A Case Study of Manufacturing Process Routing in a Medium Scale Industry

Ashwini Patil*

Department of Industrial Engineering, Vishwakarma Institute of Technology, Pune

A R T I C L E   I N F O

Keywords:
Process Routing (PR), Route Sheet, QAC (Quality Assurance and Control)

A B S T R A C T

There is an increase in product variety and logistics demand and due to this, process industries are paying more attention to process planning and scheduling. The function of process sequencing and routing specification falls in the domain of Process planning. In this paper, a process routing case study is discussed where steam drum manufacturing process routing is prepared by preparing routing sheets.

I. Introduction

The process of determining the sequence of operations to be performed in the production process is called as routing. It determines what work must be done, where and how. Routing information is provided by product or process engineering function and it is useful to prepare machine loading charts and schedules. Working with the Bill of Materials module, the Routing and Resources application defines the elements such as work centers, labor, machinery, and tooling. In terms of costs and times, these elements make up the process side of the manufacturing bill of materials. By breaking down the process in the labor types, machine groups, and tooling, Routing and Resources enables you to define operations as a combination of these elements. Routings are then created as a set of step-by-step operations and can be used in the Bill of Materials application without needing to be recreated every time.

Each Routing Task is a discrete step in the manufacturing process, and most products employ a number of them, which must be executed in a specific sequence. The Production Routing is the collection of all Routing Tasks, specifying the exact order of implementing each one of them, so the Routing is the complete list of every Task that must be done to manufacture the finished product. Each Routing Task can be associated with fixed assets like production spaces, and manufacturing machines. The setup time for the asset, to make it ready for a new production run, and the unit processing time, for each product that is operated on with the asset, can be set up for the specific Routing Tasks.

Each product that is to be manufactured will include one or more Routing Tasks that is used in the corresponding product Production Routing. A particular Routing Task can be used on many different products when this is
appropriate. This is accomplished by simply including a Routing Task in each of the different Production Routings where it should be used.

2. Literature Review

Routing may be defined as the selection of path which each part of the product will follow, which is being transformed from raw material to finished products. Routing determines the most advantageous path to be followed from department to department and machine to machine till raw material gets its final shape.

Process planning and routing is a complete determination of the specific technological process steps and their sequence to produce products at the desired quality, quantity and cost. It determines the method of manufacturing a product selects the tools and equipments, analyses how the manufacturing of the product will fit into the facilities. Routing in particular prescribes the flow of work in the plant and it is related to the considerations of layout, temporary locations for raw materials and components and materials handling systems. It is concerned with selection of path or route which the raw material should follow to get transformed into finished product. The duties include:

(a) Fixation of path of travel giving due consideration to layout.
(b) Breaking down of operations to define each operation in detail.
(c) Deciding the set up time and process time for each operation.

Once the overall method and sequence of operations is fixed and process sheet for each operation is available, then the operations times are estimated. This function is carried out using extensive analysis of operations along with methods and routing and a standard time for operation are established using work measurement techniques.

3. Techniques of Routing

While converting raw material into required goods different operations are to be performed and the selection of a particular path of operations for each piece is termed as ‘Routing’. This selection of a particular path, i.e. sequence of operations must be the best and cheapest to have the lowest cost of the final product. The various routing techniques are:

3.1. Route card

This card always accompanies with the job throughout all operations. This indicates the material used during manufacturing and their progress from one operation to another. In addition to this the details of scrap and good work produced are also recorded.

3.2. Work sheet

It contains
(a) Specifications to be followed while manufacturing.
(b) Instructions regarding routing of every part with identification number of machines and work place of operation. This sheet is made for manufacturing as well as for maintenance.

3.3. Route sheet

It deals with specific production order generally made from operation sheets. One sheet is required for each part or component of the order. These include the following:

(a) Number and other identification of order.
(b) Symbol and identification of part.
(c) Number of pieces to be made.
(d) Number of pieces in each lot, if put through in lots.
(e) Operation data which includes:
   (i) List of operation on the part.
   (ii) Department in which operations are to be performed.
   (iii) Machine to be used for each operation.
   (iv) Fixed sequence of operation, if any.
(f) Rate at which job must be completed, determined from the operation sheet.

3.4. Move order

Though this is a document needed for production control, it is never used for routing system. Move order is prepared for each operation as per operation sheet. On this the quantity passed forward, scrapped and to be
rectified are recorded. It is returned to planning office when the operation is completed.

4. Case Study

4.1. Company Background

The company being considered here was established 1986 in Pune. The company is involved in manufacturing of pressure vessels and the main product is Waste Heat Recovery Boilers.

It is a medium scale industry and some standardized products needed a proper routing of their manufacturing processes in order to make the process more economical. The standard product selected for the study is “Steam Drum”.

4.2. Steam Drum Manufacturing Process as Observed

In this company, there is no documented process for manufacturing of some standard products e.g. Steam Drum, deaerator, common header etc. Thus, company person wanted to do a manufacturing process routing for Steam Drum Manufacturing process.

For this, a thorough study of manufacturing process of steam drum, prepared routing sheets, and did some cost estimation. I recorded the times required for different operations performed on the raw material to convert it in the final product. The Flowchart for steam drum manufacturing process is given in the figure 1 for example.

4.3. Factors Influencing Routing

4.3.1. Type of Product

The factor which affects the routing process is the complexity of the product and not what the product is except this may relate to the market being served. Production routing procedures are complex and involve many records in the manufacture of large steam turbine generator sets, or locomotives to customer orders then in the production of large quantities of a standard product involving only a few component parts for example.

4.3.2. Type of Manufacturing

This is probably the most influential factor. For a large continuous manufacturing plant producing a standard product, the routing should be included in the planning of the plant layout. As the type of manufacturing affects routing, in case of continuous manufacturing such as automobiles, fertilizers etc. route are built in the layout of the plant.

4.3.3. Plant Layout

Routing and plant Layout are closely related. In the product layout, routing is short and simple while under the process layout routing tend to be long and complex. Plant layout is an important decision as it represents long term commitment. An ideal layout provides optimum relationship among output, floor area and manufacturing process.
4.3.4. Manpower Planning

Process routing is successful only if proper utilisation of manpower is done. For this, one should consider total number of manpower available and its proper allocation for the work to be done. Availability of manpower also affects routing and accordingly the production schedule. Thus, due consideration is needed towards the reason for the absenteeism.

4.3.5. Tools:

Tool is also an important factor affecting routing and production schedule because if the tools used are not in good condition, it may affect product quality resulting in delays.

4.4. Routing Sheets

The routing sheets include the operation no., operation name, manpower required for carrying out the operation, fixtures used, tools and machines used, cycle time and measures used for carrying out quality check. First, rolling of sheets and forming of dish ends is done. After this, ‘L’ Seam and ‘C’ Seam welding is carried out. Radiography test is taken for every welded joint. Then, Dish ends are welded to the shells and then other fittings like standpipe, nozzles, lifting hooks etc. is done.

At the end, Saddle fabrication is done and hydro test is taken. After Hydro Test is complete, water is drained from the drum and the drum is cleaned. After this, drum is painted and then full inspection of the drum is done. Now, the drum is ready for dispatch.

Routing sheet prepared is given in the following figure 2 for example:

**Activity**: L Seam Weld Set up  
**Location**: Near Water Tank

<table>
<thead>
<tr>
<th>Operation No.</th>
<th>Operation Description</th>
<th>Manpower</th>
<th>Machine Used</th>
<th>Tools Used</th>
<th>Jig/Fixture/Gauges</th>
<th>Cycle Time (min.)</th>
<th>Quality Check</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Removal of weak tacks</td>
<td>1</td>
<td>Cutter</td>
<td></td>
<td></td>
<td>20</td>
<td>Visual</td>
<td>This is currently not done on levelled surface</td>
</tr>
<tr>
<td>2</td>
<td>Tacking of small metal plate to shell near edge 1st point</td>
<td>2</td>
<td>Welding Machine, Welding Electrode</td>
<td></td>
<td></td>
<td>1</td>
<td>Visual</td>
<td>This is a L shaped plate</td>
</tr>
<tr>
<td>3</td>
<td>Tacking of small metal plate to shell near edge 2nd point</td>
<td>2</td>
<td>Welding Machine, Welding Electrode</td>
<td></td>
<td></td>
<td>1</td>
<td>Visual</td>
<td>This is a time consuming process</td>
</tr>
<tr>
<td>4</td>
<td>Insertion of key in the gap</td>
<td>1</td>
<td>Hammer</td>
<td>Key, Small metal plate</td>
<td>Key, Small metal plate</td>
<td>0.5</td>
<td>Visual, Electrode of 3 mm dia.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Tack Welding</td>
<td>1</td>
<td>Welding Machine, Welding Electrode</td>
<td>Key, Small metal plate</td>
<td>Key, Small metal plate</td>
<td>5</td>
<td>Visual</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 2**: Routing sheet for ‘L’ Seam Weld Set-up
5. Observations

5.1. Manpower
- Since, most of the workers are on contract basis, workers belonging to one contractor but working on two different jobs keep on changing.
- When the contractor changes or workers are new sometimes they are not aware of how particular work is to be done.
- Proportion of skilled labor to unskilled labor is lower jobs keep getting delayed due to this.
- Absenteeism among contract labors is considerable.
- Job priorities are not set properly; they keep changing hence causing delay in execution. Non availability of resources as per specific job requirements.
- Due to space constraint proper industrial engineering study e.g. time study, motion study is not done and lot of time is lost in either material movement or resource movement.
- Safety practices like wearing helmets, hand glows, shoes are not being followed.
- Proper job allocation or responsibility allocation between QAC and Production personnel is required.

5.2. Process
- Limited use of fixtures in various manufacturing processes. In the following photo one person is holding sheet pieces and welder is welding them. This is done to maintain required gap between the edges of shell for proper welding. This requires 1 more person instead of 1 welder. Second picture shows key inserted between the sheet pieces for maintaining gap.
- It is recommended that the ‘L’ seam and ‘C’ seam welding to be done on leveled surface which is not currently observed.
- Specific tools need to be made available for particular job.
- Due to space constraint, the location for manufacturing of job is decided at the last moment depending upon space available resulting into loss of time.
- Due to space constraint, rollers assembly is done just before the job needs to place on the rollers.
- Since the roundness measuring process is manual, lot of operational time is lost.
- As contractor keeps deploying new resources every time and due to knowledge gap at various levels, drawing discrepancies, limited tools and tackles, right supervision the rework is more, which can be brought down.
- As the organization is growing organization, with the business growing faster there is some inadequacy of tools which is being addressed.

5.3. Plant Layout
- Due to space constraint, locations for manufacturing of particular part are not fixed.
- Raw materials are stored at the spaces where it is possible.
- Material handling is more.
- Back tracking is observed.

6. Suggestions

6.1. Manpower
- A team of workers should be assigned for one particular job.
- When welding is going on other workers should work on other parts
of same job. This utilizes time and manpower properly.

- Team of workers assigned for a particular job should not be changed.
- Absenteeism in workers should be addressed.
- When the contractor is new some time should be spent on training his people for the work being done. This helps to reduce work and also saves time.
- Safety issue should be taken care.
- One person from QAC and one from production should follow one job.
- Readymade fixtures available in the market can be used for keeping or can be fabricated in-house.
- Small devices like bench vise can be used for holding small sheet pieces while working on them. Currently they are being kept on floor.
- ‘L’ and ‘C’ seam welding should be done on a leveled surface to avoid any misalignment and rework.
- Roundness measuring of steam drum shells should be done with a roundness measuring instruments like gauges etc. instead of measuring manually.
- Material handling should be avoided by rearranging plant layout.
- Small material handling equipments should be purchased so that waiting time for crane can be reduced. This is because small parts can be handled by small equipment.
- Advanced tools and tackles should be deployed in the process to reduce cycle time.

6.3. Plant Layout

- Material handling can be reduced by allocating fixed locations for raw material required for that particular rolled shells received, dish ends etc.
- Back tracking can be avoided by making trying to move things forward. This means by moving the manufacturing process forward only and reducing rework.
- Locations for manufacturing particular parts should be fixed.

7. Conclusion

Follow-up of this routing will reduce lead times by optimum utilization of the time. Fixed locations for the manufacturing processes will reduce the material handling and thus the cost associated with it.

References

of same job. This utilizes time and manpower properly.

Team of workers assigned for a particular job should not be changed. Absenteeism in workers should be addressed.

When the contractor is new some time should be spent on training his people for the work being done. This helps to reduce work and also saves time.

Safety issue should be taken care. One person from QAC and one from production should follow one job.

Readymade fixtures available in the market can be used for keeping or can be fabricated in-house. Small devices like bench vise can be used for holding small sheet pieces while working on them. Currently they are being kept on floor.

"L" and "C" seam welding should be done on a leveled surface to avoid any misalignment and rework.

Roundness measuring of steam drum shells should be done with a roundness measuring instruments like gauges etc. instead of measuring manually.

Material handling should be avoided by rearranging plant layout. Small material handling equipments should be purchased so that waiting time for crane can be reduced. This is because small parts can be handled by small equipment.

Advanced tools and tackles should be deployed in the process to reduce cycle time.

6.3. Plant Layout

Material handling can be reduced by allocating fixed locations for raw material required for that particular rolled shells received, dish ends etc. Back tracking can be avoided by trying to move things forward. This means by moving the manufacturing process forward only and reducing rework.

Locations for manufacturing particular parts should be fixed.

7. Conclusion

Follow-up of this routing will reduce lead times by optimum utilization of the time. Fixed locations for the manufacturing processes will reduce the material handling and thus the cost associated with it.

References


