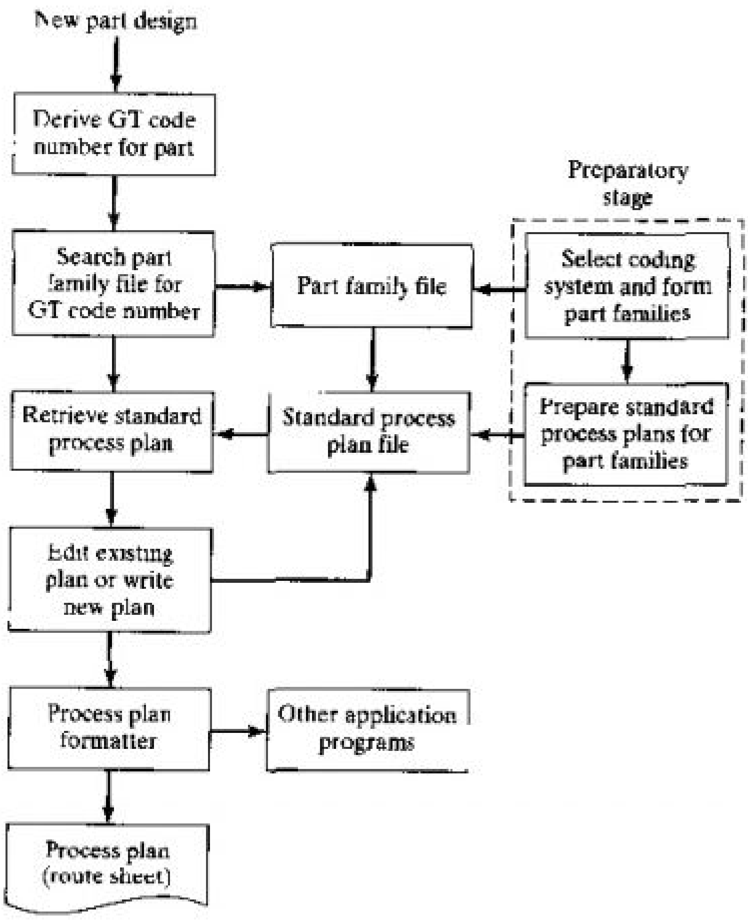
Synthesis—closely related with the following step, analysis, synthesis refers to the bundling of information that occurs after problem definition, and concurrently during analysis, and after re-analysis.

Analysis and optimization—closely related to the previous step, analysis is concerned with the investigation of design specification information, and the optimization of this information, as well as a synthesis of new information, as required.

Evaluation—involves measuring the design against the specifications established in the problem definition phase. This evaluation may require the building and testing of prototype models to assess operative performance metrics for the proposed design. This may lead to the re-design of certain or all elements.

Presentation—this is the final phase, where the design is documented by means of drawings, material specifications, assembly lists, and so on. Documentation means that the design database is created. ENDLIST

7)



A *retrieval CAPP* system, also called a *variant CAPP* system, is based on the principles of group technology (GT) and parts classification and coding. In this type of CAPP, a standard process plan (route sheet) is stored in computer files for each part code number. Before the system can be used for process planning, a significant amount of information must be compiled and entered into the CAPP data files. This is the "preparatory phase:' It consists of the following steps:

(1) selecting an appropriate classification and coding scheme for the company,

(2) forming part families for the parts produced hy the company; and

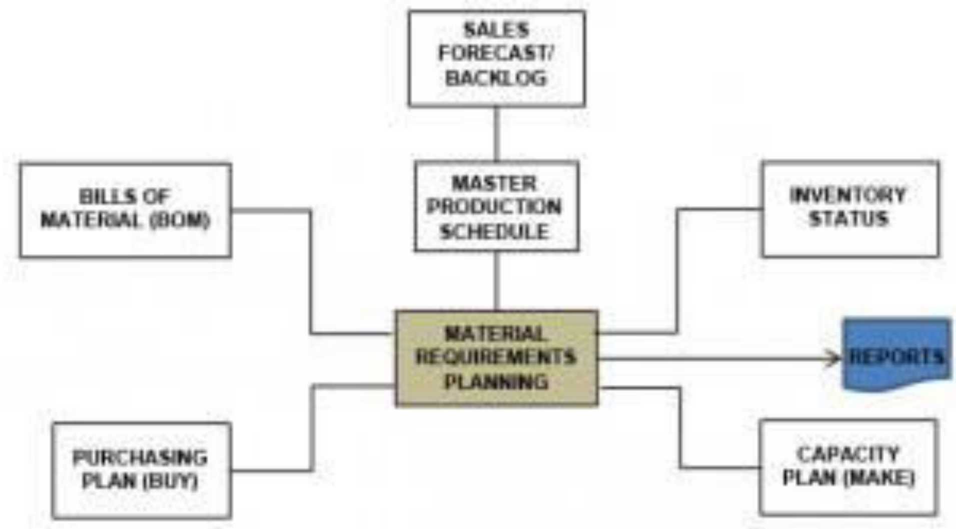
(3) preparing standard process plans for the part families. It should be mentioned that steps (2) and (3) continue as new parts are designed and added to the company's design data base.

After the preparatory phase has been completed, the system is ready for use, For a new component for which the process plan is to be determined. the first step is to derive the GT code number for the part. With this code number, a search is made of the part family, *file* to determine if a standard route sheet exists for/he given part code. If the file contains a process plan for the part it is retrieved and displayed for the user. The standard process plan is examined to determine whether any modifications are necessary. It might be that although the new part has the same code number. there are minor differences in the processes required to make it. The user edits the standard plan accordingly. This capacity to alter an existing process plan is what gives the retrieval system its alternative name: variant CAPP system.

If the file does not contain a standard process plan for the given code number, the user may search the computer file for a similar or related code number for which a standard route sheer does exist. Either by editing an existing process plan, or by starting from scratch, the user prepares the route sheet for the new part. This route sheet becomes the standard process plan for the new part code number

The process planning session concludes with the process plan formatter, which prints alit the route sheet in the proper format. The formatter may call other application programs into use: for example, to determine machining conditions for the various machine tool operations in the sequence. to calculate standard times (or the operations (e.g., for direct labor incentives). or to compute cost estimates for the operations.

8)



MRP Objectives

MRP has several objectives, such as:

- **Reduction in Inventory Cost**: By providing the right quantity of material at right time to meet master production schedule, MRP tries to avoid the cost of excessive inventory.
- **Meeting Delivery Schedule**: By minimizing the delays in materials procurement, production decision making, MRP helps avoid delays in production thereby meeting delivery schedules more consistently.
- **Improved Performance**: By stream lining the production operations and minimizing the unplanned interruptions, MRP focuses on having all components available at right place in right quantity at right time.

MRP System

A simple sketch of an MRP system is shown. It can be seen from the figure that an MRP system has three major input components:

- **Master Production Schedule (MPS**): MPS is designed to meet the market demand (both the firm orders and forecasted demand) in future in the taken planning horizon. MPS mainly depicts the detailed delivery schedule of the end products. However, orders for replacement components can also be included in it to make it more comprehensive.
- **Bill of Materials (BOM) File**: BOM represents the product structure. It encompasses information about all sub components needed, their quantity, and their sequence of buildup in the end product. Information about the work centers performing buildup operations is also included in it.

- **Inventory Status File**: Inventory status file keeps an up-to-date record of each item in the inventory. Information such as, item identification number, quantity on hand, safety stock level, quantity already allocated and the procurement lead time of each item is recorded in this file.

After getting input from these sources, MRP logic processes the available information and gives information about the following:

- **Planned Orders Receipts**: This is the order quantity of an item that is planned to be ordered so that it is received at the beginning of the period under consideration to meet the net requirements of that period. This order has not yet been placed and will be placed in future.
- **Planned Order Release**: This is the order quantity of an item that is planned to be ordered in the planned time period for this order that will ensure that the item is received when needed. Planned order release is determined by offsetting the planned order receipt by procurement lead time of that item.
- **Order Rescheduling**: This highlight the need of any expediting, de-expediting, and cancellation of open orders etc. in case of unexpected situations.

iii) $[R] = \begin{bmatrix} \cos 45 & -\sin 45 \\ \sin 45 & \cos 45 \end{bmatrix}$

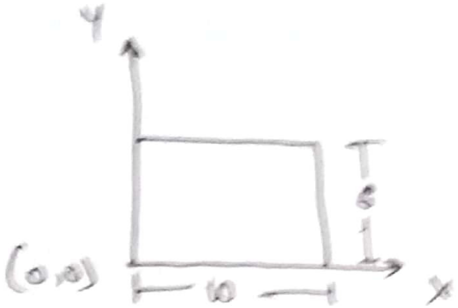
$[P'] = [R] \times [P]$

$= \begin{bmatrix} 0 & 7.07 & 2.828 & -4.242 \\ 0 & 7.07 & 11.312 & 4.242 \end{bmatrix}$

iv) $[R] = \begin{bmatrix} \cos(-30) & -\sin(-30) \\ \sin(-30) & \cos(-30) \end{bmatrix}$

$= \begin{bmatrix} 0 & 8.66 & 11.66 & 3 \\ 0 & -5 & 0.196 & 5.196 \end{bmatrix}$ //

6)



$$[P] = \begin{bmatrix} 0 & 10 & 10 & 0 \\ 0 & 0 & 6 & 6 \end{bmatrix}$$

i) $$[T] = \begin{bmatrix} 3 & 3 & 3 & 3 \\ 4 & 4 & 4 & 4 \end{bmatrix}$$

$$[P'] = [P] + [T]$$

$$= \begin{bmatrix} 3 & 13 & 13 & 3 \\ 4 & 4 & 10 & 10 \end{bmatrix}$$

ii) $$[S] = \begin{bmatrix} 3 & 0 \\ 0 & 3 \end{bmatrix}$$

$$[P'] = [S] \times [P]$$

$$= \begin{bmatrix} 3 & 0 \\ 0 & 3 \end{bmatrix} \times \begin{bmatrix} 0 & 10 & 10 & 0 \\ 0 & 0 & 6 & 6 \end{bmatrix}$$

$$= \begin{bmatrix} 0 & 20 & 30 & 0 \\ 0 & 0 & 18 & 18 \end{bmatrix}$$

iii) $$[S] = \begin{bmatrix} 2 & 0 \\ 0 & -1 \end{bmatrix}$$

$$[P'] = [S] \times [P]$$

$$= \begin{bmatrix} 2 & 0 \\ 0 & -1 \end{bmatrix} \begin{bmatrix} 0 & 10 & 10 & 0 \\ 0 & 0 & 6 & 6 \end{bmatrix}$$

$$= \begin{bmatrix} 0 & 20 & 20 & 0 \\ 0 & 0 & -6 & -6 \end{bmatrix}$$

4)

Given $n = 12$ $T_d = 6 min$

$T_c = 1.2 min$

$P = 0.03$

For stage 1, $n_1 = 6$ A2

For stage 2, $n_2 = 6$

UPPER BOUND,

a) Efficiency of line without buffer.

$$E = \frac{T_c}{T_c + F T_d}$$

$F = n.p = 12 \times 0.03 = 0.36$

$$E = \frac{12}{1.2 + 0.36 \times 6} = 35.71\%.$$

b) Efficiency with buffer.

$E = \min\{E1, E2\}$

Since $n_1 = n_2$; $F_1 = F_2$ & $E_1 = E_2$

$F_1 = F_2 = n_1 p = 6 \times 0.03 = 0.18$

$$E_1 = E_2 = \frac{T_c}{T_c + F_1 T_d} = \frac{1.2}{1.2 + 0.18 \times 6}$$

$E_1 = E_2 = 52.63\%$

$E_\infty = \min\{E_1, E_2\} = 52.63\%$

With lower bound,

a) Efficiency without buffer :-

$$E = \frac{T_c}{T_c + F T_d}$$

$$F = 1 - (1-p)^n$$

$$= 1 - (1 - 0.03)^{12} = 0.306$$

$$E = \frac{1.2}{1.2 + 0.306 \times 6} = 0.39 = 39.51\%$$

b) Efficiency with storage buffer :-

$$E_\infty = E\min\{E_1, E_2\}$$

here, $n_1 = n_2 = 6$

$$F_1 = F_2 = 1 - (1-p)^{n_1}$$

$$= 1 - (1 - 0.03)^6$$

$$F_1 = F_2 = 0.167$$

$$E_1 = E_2 = \frac{T_c}{T_c + F_1 T_d} = \frac{1.2}{1.2 + 0.167 \times 6} = 0.545$$

$$E_\infty = \min\{E_1, E_2\}$$

$$E_\infty = 54.50\%$$