51
Chapter

Cellular Manufacturing

Chapter Outcomes

After completing the chapter, you will be able to:

- Understand the concept of cellular manufacturing.
- Decide when to use Cellular manufacturing.
- Describe the essential requirement for group formation and characteristics of part family.
- Explain the procedure to implement Cellular manufacturing.
- Describe the relationship between lean and Cellular manufacturing.
- Understand the flow analysis and Cluster Analysis.

51.1 INTRODUCTION

Cellular Manufacturing (Popularly called by the name Group technology) is an approach to organizing manufacturing which can be applied in any industry where a small batch variety production is used. The basic concept of Cellular manufacturing is relatively simple. It is the identification and bringing together related or similar parts and processes, to make advantage of the similarities which exist, during all stages of design and manufacture. Cellular Manufacturing is based on the fact that small lots of different parts can be produced more economically, if they are grouped and scheduled for production according to the common characteristics. GT exploits the part similarities by utilizing similar processes and tooling to produce them machines are grouped into cells, each cell specializing in the production of a part family Called cellular manufacturing Cellular manufacturing can be implemented by manual or automated methods – When automated, the term flexible manufacturing system is often applied.

51.2 DEFINITION OF GROUP TECHNOLOGY

It is an approach to the organization of work in which organizational units are relatively independent groups, each responsible for the production of a given family of products. A group is a combination of a set of workers and a set of machines and/or other facilities lay out in one reserved area, which is designed to complete a specified set of products. A family is the set of products produced by a group. As early as in the 1920 it was observed, that using product-oriented departments to manufacture standardized products in machine companies lead to reduced transportation. This can be considered the start of ***Group Technology*** (GT). Parts are classified and parts with similar features are manufactured together with standardized processes. As a consequence, small "focused factories" are being created as independent operating units within large facilities.

More generally, Group Technology can be considered a theory of management based on the principle that "*similar things should be done similarly*". In our context, "things" include product design, process planning, fabrication, assembly, and production control. However, in a more general sense GT may be applied to all activities, including administrative functions.

The principle of group technology is to divide the manufacturing facility into small groups or *cells* of machines. The term ***cellular manufacturing*** is often used in this regard. Each of these cells is dedicated to a specified family or set of part types. Typically, a cell is a small group of machines (as a rule of thumb not more than five). An example would be a machining center with inspection and monitoring devices, tool and Part Storage, a robot for part handling, and the associated control hardware. The idea of GT can also be used to build larger groups, such as for instance, a department, possibly composed of several automated cells or several manned machines of various types. Pure item flow lines are possible, if volumes are very large. If volumes are very small, and parts are very different, a functional layout (job shop) is usually appropriate. In the intermediate case of *medium-variety*, *medium-volume* environments, group configuration is most appropriate. GT can produce considerable improvements where it is appropriate and the basic idea can be utilized in all manufacturing environments:

- To the *manufacturing engineer* GT can be viewed as a role model to obtain the advantages of flow line systems in environments previously ruled by job shop layouts. The idea is to form groups and to aim at a product-type layout within each group (for a family of parts). Whenever Possible, new parts are designed to be compatible with the processes and tooling of an existing Part family. This way, production experience is quickly obtained, and standard process plans and tooling can be developed for this restricted part set.
- To the *design engineer* the idea of GT can mean to standardize products and process plans. If a new part should be designed, first retrieve the design for a similar, existing part. Maybe, the Need for the new part is eliminated if an existing part will suffice. If a new part is actually needed, the new plan can be developed quickly by relying on decisions and documentation previously made for similar parts. Hence, the resulting plan will match current manufacturing Procedures and document preparation time is reduced. The design engineer is freed to concentrate on optimal design.

Cellular manufacturing is a manufacturing process that produces families of parts within a single line or cell of machines operated by machinists who work only within the line or cell. A cell is a small scale, clearly-defined production unit within a larger factory. This unit has complete responsibility for producing a family of like parts or a product. All necessary machines and manpower are contained within this cell, thus giving it a degree of operational autonomy. Each worker is expected to have mastered a full range of operating skills required by his or her cell. Therefore, systematic job rotation and training are necessary conditions for effective cell development. Complete worker training is needed to ensure that flexible worker assignments can be fulfilled.

Cellular manufacturing, which is actually an application of group technology, has been described as a stepping stone to achieving world class manufacturing status. The objective of cellular manufacturing is to design cells in such a way that some measure of performance is optimized. This measure of performance could be productivity, cycle time, or some other logistics measure. Measures seen in practice include pieces per man hour, unit cost, on-time delivery, lead time, defect rates, and percentage of parts made cell-complete.

This process involves placing a cluster of carefully selected sets of functionally dissimilar machines in close proximity to each other. The result is small, stand-alone manufacturing units dedicated to the production of a set or family of parts—or essentially, a miniature version of a plant layout.

While the machinery may be functionally dissimilar, the family of parts produced contains similar processing requirements, Thus, all parts basically follow the same routing with some minor variations (*e.g.*, skipping an operation). The cells may have no conveyorized movement of parts between machines, or they may have a flow line connected by a conveyor that can provide automatic transfer.

Cellular manufacturing is a hybrid system that links the advantages of a job shop with the product layout of the continuous flow line. The cell design provides for quick and efficient flow, and the high productivity associated with assembly lines. However, it also provides the flexibility of the job shop, allowing both similar and diverse products to be added to the line without slowing the process.

51.3 CELLULAR (GROUP) LAYOUT

With the line layout, machines or workstations are arranged in a line in their sequence of operation. It is preferred when in all the components made on the line use the same work stations in the same sequence.

When line layout cannot be used. The machines and workstations are used to process the parts in batches and the facilities are arranged with respect to functions.

New method of facilities layout called Cellular (group) technology is based respect on product specialization. Group of machines chosen for each family are situated together in a group layout in such a way that parts flow from one machines to the next in the sequence of operation. it is not necessary for every part to visit each machines but machines in a group or cell should ideally be capable of carrying out all the operations required in the family. The group layout is shown in the Fig. 51.1.

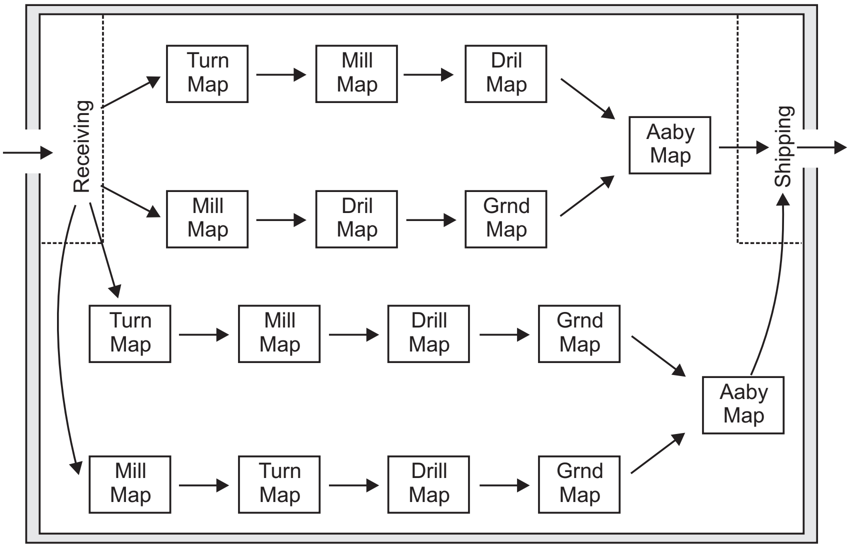

Fig. 51.1: Group Layout

51.4 DESIRABLE CHARACTERISTICS OF GROUP

1. There should be group of workers special to the group. The group of workers associated with a specific group makes a good team and they learn to understand the special problems associated with machines and equipment and with the family of components which they make. Workers should not be allowed to move or transferred out of the group.
2. There should be group of machines and equipment special to each group. The group should be supplied with machines that are needed to process all the components in the families. The parts should not move out of the group for operations on machines belonging to other groups. This helps to reduce throughput time, WIP inventory and handling time.
3. Specially allocated area to house machines and equipment. This is an essential characteristic of full benefits of GT is to be obtained.
4. Group should have its own special products to be completed.
5. A common output target for the group.
6. This characteristic is essential if full advantage is to be taken of the use of planned sequence of loading to reduce set-up times and through put times and to increase machine capacity.
7. The number of workers in the group should be small.

51.5 BENEFITS OF GROUPS

1. Reduction in throughput time as all operations on a part are done inside the group.
2. Decrease in work in process inventory (WIP).
3. Improvement in quality levels.
4. Completion of work as per due date or schedule.
5. Reduced set-up time hence increase in productive capacity.

51.6 IMPLEMENTATION PROCESS

A wide variety of methods for the implementation of cellular manufacturing have been proposed. These range from complex mathematical and computer and models to straightforward applications, such as production flow analysis.

A pattern for implementation is represented below:

The first step in implementing cellular manufacturing is to break down the various items produced by the company into a number of part sets or families. The grouping process (group technology) involves identifying items with similarities in design characteristics or manufacturing characteristics, and grouping them into part families. Design characteristics include size, shape, and function; manufacturing characteristics or process characteristics are based on the type and sequence of operations required. In many cases, though not always, the two kinds of characteristics are correlated. Therefore design families may be distinctly different from processing families.

Once identified, similar items can be classified into families. Then a system is developed that facilitates retrieval from a design and manufacturing database. For example, the system can be used to determine if an identical or similar part exists before a completely new part is designed. If a similar part is found, it may be that a simple modification would produce satisfactory results without the expense of new part design. Similarly, planning the manufacturing of a new part after matching it with an existing part family can eliminate new and costly processing requirements.

This grouping of part or product families requires a systematic analysis that often proves to be a major undertaking. Usually, there is a considerable amount of data to analyze, and this in turn can be quite time-consuming and costly. Three primary methods exist for accomplishing the grouping process: visual inspection, examination of design and production data, and production flow analysis. Visual inspection is the least accurate of the three but nonetheless the simplest and the least costly. The most commonly used method of analysis is the examination of design and production data. This method is more accurate but is also more time-consuming. Production flow analysis examines operation sequences and machine routing to uncover similarities (therefore, it has a manufacturing perspective rather than a design perspective). However, unless the operation sequencing and routings are verified, this method could be far from optimal.

The resulting number of families determines the number of cells required, as well as what machines are required within each cell. The cell usually includes all the processing operations needed to complete a part or subassembly. However, it is possible for a product to go from raw materials to packaging and be ready for shipment by the time it reaches the end of the cell.

The families will also help determine where within the cell each machine will be located for the most efficient flow, and how many employees are needed within each cell. After the product families are determined, the machines needed for the production process of a specific family are organized into cells according to processing requirements (*e.g.*, the order of processing). Frequently, machines are grouped in an efficient U-shaped configuration. Since each machine operates on its own for much of the cycle, few workers may be needed, and even then only for a limited number of steps.

The optimal layout is one that minimizes the distance between cells, or the distance to the next production point. The resulting reduction in time and handling ultimately provides a reduction in processing costs. Some firms utilize "linked-cell manufacturing," which is the concept of arranging the manufacturing cells near the assembly cells. Again, this decreases travel distances while reducing materials handling. Hopefully, the floor layout will also provide for the easy flow of a product to shipping, if shipping is located close to the cells in a streamlined flow.

Some plants in advanced stages of cellular manufacturing utilize what is known as a "mini-plant." The cell not only does the manufacturing, but also has its own support services, including its own industrial engineer, quality manager, accountant, and marketing representative and/or salesperson. Only research and development and human resource management are not dedicated to the mini-plant.

An entire facility can be broken down into a number of mini-plants, each of which operates as an independent profit center.

51.7 STAGES IN GROUP TECHNOLOGY MANUFACTURE

1. The parts of each of the items processed are examined and placed in to logical classes or families and the operations sequence for each class of parts is determined and specified.
2. Groups of facilities suitable for processing of these classes of parts are specified using the operations planning details and forecaster demand for the items and hence the components.
3. The sequencing of each class of parts for each group of facilities.

51.8 CELLULAR CONCEPT

Concept of performing all of the necessary operations to make a component, subassembly, or finished product in a work cell. Basic assumption is that product or part families exist and that the combined volume of products in the family justifies dedicating machines and workers to focused work-cells.

Basic building blocks of cells

- Workstations
- Machines
- Workers
- Tools, gauges, and fixtures
- POU materials storage
- Materials handling between work stations

51.9 FORMATION OF PART FAMILIES

A family is a collection of parts which are similar for purpose of manufacture. Usually they are related by size geometry shape and required similar manufacturing operations.

The key factor in using Group Technology successfully is the ability to identify readily items within the same family.

1. Coding and Classification System

The four systems are commonly used for classification;

(*i*) British System
(*ii*) Mitrofanov System
(*iii*) Optiz System
(*iv*) Vuoso System

(*i*) The British system

When applied to GT, this requires an eight-digit primary code or monocode which effectively sets down the design characteristics of the parts, followed by a secondary code or polycode, identifying the manufacturing characteristics. All other digits are tailor made to the each organization.

(*ii*) Mitrofanov system

This system is a contribution by S.P. Mitrofanaov, one of the earliest known workers in G.T. who first conceived the idea of composite component. It is a production oriented code of seven digits-

First digit (0-9)	Section	
Second digit (0-9)	Class	Parts characterized by common functions & structural shape.
Third digit (0-9)	sub class	parts characterized by common shapes and similar processing methods
Fourth digit (0-9)	Group	Characterized by similar shapes and number of manufacturing operations.
Fifth digit (0-9)	Type	Operation type
Sixth & Seventh digit (0-9)	Size	

(*iii*) Optiz system

This system is applicable to only machined components. It is uses 5 digit to define shape, followed by four "Optional extra" digits specifying size, material, original shape of raw materials and accuracy.

(*iv*) Vuoso system

This was developed by Vuoso Research institute for machine tools and metal cutting in Czechoslovakia in 1959. It is a simple 4 digit code. A family is a collection of parts. Which are similar for purpose of manufacture? Usually they are related by size and geometric shape and require similar manufacturing operations.

51.10 PRODUCTION FLOW ANALYSIS

This technique was derived by Burbidge (1975) to enable groups of parts to be defined in terms of the operations that they will require for their manufacture. Major groups are formed using factory flow analysis on the basis of similar operation route sequence.

Production flow analysis has three stages -

1. **Factory Flow Analysis -** This is concerned with the first major division in to large groups of department size and into very large families of parts to be made in these departments.
2. **Group Analysis -** This concerned with the division of the plant assigned to each department on to groups and the division of parts in to associated families. The primary aims is to achieve the simplest possible material flow system inside each department and, to help to achieve this, the three secondary aims are adopted. As far as possible, each part should be processed in one group only, each machine type should be exist in one group only and incompatible processes should be in different groups.

3. **Line Analysis -** This is concerned with the flow of materials between machines inside the groups and with planning the best layout for machines. The aim is to find the sequence of machines which will give the nearest approximation to line flow.

51.11 CLUSTER ANALYSIS

Clustering is the science of classification of objects based upon their possession or lack of defined characteristics. This approach provides a way to study the similarities between diverse populations of objects in a quantitative manner.

The clustering approach provides algorithms. For the study of similarities between objects in a quantitative manner. This involves three stages.

1. Preparation of part operation matrix. This indicates whether the features are either present or absent.
2. Compute a similarity co-efficient matrix. This is based on the extent to which the parts share common characteristics
3. Perform a cluster analysis.

The similarity between each pair of objects is examined and groups of objects formed such that within each group the objects are similar to each other according to the set of rules.

Choice of Family

The composition of family of parts which are "housed" in a group is largely determined by the equipment available within the organization. Four aspects of the group likely to result from family should be examined.

(*i*) What load will the family generate?
(*ii*) What capacities and capabilities would be needed?
(*iii*) Is it possible to set up the group for the family?
(*iv*) Are the necessary machines available or to be obtained?

51.12 COMPOSITE COMPONENT

Once a family has been identified, a composite component may be conceptualized. It is the one which contains all of the features of all the members of the family composite cum part family shown in Fig. 51.2. The available machines are then surveyed to find which group can be best put together to produce the family. Composite part concept: (*a*) the composite part for a family of machined rotational parts, and (*b*) the individual features of the composite part.

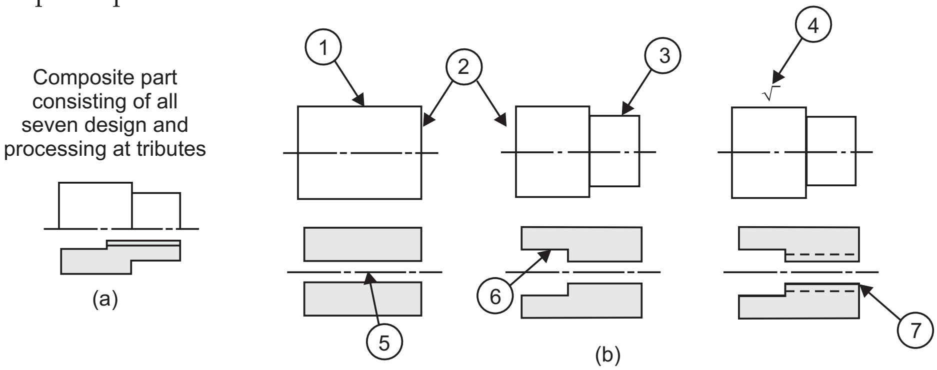

Fig. 51.2: Composite part

51.13 FACILITIES SEQUENCING

The facilities necessary to perform all operations on the part family and the expected load on each equipment can be listed for each family identified.

"Singleton" outlined a simple method for determining a layout sequence for a number of operations or machines through which a variety of parts is processed, each part having a particular route through the operation. Travel or cross charts are sometimes used in developing layouts. Such charts show the nature of the inter-operation movements for all parts for a given period of time.

Sequencing

The determinations of sequence in which batches of parts are loaded on to the group technology cell or 'Line' will be influenced by the desire set-up cost and minimize throughput time.

51.14 WHEN TO USE GT AND CELLULAR MANUFACTURING

1. The plant currently uses traditional batch production and a process type layout – these results in much material handling effort, high in-process inventory, and long manufacturing lead times.
2. The parts can be grouped into part families – A necessary condition to apply group technology – Each machine cell is designed to produce a given part family, or a limited collection of part families, so it must be possible to group parts made in the plant into families.

51.15 PROBLEMS IN IMPLEMENTING GT

1. **Identifying the part families**
   – Reviewing all of the parts made in the plant and grouping them into part families is a substantial task
2. **Rearranging production machines into GT cells**
   – It is time-consuming and costly to physically rearrange the machines into cells, and the machines are not producing during the changeover.

Part Family

A collection of parts that possess similarities in geometric shape and size, or in the processing

Steps used in their manufacture

Part families are a central feature of group technology

– There are always differences among parts in a family

– But the similarities are close enough that the parts can be grouped into the same family

Part Families

- Two parts that are identical in shape and size but quite different in manufacturing:

(*a*) 1,000,000 units/yr, tolerance = 0.010 inch, 1015 CR steel, nickel plate;

(*b*) 100/yr,

Tolerance = 0.001 inch, 18-8 stainless steel

Ten parts are different in size, shape, and material, but quite similar in terms of manufacturing.

All parts are machined from cylindrical stock by turning; some parts require drilling and/or milling.

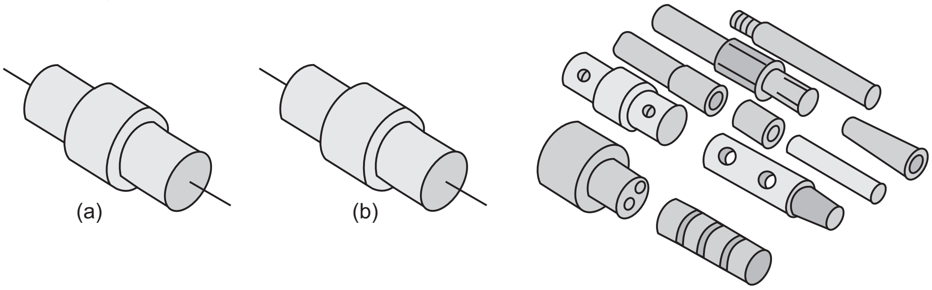

Fig. 51.3: Part Family

51.16 BENEFITS OF CELLULAR MANUFACTURING

Many firms utilizing cellular manufacturing have reported near immediate improvements in performance, with only relatively minor adverse effects. Cited improvements which seem to have occurred fairly quickly include reductions in work-in-process, finished goods, lead time, late orders, scrap, direct labor, and workspace.

In particular, production and quality control is enhanced. By breaking the factory into small, homogeneous and cohesive productive units, production and quality control is made easier. Cells that are not performing according to volume and quality targets can be easily isolated, since the parts/products affected can be traced to a single cell. Also, because the productive units are small, the search for the root of problems is made easier.

Quality parameters and control procedures can be dovetailed to the particular requirements of the parts or work pieces specific to a certain cell. By focusing quality control activity on a particular production unit or part type, the cell can quickly master the necessary quality requirements. Control is always enhanced when productive units are kept at a minimum operating scale, which is what cellular manufacturing provides.

When production is structured using cellular manufacturing logic, flow systematization is possible. Grouping of parts or products into sets or families reveals which ones are more or less amenable to continuous, coupled flow. Parts that are standardized and common to many products will have very low changeover times, and thus, are quickly convertible to continuous, line-flow production. Products that are low-volume, high-variety and require longer set-up times can be managed so that they evolve toward a line flow.

Cells can be designed to exploit the characteristics peculiar to each part family so as to optimize the flow for each cell and for groups of cells as a whole. Flow systematization can be done one cell at a time so as to avoid large disruptions in operations. Then the cells that were easy to systemize can provide experience that can be exploited when the more difficult systematization projects occur later. Cells that have been changed to a line flow will invariably show superior performance in the areas of quality, throughput time, and cost, which can lead to eventual plant wide benefit.

Work flow that is adapted to the unique requirements of each product or part allows the plant to produce high-volume and high-variety products simultaneously. Since the cell structure integrates both worker and product versatility into a single unit, it has the potential to attain maximum system flexibility while maintaining factory focus. Cells can be designed around single products, product groups, unique parts, part families, or whatever unique market requirements are identified. For the same part, there may be one high-volume, standardized design and one low-volume customized design. Cells can be built specifically for any of these with a focus on the individual marketing or production requirement called for by the individual product or part.

Systematic job rotation and training in multiple skills also make possible quick, flexible work assignments that can be used to alleviate bottlenecks occurring within the cell. Since normal cell operation requires the workers to master all the skills internal to the cell, little or no additional training should be needed when workers have to be redeployed in response to volume or sales mix changes. When it is routine for workers to learn new skills, they can be easily transferred to another job within the cell or possibly even to an entirely different production unit. Without this worker flexibility and versatility, there can be no real production system flexibility.

Limitations

While its benefits have been well documented, it should also be noted that some have argued that implementing cellular manufacturing could lead to a decrease in manufacturing flexibility. It is felt that conversion to cells may cause some loss in routing flexibility, which could then impact the viability of cell use. Obtaining balance among cells is also more difficult than for flow or job shops. Flow shops have relatively fixed capacity, and job shops can draw from a pool of skilled labor so balance isn't that much of a problem. By contrast, with cells, if demand diminishes greatly, it may be necessary to break up that cell and redistribute the equipment or reform the families.

Also, some researchers have warned that the benefits of cellular manufacturing could deteriorate over time due to ongoing changes in the production environment. Finally, it must be noted that conversion to cellular manufacturing can involve the costly realignment of equipment. The burden lies with the manager to determine if the costs of switching from a process layout to a cellular one outweigh the costs of the inefficiencies and inflexibility of conventional plant layouts.

15.17 IMPACT OF CELLULAR MANUFACTURING ON WORKERS

Nancy Hyer and Urban Wemmerlov noted in Mechanical Engineering that while technology and processes represent the "hard side" of cells, people represent the "soft side." They state that the soft side factors are far more difficult to change than are the hard side factors. Most implementing firms spend most of their time struggling with soft issues. Cellular manufacturing calls for radical changes in the way industrial work is designed, structured, planned, controlled, and supervised. It makes worker self-management a reality, so management must be convinced that the workers can master all the required aspects of the work.

The decision to implement cellular manufacturing requires a deep commitment to excellence and a desire to permanently change the way factories are viewed and managed. Cellular manufacturing affects workers in a number of ways. Among the factors now discussed are issues of self-management, motivation, employee input, supervision, and group cohesiveness.

Self Management

Cell workers are encouraged to think creatively about production problems and are expected to arrive at pragmatic solutions to them. While they are free to seek advice from plant management and staff, the identified problems and subsequent analysis, and usually the solutions, are entirely their own. Workers have the authority and are encouraged to implement and follow up on action plans to improve their work. Some managers ask cells to set improvement targets for themselves and measure their performance in comparison to these targets. In addition, workers are given the freedom to plan, coordinate, and control their work within their cell as long as they meet company standards of quality, volume, time, and cost.

Motivation

Behavioral psychology proposes that challenging work assignments keep employees motivated, satisfied, and productive. Flexible work assignments within the cells ensure that employees are constantly learning new tasks and constantly being challenged. Job rotation within the cell introduces variety in work patterns, thereby breaking the monotony (which has been known to cause absenteeism and problems in quality and productivity). Industrial work is productively accomplished in a group work setting. Cellular manufacturing can energize the group, attacking the lethargy found in many industrial situations.

Employee Input

With the cell work group energized and motivated, the employees are more likely to actively and continually bring their mental capabilities to bear on job-related problems. Cell workers are the closest ones to the production process, so practical ideas are likely to instigate other ideas, which could then give rise to a continuous, almost self-sustaining chain reaction of improvement. As the workers see their own creative output being implemented, they begin to develop self-esteem and a stronger desire to succeed. They even begin to challenge each other to improve on their prior accomplishments.

The drive toward excellence is fueled by the human need to achieve until the desire to excel and continuously improve becomes part of the factory culture. Then as workers learn by doing more, they become more proficient at generating ideas which, perpetuates the cycle of improvement. Cellular manufacturing can be the structural catalyst that starts, contains, and sustains the improvement process.

Supervision

The intense use of manufacturing cells tends to flatten the factory management structure and reduce overhead costs. When work group autonomy, worker versatility, and small group improvement activities converge, the need for supervision is drastically reduced, if not eliminated all together. Cell manufacturing perpetuates the idea that the work group should supervise itself. A workforce that is motivated, trained, and assigned specific clear responsibility for a product or part, coupled with simplified production planning and control, does not need to be minutely controlled or supervised in order to do a good job.

Group Cohesiveness

The creation of small-scale productions dedicated to production of a few similar parts increases work group cohesiveness. Since each cell has few employees, typically less than fourteen, extensive interpersonal contact is unavoidable. The workers are now part of a single, identifiable unit with operating autonomy and responsibility for a specific product, linked by the common purpose of continually improving the productive unit for which they are responsible. The cell structure keeps problems at a level where they are manageable and gives employees the opportunity to exercise their creative potential in a pragmatic way. When problems calling for technical expertise beyond that of the workers, managers and production staff can be called on to provide assistance. Cell manufacturing builds a cohesive subculture within the wider social environment of the plant.

The use of flexible work assignments contributes even more to the group's cohesiveness and loyalty. Employees who regularly perform the work also done by coworkers are more likely to demonstrate empathy and support when dealing with each other on the job. If each worker has experienced each job firsthand, they are more able to offer encouragement and advice on how the work can be improved and each worker is more receptive to the input of his or her coworkers. Each worker can view and understand completely the task, responsibilities, and mission that top management has dedicated to the cell. The cross-fertilization process that emerges can generate some truly creative ideas for process improvement. As the expression goes, "as iron sharpens iron, so shall one man sharpen another."

Finally, work group cohesiveness, reinforced by the cell structure, facilitates total people management. Due to its small scale and mission focus, the cell can be easily mobilized. Top management is too far removed, spatially and socially, from the workers to be able to interact with them extensively enough to significantly control the socialization process. Management can shape corporate values and create a nurturing social environment, but it cannot instill these values into the minds of the lower level employees. Hence, corporate values are better communicated and instilled into daily work habits by small group processes.

The cell is better able to exercise social control over deviant workers since it can directly and immediately manipulate social rewards and punishment. Any worker who fails to conform may find his deviant behavior quickly detected and reacted to by the withdrawal of the social support of the cell. Deviant behavior that is hidden from management for long periods of time is very visible to the small group and can be dealt with quickly.

Conversely, high-performing group members are also quickly visible but are rewarded with esteem and respect from the other cell workers. Consequently, management can work through the cell to instill the corporation's values, attitudes, and philosophies. Once these are internalized by the group's key members, the group itself will take over the socialization process of indoctrinating these values into the mindset of each worker.

51.18 FOCUSED CELLULAR MANUFACTURING

In *International Journal of Operations and Production Management*, Fahad Al-Mubarak and Basheer M. Khumawala discuss a similar alternative to cellular manufacturing, focused cellular manufacturing (FCM). They define focused cellular manufacturing as a layout scheme that groups components by end-items and forms cell of machine for fabrication and assembly of the end-items. It differs from cellular manufacturing in that it does not attempt to take advantage of process similarities so as to reduce setup times.

The major advantage of FCM is the reduction of completion times for assembled end-items and workin-process inventories while maintaining some degree of flexibility. In addition, it should be easy to install in a firm producing a few end-items in large volume or many end-items produced in small volume. Apparently, installing a single, focused cell for a few end-items is more practical than installation of many cells as required for a cellular layout.

The flow systematization and physical process integration of cellular manufacturing reinforce each other in potent ways. The underlying mechanisms can be collectively used to push manufacturing to higher performance levels. The result is an effectively designed cellular manufacturing structure, a production operation that integrates many concepts of superior manufacturing performance into a single small-scale production unit whose place in the large manufacturing system is clearly visible.

One final note is to distinguish cellular manufacturing from flexible manufacturing. A flexible manufacturing system is a more fully automated version of cellular manufacturing. A flexible manufacturing system utilizes a computer to control the start of work at each machine and to control the transfer of parts from machine to machine. While quite expensive, flexible manufacturing systems enable manufacturers to achieve some of the benefits of product layouts with small batch sizes provide greater flexibility because the system can operate with little or no human intervention.

Cell production has the flow production line split into a number of self-contained units. Each team or 'cell' is responsible for a significant part of the finished article and, rather than each person only carrying out only one very specific task, team members are skilled at a number of roles, so it provides a means for job rotation.

Cell production is a form of team working and helps ensure worker commitment, as each cell is responsible for a complete unit of work, which Herzberg would view as part of **job enrichment.**

Cells would usually have responsibility for organizing work rosters within the cell, for covering holiday and sickness absences and for identifying recruitment and training needs.

Cells deal with other cells as if they were customers, and take responsibility for quality in their area.

Amongst the benefits claimed for cell production are:

- Closeness of cell members should improve communication, avoiding confusion arising from misunderstood or non-received messages
- Workers become multi-skilled and more adaptable to the future needs of a business
- Greater worker **motivation**, arising from variety of work, team working and more responsibility
- Quality improvements as each cell has 'ownership' for quality on its area
- Some of the downsides of using cell production include:
- The company culture has to encourage trust and participation, or workers can feel that they are being constantly pushed for more and more output with no respite
- The company may have to invest in new materials handling and ordering systems suitable for cell production
- Cell production may not allow a firm to use its machinery as intensively as in traditional flow production
- Some small scale production lines may not yield enough savings to make a switch cell production economically worthwhile
- The allocation of work to cells has to be efficient so that they have enough work, but not so much that they are unable to cope
- Recruitment and training of staff must support this approach to production

The cell with one worker, two workers and two workers with rabbit chase are represented in Fig. 51.4.

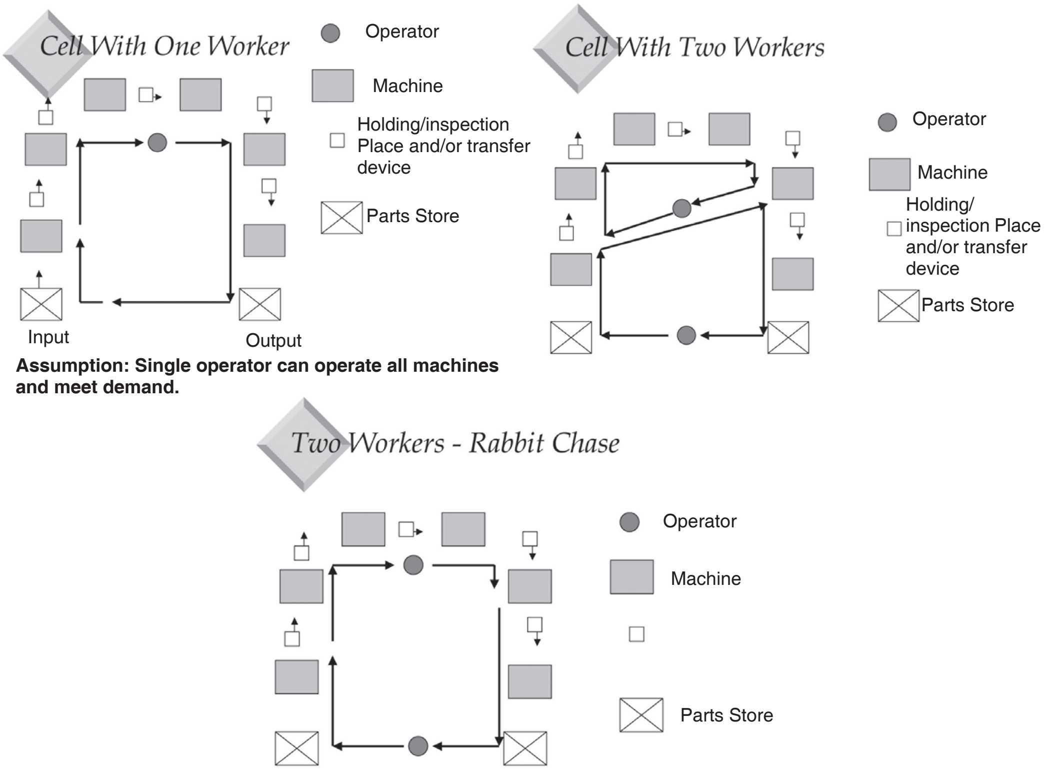

Fig. 51.4: The cell with one worker, two workers and two workers with rabbit chase

Cellular Layout Based on GT

- Each cell specializes in **producing one or a limited number of part families**

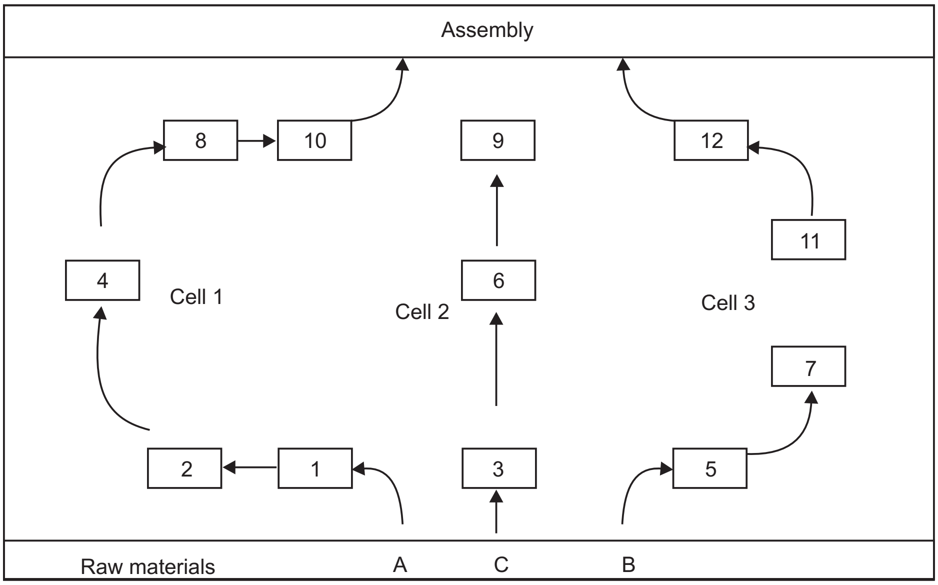

Fig. 51.5: Cellular Layout

Cellular manufacturing, one of the main tools of Lean Manufacturing, helps to create a concept known as single or one-piece flow. Equipment and the workstations are arranged in sequences to allow for a smooth flow of materials and components through the process. The cell is made up of workers and the equipment required performing the steps in creating the product. The layout of the equipment and the workstations is determined by the logical sequence of production. By grouping similar products into families that can then be processed on the same equipment in the same sequence, cellular manufacturing offers companies the flexibility to give customers the variety they require. Factories converted to cellular manufacturing benefit by the reduction of overproduction and waste, shorter lead time, improved quality and productivity, improved teamwork and communication.

Cell Requirements

The main requirement of Cellular Manufacturing is to ensure that all equipment required for production is operating at 100% efficiency at all times. Through short daily inspections, cleaning, lubricating, and making minor adjustments, minor problems can be detected and corrected before they become a major problem that can shut down a production line. **New Terms** Many new terms have emerged in the last few decades in virtually all fields of human endeavor. The field of manufacturing has also been affected by this trend - in fact, many buzzwords of the past have become just plain words of the present, used in daily conversations as well as various media. One such word - or rather a phrase, or a term - is **Lean Manufacturing**. Even for those not familiar with management of modern manufacturing, the term Lean manufacturing can have different meanings to some people, some correct and some incorrect. The word **lean**, as an adjective, is mostly used as means to describe something as *non-fat*, for example, *lean meat*. It can also mean to describe a non-productive or non-prosperous situation or period. It means identification and elimination of inefficiencies and waste. It also means a concentrated effort to achieve this goal.

Cellular Manufacturing

The basic concept of cellular manufacturing is the integration of management practices with technological advances. To be truly successful requires a thorough understanding of the because and elimination of waste at all levels, and that means both operations and processes.

There are several important considerations involved in order to achieve the best benefits:

- Reduction of lead time Utilization of available space
- Maximizing flexibility Emphasizing teamwork
- Improving communications Productivity and quality improvement

One Piece or Many

The question that comes up frequently is how many pieces to run at a given time? In this manufacturing environment, the product moves through the process based on customer's needs, one at a time, with no undesired interruptions. Various equipment and workstations are arranged in sequences to allow for a smooth flow of materials and components through the process. A particular cell is made up of the team members and the equipment that is required to follow the steps in manufacturing of the product.

Purpose of Cells

Joining machining technologies with tooling and setup technologies, and combining them with people skills and positive management (coaching rather than supervising), can all result in a very good manufacturing environment. As various processes and operations are at the core of manufacturing, it is important to understand that a cell is just a group of people and equipment Working together toward a certain goal.

Although the concept of individual cells suggests certain independence from other cell operations, but how each cell interacts with other cells in the same manufacturing situation.

Certain cooperation is not only needed but also necessary. Each cell should work towards its own goals and keep contact with other cells to the minimum. Typically, a single cell is designed to a family of similar parts; an example of such an approach is a work on a conveyor line or in Assembly.

Cell Description

A cell is defined as a combination of people and equipment that work together in order to complete a process in a set sequence. This arrangement allows manufacturers to achieve the main goals of Lean manufacturing - multi-variety products and one-piece flow. In a typical cell, All machinery and other equipment are arranged in close relation to each other. This results in the reduction or even elimination of time that is needed to move parts between machines in the cell. The most common cells used in industry are the C-shaped, U-shaped, or L-shaped cells.

51.19 LEAN AND CELLULAR MANUFACTURING RELATIONSHIP

In today’s business world, competitiveness defines an industry leader. The drive toward maximum efficiency is constantly at the forefront of such companies’ objectives. Managers across the country are striving to adopt lean manufacturing practices to help address worries about their bottom line. Cellular Manufacturing is one staple of lean manufacturing.

Cellular Manufacturing is an approach that helps build a variety of products with as little waste as possible. A cell is a group of workstations, machine tools, or equipment arranged to create a smooth flow so families of parts can be processed progressively from one workstation to another without waiting for a batch to be completed or requiring additional handling between operations. Put simply, cellular manufacturing group’s together machinery and a small team of staff, directed by a team leader, so all the work on a product or part can be accomplished in the same cell eliminating resources that do not add value to the product.

How to Incorporate Cellular Manufacturing

The implementation process of shedding the traditional manufacturing processes and embracing the drastically different cellular manufacturing techniques can be a daunting task. Management must deal with many issues including: cell design and set up, team design and placement, employee training, teamwork training, as well as other company functional issues. A project team should be put together that consists of management and production employees to handle these changes.

Cell Design and Setup should be executed to facilitate the movement of the product through its production cycle and should also be able to produce other similar products as well. The cells are arranged in a manner that minimizes material movement and are generally set up in a “U” shaped configuration.

Team Design and Placement is a crucial part of the process. Employees must work together in cell teams and are led by a team leader. This team leader becomes a source of support for the cell and is oftentimes responsible for the overall quality of the product that leaves his/her cell.

Employee Training must also accompany the change to cellular manufacturing. In cellular manufacturing workers generally operate more than one machine within a cell which requires additional training for each employee creating a more highly skilled workforce. This cross-training allows one employee to become proficient with his/her machines and while also creating the ability to operating other machines within the cell when such needs arise.

Teamwork Training should generate camaraderie within each cell and stimulate group related troubleshooting. Employees within each team are empowered to employ ideas or processes that would allow continuous improvement within the cell, thus reducing lead times, removing waste and improving the overall quality of the product.

Other issues that must be addressed include changes in purchasing, production planning and control, and cost accounting practices. Arranging people and equipment into cells help companies meet two goals of lean manufacturing: one-piece flow and high variety production. These concepts dramatically change the amount of inventories needed over a certain period of time.

- One-piece flow is driven by the needs of the customer and exists when products move through a process one unit at a time thus eliminating batch processing. The goals of once-piece flow are to produce one unit at a time continuously without unplanned interruptions and without lengthy queue times.
- High-variety production is also driven by the needs of the customer who expect customization as well as specific quantities delivered at specific times. Cellular manufacturing provides companies the flexibility to give customers the variety they demand by grouping similar products into families that can be processed within the same cell and in the same sequence. This eliminates the need to produce products in large lots by significantly shortening the time required for changeover between products.

Cellular manufacturing creates the ability to incorporate one-piece flow production which produces multiple time and monetary benefits. First, it reduces material handling and transit times. By having the machinery to complete a certain process grouped together in a cell, the product spends more time on the machinery and less time in transit between machines. Unlike batch processing, materials do not accumulate at a certain location to be worked or moved. This allows the operator the ability (in most cases) to move the unfinished product to the next station without the need of specialized equipment to move what would be, in a batch process, a larger load, farther distances.

With decreased material handling and transit time, accompanied by virtually eliminating queue times associated with batch processing, comes shortened part-cycle times. In other words, the time it to produce one unit of a particular product resulting in shorter delivery dates for the customer.

Also associated with one-piece flow are reduced work-in process inventories. With a continuous and balanced flow of product through the cell, no major buildup of material occurs between workstations eliminating the need of excess space to store in-process goods. This also allows workstations and/or machinery to be moved closer together. Less WIP is easier to manage and allows the manufacture to operate with shorter lead times.

Another benefit of cellular manufacturing is based on the capability to produce families of similar products within each cell. Adjustments required to setup machinery should not be significant for each family product. Reduced change over times will enable more frequent product line changes and items can be produced and delivered in smaller lots sizes without significant cost implications.

In addition to the aforementioned production benefits, there are also numerous benefits that are associated with the employees and their involvement in each cell. First, a cell on average employs a small number of workers that produce the complete part or product. Workers become multifunctional and are responsible for operating and maintaining numerous pieces of equipment and or workstations. They are also able to cover other workstations within the cell when required to do so.

In terms of worker productivity, the ability to deal with a product from start to finish creates a sense of responsibility and an increased feeling of teamwork. A common purpose is created and gives"ownership" to the production teams. Feedback on quality and efficiency is also generated from the teams building continuous improvement within the cells and adjusting quality issues right away and not after an entire batch has been produced.

SUMMARY

The basic concept of Cellular manufacturing is relatively simple. It is the identification and bringing together related or similar parts and processes, to make advantage of the similarities which exist, during all stages of design and manufacture. Cellular Manufacturing is based on the fact that small lots of different parts can be produced more economically, if they are grouped and scheduled for production according to the common characteristics.

It is an approach to the organization of work in which organizational units are relatively independent groups, each responsible for the production of a given family of products. A group is a combination of a set of workers and a set of machines and/or other facilities lay out in one reserved area, which is designed to complete a specified set of products.

Basic building blocks of cells

- Workstations
- Machines
- Workers
- Tools, gages, and fixtures
- POU materials storage
- Materials handling between work stations a family are a collection of parts which are similar for purpose of manufacture. Usually they are related by size geometry shape and required similar manufacturing operations. The key factor in using Group Technology successfully is the ability to identify readily items within the same family.

Major noticeable improvements which seem to have occurred fairly quickly include reductions in work-in-process, finished goods, lead time, late orders, scrap, direct labor, and workspace.

In particular, production and quality control is enhanced. By breaking the factory into small, homogeneous and cohesive productive units, production and quality control is made easier. Cells that are not performing according to volume and quality targets can be easily isolated, since the parts/products affected can be traced to a single cell. Also, because the productive units are small, the search for the root of problems is made easier.

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