CHAPTER II

THEORETICAL CONSIDERATION

This chapter discuss theoretical aspects which include tools , techniques and rules which can be applied to process of making cutting die effectively .

2.1 Work Breakdown Structure

Work breakdown structure is a systematic and disciplined approach for breaking down a project into its many components and sub-components . The work of a project is divided into and subdivided through increasing levels of details rather than breaking the work into a low level of details in a single step .

Developing the work definition in a structures way provides better results in management and control . It provides a clear picture of the work elements to be performed . It can be used to ensure that equal emphasis is given to work in different areas . Hence , the tree basic structure for work breakdown structure and organization structure , product structure and process structure .

1) Organization Structure

Organization structure breaks the project organization down into teams which are involved in the project similar to an organization chart . It is different in that it focuses on the work to be performed in each organization and on input to the project from each organization . The organization structure implies the flow of the process and the development of the final product . Therefore , it is excellent for organizational chart .

2) Product Structure

Product structure breaks the work into packages similar to that of bill of material . It is an appropriate structure for hardware items . The structure starts with the final product and then breaks into its major components and sub-component ,

respectively . This breakdown continuous into the parts . This structure implies organizational responsibility and the time - phasing of the workers . It is excellent for emphasis on quality .

3) Process Structure

Process structure breaks the work into time phase . It uses the list of all work on assemblies , sub-assemblies , components and part in each phase to highlight where each work is taking place into the process . Thereby , this structure implies organizational responsibility and the structure of the product . Process is excellent for emphasis on schedule .

Work breakdown structure take variety , which in turn , serve a wide variety of purposes . Work breakdown structure may be described as a hierarchy structure , which is designed to logically subdivide all the elements of the project into a practical presentation as a vertical tree diagram .

2.2 Method of Production

The following are the three main methods of the production :

1) Job Production

This is the oldest method of production on a very small scale . With this method , individual requirements of the consumers can be met . Each order stands alone and is not likely to be repeated . This type of production has a lot of flexibility of operation and hence general purpose machines are required .

Factories adopting this type of production , are generally small in size (ship building in an exception) . The layout of such factories is made flexible so that the maximum varieties of work can be easily and efficiently carried out with slight adjustments .

Even in this age of industrialization , many things are produced on unit production . This type of production is used for thing which can not be produced on a large scale , thing of high artistic nature requiring maximum attention , die work and foundry work etc. Man working in unit production gets an opportunity to produce large type of products enhance his skills , and can become expert in a very short time .

Advantage

1) It is not the only method which can meet the individual requirements .

2) There is no managerial problems , because of very less number of workers , and small size of concern .

3) Such type of production requires less money and easy to start .

4) There is less risk of loss to the factory adopting this type of production .

5) Because of flexibility , there is no chance of failure of factory due to the reduction of demand in particular field .

Disadvantage

1) There is no scope of commercial economy .

2) As the purchase of raw materials is less , hence cost of raw materials per unit will be slightly more .

3) For handling different types of jobs , only skilled and intelligent workers are needed , thus labor cost increased .

2. Mass Production

This method of production is a large scale of production and is a continuous production . In the method of job production , factory works only when orders are received and when orders are not received for some time then for that period work may come to a standstill . But mass production is a continuous production and it does not have any non-producing time .

This type of production requires specially planned layout , one purpose machinery and costly jigs and fixture etc. In this method , with the used of automatic machines , articles automatically move forward from one stage to the next stage of manufacturing operation .

In mass production , simplification and standardization of products are made. With the help of specialized (one purpose) machines , articles of standardized nature can easily and economically be produce on a large scale .

Lay out of plants is such that it can be used for only one type of product . Sequence of flow of the product during manufacturing remains same . In this type of production, different machines are assigned a definite nature of work. Throughout the run of the plant, only one type of product can be manufactured.

To avoid the problem of material handling, use of mechanical means such as conveyors of different types, cranes etc. can be used.

Advantages

1) Mass production gives better quality and increased production.

2) Wastage is minimum.

3) As raw materials are purchased on a large scale and hence higher margin of profits can be made while purchasing them.

4) Sales and advertising do not prove to be costly as their expenses are spread over thousands of articles produced, hence cost per unit is low.

5) Only few skilled and rest semi-skilled workers are required hence labor cost is reduced.

Disadvantages

1) During the period of less demand, heavy losses on the in vested capital may take place.

2) Because of all the machines used are one purpose machines therefore, this type of production is not changeable to other types of production.

3) Most of the workers handle only particular operations. They may get skill in their job but after some time they feel bored with the repetition of same type of work.

4) As this type of production is on a large scale, therefore it can not fulfill individual taste. It produces things of standardized form which are demanded on a large scale.

3) Batch Production

This type of production is generally adopted in medium size enterprises. Batch production is a stage in between job production and mass production. Batch production is bigger in scale than the job production while is it smaller than that of mass production. Batch production required more machine than of job production and less machine than that of mass production. In batch production, some of the machines are one purpose machines and remaining as general purpose machine. This type of production, different products are manufactured and stocked and then sold on receipt order.

Advantages

1) While comparing with mass production, it requires less capital.

2) If demand for one product decreases then the production for another product may be increased, thus the risk of loss is very less.

3) Comparing with job production, it is more advantageous commercially.

Disadvantages

1) Comparing with mass production, cost of sales and advertisement per unit is more.

2) Raw material to be purchased are in less quantity than that in mass production. Therefore, it is slightly costlier than that of mass production, because less quantity discount available.

2.3 Group Technology

In large manufacturing facilities , tens of thousand of different parts are made and placed in inventory . Although many of these parts have certain similarities in shape and method of manufacturing , each part was traditionally views as a separate entity and produced in batches , involving considerable duplication and redundancy .

Thus overall manufacturing efficiency is hurt because most of manufacturing today is batch production . The traditional product flow in a batch manufacturing operation is shown as fig. 2.1a . Note that machines of the same type are arrange in groups , that is , groups of lathes , of milling machine , of drilling press and of grinders . In such a layout (traditional layout) there is considerable random movement , as shown by the arrows that indicate movement of material and part , such an arrangement is not efficient because it wastes time and effort . The machine in cellular manufacturing are arrange in more efficient product line .

Group technology (GT) is a manufacturing concept that seeks to take advantage of the design and processing similarities among parts , similar things should be done similarity . The things are include product design , process planning , fabrication , assembly , and production control . It is an enabling technology . It allows design , manufacturing , and other descriptive data to be collected and communication in a common language .

One approach to GT for design is the use of common part families : the identification of groups and also provides a basis for the design of group tooling . Standard machine setup are often possible with a little change or no changeover required between parts within the composite family.

It may be necessary to include several part families in a machine group to justify machine utilization . Even within a family , parts may skip certain operations or require different machine sequence .

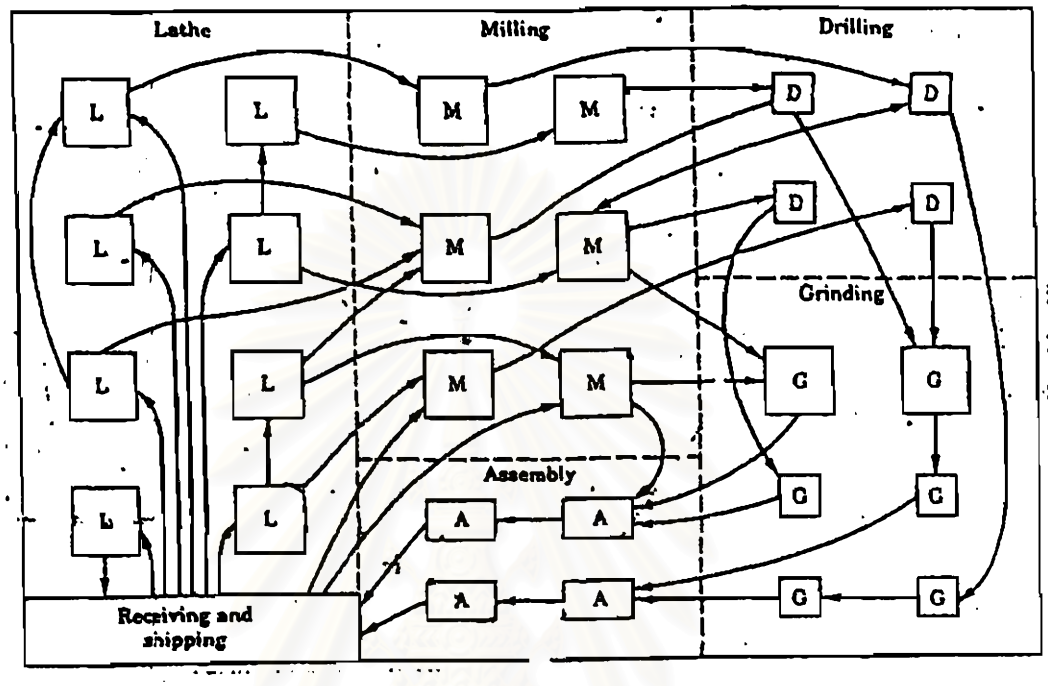


Figure 2-1a Function layout of machine tools in a traditional plant[1]

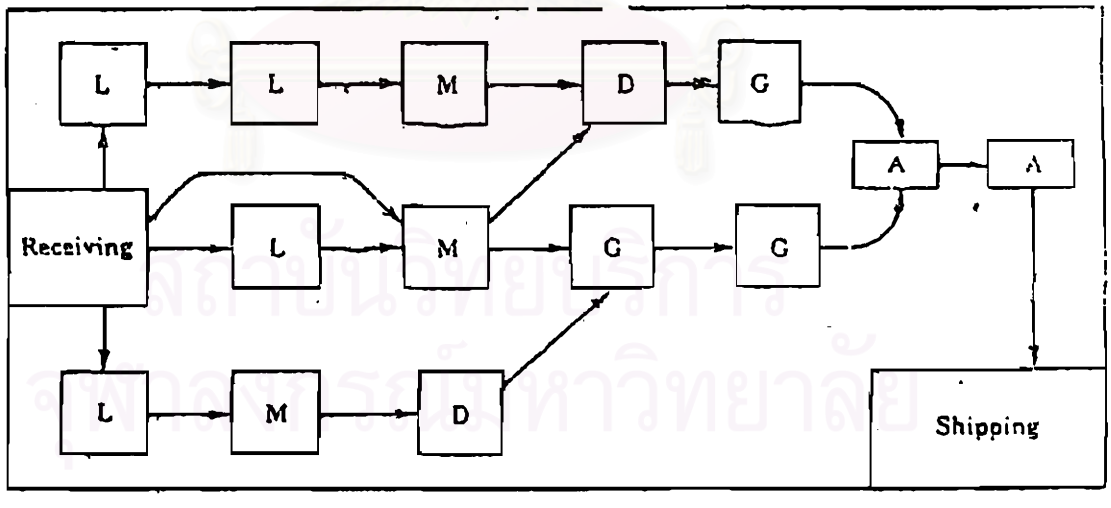


Figure 2-1b Group technology (cellular) layout [2]

[1] Manufacturing Engineering and Technology (Addison Wesley,1995) p.1197

[2] Ibid.

2.3.1 Classification of Group Technology

There are three types of GT shown in the following.

2.3.1.1 The GT flow line

The GT flow line is used when all parts assigned to the group follow the same machine sequence and require relatively proportional time requirement on each machine. The GT flow line operates as a mixed product assembly line system. In some cases automated transfer mechanisms can be used within the group for handing part .

2.3.1.2 The GT cell

The GT cell allows parts to move from any machine to any other machine . Although flow is not unidirectional , machines are located in close proximity .

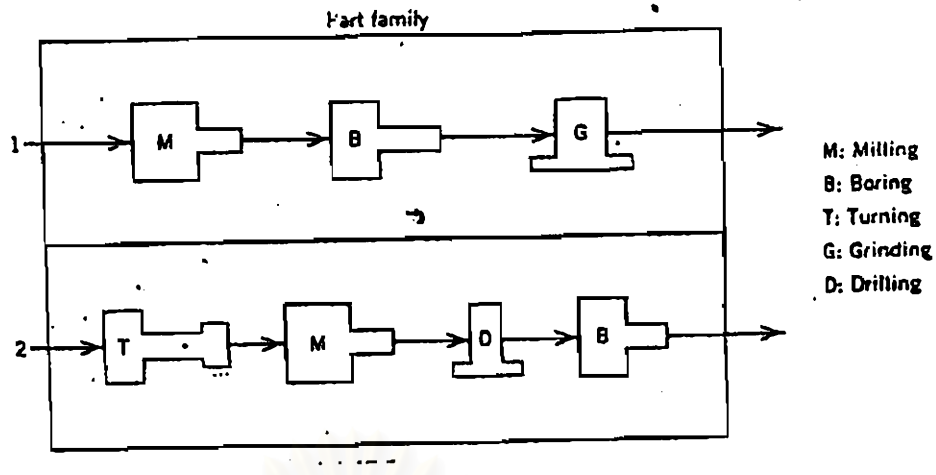
2.3.1.3 The GT center

The GT center is a logical arrangement. Machine may be located as in a process layout by using function departments, but each machine is indicated to producing despite the increase material handling. GT centers are appropriate when large machines have already been located and can not be moved , or when product mix and part dynamic and would require frequent re-layout .

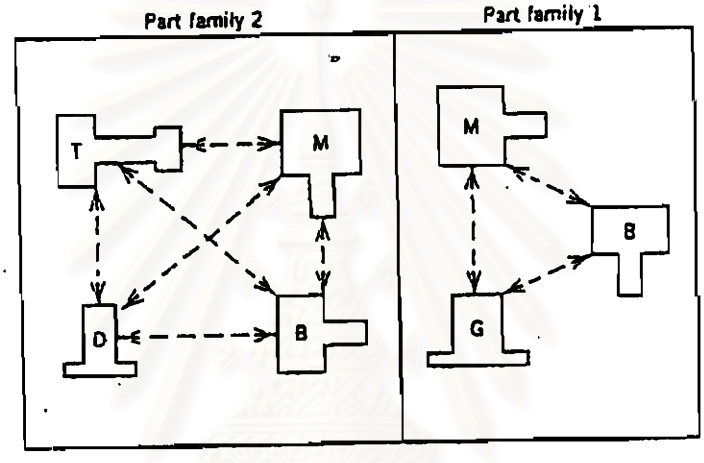
2.3.2 Advantages of Group Technology

The advantages of group technology include standardization of part design and minimization of design duplication .

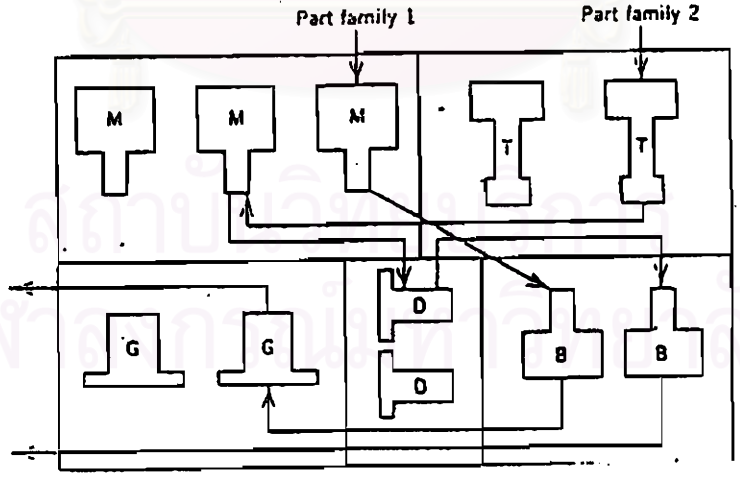
Group technology is capable of improving productivity and reducing costs in batch production to approach those of mass production. Potential saving cost and time in each of the various design and manufacturing phases can range from 5 to 75 percent .



(a) GT Flow line



(b) GT Cell



(c) GT Center

Figure 2-2 Types of Group Technology Layout[3]

[3] A Framework for Production Planning and Control of Cellular Manufacturing (Decision Science Institute,1982) p.167

2.4 Part Families

Parts may be similar in design and/or in the manufacturing processes used to produce them. A group of such parts is called a part family. It is possible for parts in the same family to be very similar in design yet radically different in the area of production requirements.

There methods can be used to group parts into families :

1) Sight inspection
2) Route sheet inspection
3) Parts classification and coding

All three methods require the expertise of experienced manufacturing personnel. Sight inspection is the simplest , least sophisticated method . It involves looking parts , photos of parts , or drawings of parts .

The second method involves route sheets that are used to route the parts through the various operations to be performed . This can be an effective way to group parts into manufacturing part families , provided the route sheets are correct . If they are , this method is more accurate than the sight inspection approach . This method is sometimes referred to as the production flow analysis (PFA) method .

The most widely used method for grouping parts is the third method : parts classification and coding . This is also the most sophisticated , most difficult , and most time - consuming method .

2.5 Parts Classification and Coding

Parts classification and coding is a method in which the various design and/or manufacturing characteristics for a part are identified , listed , and assigned a code number . Recall that these characteristics are referred to as attributes . This is a general approach used in classifying and coding parts . Many different systems

have been developed to actually carry out the process, none of which has emerged as the standard .

The many different classification and coding systems that have been developed all fall into one of three groups :

1) Design attribute group

2) Manufacturing attribute group

3) Combine attribute group

Design Attribute Group

Classification and coding systems that use design attributes as the qualifying criteria fall into this group. Commonly used design attributes include :

1) Dimensions

2) Tolerance

3) Shape

4) Finish

5) Material

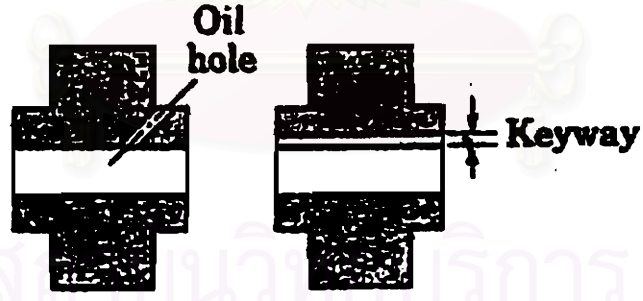


Figure 2-3 Grouping parts similarity to their geometric similarity[4]

Manufacturing Attribute Group

Classification and coding systems that use manufacturing attributes as the qualifying criteria fall into this group. Commonly used manufacturing attributes include the following :

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[4] Manufacturing Engineering and technology (Addison Wesley , 1995) p. 1186

1) Production processes

2) Operational sequence

3) Production time

4) Tools required

5) Fixtures required

6) Batch size

Figure 2-4 Grouping parts according to their manufacturing similarity[5]

Combined Attribute Group

There are advantages in using design attributes and advantages in using manufacturing attributes. Systems that fall into the design attribute group are particularly advantageous if the goal is design retrieval. Those in the manufacturing group are better if the goal is a production - related function.

2.6 Coding systems

Coding can be based on a company's own system or one several classification and coding systems that are available commercially. Because of widely varying product lines and organizational needs , none of the Classification and coding systems has been universally adopted .

The code structure for part families consists of members, letters, or a combination of both. Each specific part or component of a product is assigned a

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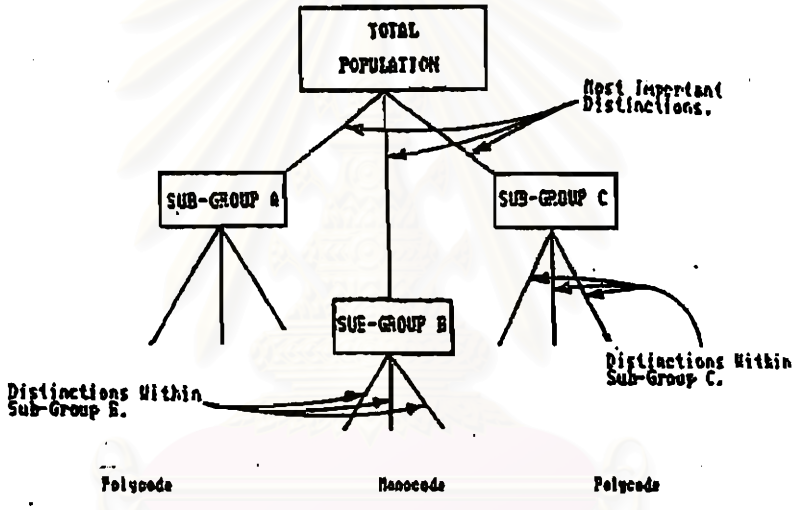
[5] Ibid.

code, Which may pertain to design attributes only (generally less than 12 digits) or manufacturing attributes only, although most advanced systems include both, using as many as 30 digits. The three basic levels of coding vary in degree of complexity. They are :

(a)

DIGIT	CLASS OF FEATURE	POSSIBLE VALUES OF DIGITS							
		1	2	3	4	5	6	7	8
1	EXT.SHAPE	SHAPE 1	SHAPE 2	SHAPE 3	-	-	-	-	-
2	INT.SHAPE	NONE	SHAPE 1	-	-	-	-	-	
3	# HOLES	0	1 - 2	3 - 4	5 - 8				
4	TYPE HOLES	AXIAL	CROSS	AXIALACROSS					
5	FLATS	EXT.	INT.	BOTH					
6	GEAR TEETH	SPUR	HELICAL						
7	SPLINES								

(b)



(c)

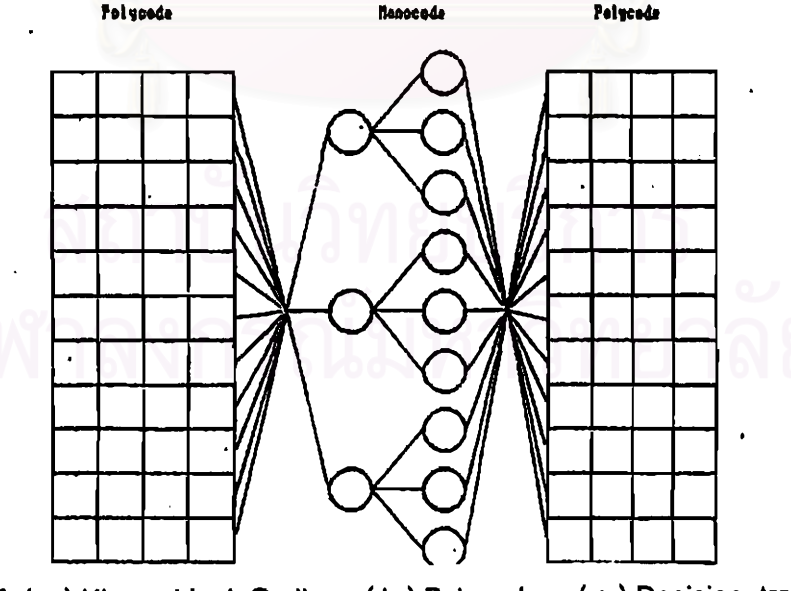


Figure 2-5 (a) Hierarchical Coding , (b) Polycodes , (c) Decision tree-coding [6]

[6] A cellular manufacturing system for sheet metal for components (Thesis, Chulalongkorn University,1989) p.8

Hierarchical coding

In this code, also called monocode, the interpretation of each succeeding digit depend on the value of the preceding digit . Each symbol amplifies the information contained in the preceding digit , so a digit in the code cannot be interpreted alone . The advantage of this system is that a short code can contain a large amount of information . However, this method is difficult to apply in a computerized system .

Polycodes

Each digit in this code, also known as chain type, has its own interpretation, which does not depend on the preceding digit. This structure tends to be relatively long, but allows identification of specific part attribute and is well suite to computer implementation .

Decision tree-coding

This system, also called hybrid codes, is the most advanced and combines both design and manufacturing attributes .

2.7 Cellular Manufacturing

The concept of group technology can be implemented effectively in Cellular Manufacturing, consist of one or more manufacturing cells. A manufacturing cell is a small unit of one to several workstations within a manufacturing system. The work stations usually contain one or more machines, each performing a different operation on the part. The machine can be modified, re-tools and regroup for different product lines within producing families of parts that have relatively constant demand.

Cellular Manufacturing thus far has been utilized primarily in machining and sheet metal forming operations . The machine tools commonly used in manufacturing cells are lathes, machining centers, milling machines, drills, and grinder. Cellular manufacturing has some degree of automatic control for :

1) Loading and unloading raw material and work pieces at workstation.

2) Changing tool at workstation.

3) Transferring work pieces and tools between workstation.

4) Scheduling and controlling the total operation in the cell.

2.7.1 Types of Cells

In deciding how to break down manufacturing activities into cells, we have to deal with the following two types of variable.

1) Type of Activity

- Component manufacturing : machining , drilling , milling , turning , pressing , forging . (there is some overlap from basic forming processes ,e.g. die casting and injection molding fit in both areas , but most extruding , rolling , etc. belong in basic forming industries .

- Assembly : putting things together .

- Process : painting , plating , heat treating , surface treatment .

Component Manufacturing Cells

There cells are defined by co-locating and managing as a single unit all the equipment needs to manufacturer a family of geometrically related components, or process related components . There are responsible for the output of a finished family of the components and all the processes required - machining , drilling , milling, turning , pressing ,etc. -are locates in the cell . Component cells have a series customers in the assembly business whose requirements they have to fulfill . They get to know their customers and the products and become familiar with the tempo of supply .

Assembly Cells

The defining characteristic of assembly cells is that they are organized around a family of assembled products rather than a family of components . They are planned around the hierarchy of component subassembly and final assembly . The complexity of the product determines whether you need both a subassembly an a final assembly . Subassembly cells draw parts from one or more of the component cells from the external suppliers who provide bought - out component . Excellent cell design and engineering act as enables for teaming and team-based manufacture which provide significant , durable benefits in productivity , lead time and quality .

Process Cells

These cells are defined by the process they carry out : heat treat , surface treat etc. They are built around a core process which they provide as a service to other areas of manufacturing , selling , this service to the other team leaders in the business who bring their work to it . The team leader in the process cell will form working relationships with the people in the cells , start to understand the working patterns of the cells , and understand what they have to do to provide each cell with the service it needs.

2) Volume and Complexity (see fig 2.6)

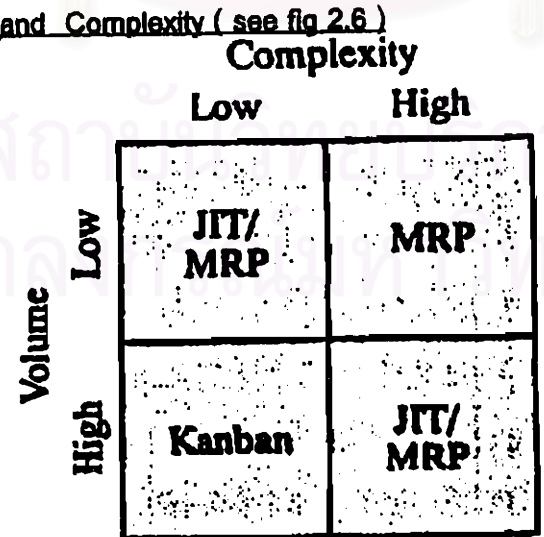


Figure 2.6 Methods for dealing with variable volumes and complexities [7]

[7] Cell in industry : Managing teams for profit (McGraw Hill,1994) p.92

Fig 2.6 show the appropriate method for dealing with variable volumes and complexities to make sure real demand exists from customer cells before allowing the next lot of material to be manufactured and moved . A Kanban system will deal with high volume , low complexity items , while a combination of JIT and MRP will be needed for low volume , low complexity items and high volume , high complexity items ; MRP alone should be adequate for low volume , high complexity parts .

2.7.2 Advantage of Manufacturing Cell Design

Because of the unique feature of manufacturing cells, Their design and implementation in the tradition plants require reorganization of the plant and rearrangement of existing product flow lines. The machine may be arranged along line, U shape, L shape or in a loop. For a group-machine cell where are handled by the operator, the U-shaped arrangement is convenient and efficient because the operator can easily reach the various machines. For mechanized material handling, the linear arrangement and loop layout are more efficient. Selecting the best machine and material-handling equipment arrangement also depends on factors such as production rate and type of product and its shape, size and weight.

The important feature of cellular manufacturing is the economics of reduced work in progress and product quality problems that are detected right away, thus improving productivity. Furthermore, because of the variety of machine and progress involved, the operator become multifunctional and is not subjected to the tedium involve with working on the same machine . The result is increased productivity, an important benefit of attended cells .

2.8 Team Management

2.8.1 Team Formation

There are four stages of team formation :

1) Forming : finding out about the other team members : who they are , where they come from , their track record , what baggage have they brought with them into the team .

2) Storming : A stage conflict , working out what team role each individual is going to fulfill .

3) Norming : After the storming , people starts to compromise and reach agreement , setting out the role of each individual and the rules and guidelines by which the team will operate , defining acceptable performance standards and what will be needed to achieve them .

4) Performing : Everyone understands what they have to do and has unconscious agreement with the other team members .

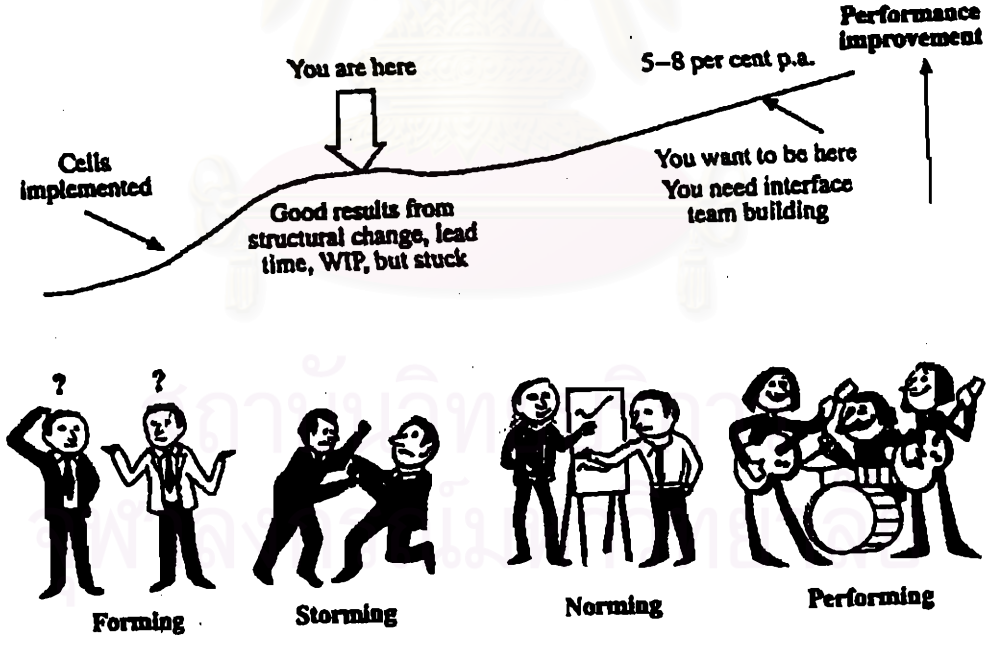


Figure 2.7 Stages of team formation : forming , storming , norming , and performing [8]

[8] Ibid. p. 70

2.8.2 A Multi-Skills . Multi-Process Production Unit

Cell manufacturing brings together in one location all the skills (people) and processes (machinery and equipment) needed to produce a defined product or family of parts (fig 2.8) . The team members have access to all the processes required to produce the product and the people have the breadth of skills needs to carry out those processes . This does not mean that every team member has to be able to do every task , but each team member should be able to undertake more than one task . The ultimate aim might be to achieve a situation where 70 percent of the people have 70 percent of the skills .

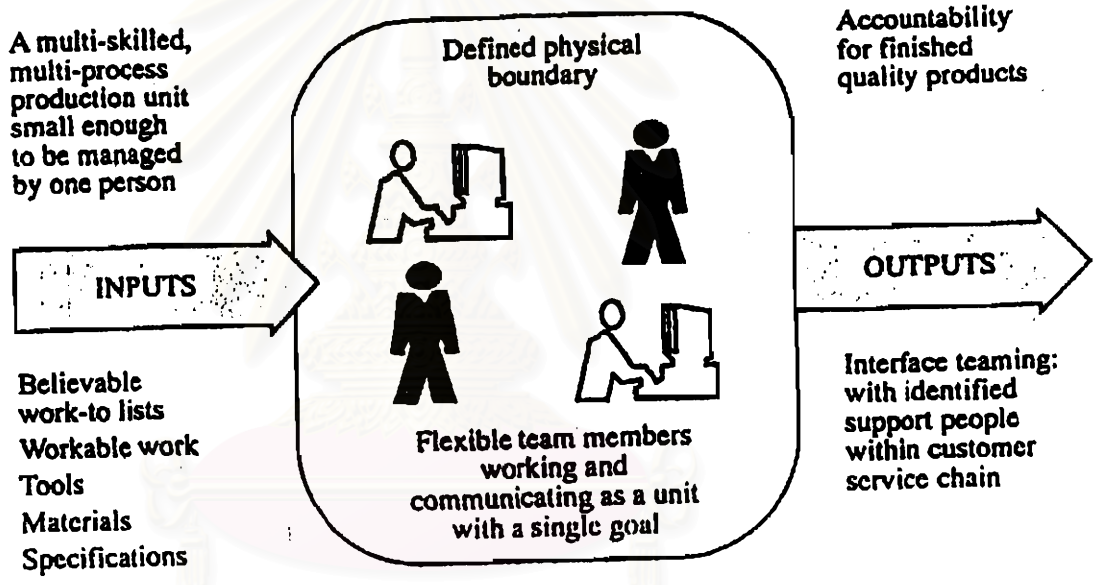


Figure 2.8 A multi-skilled , multi-process production unit [9]

2.8.3 Managed Production Unit

There are two issues involved in sizing the production unit so that small enough to be managed by one person : span of vision and number of people . The production unit needs to be arrange so that the team leader can see everything he is accountable for in one span of vision . When the team leader can see all

[9] Ibid. p.54

that he is accountable for by standing up and looking around , he can rely on ' visible ' management .

Creating units small enough to be managed by one person is one of the things that bring this sort of flexibility into a large company .

The number of people in the team is the other issue involves in creating a unit small enough to be managed by one person . Most of you would agree that it is really possible for one person to manage an absolute maximum of 20 people .

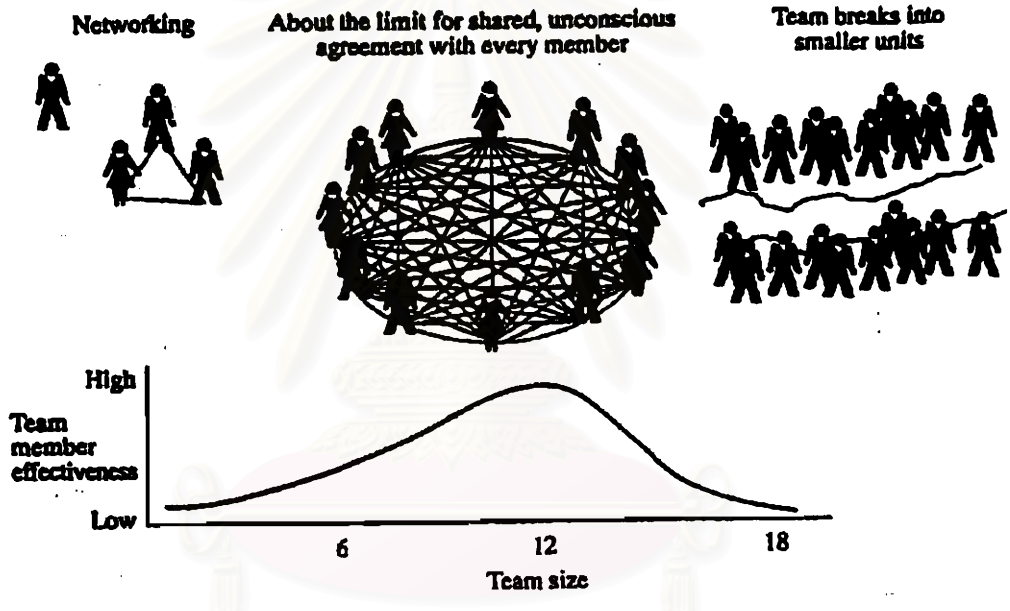


Figure 2.9 Team size[10]

Fig 2.9 show that for up out to about 12 people the output from an effective team is greater than the sum of individuals , contribution ; this is due to the high levels of unconscious network is about the limit of a team to be able to unconsciously share goals , tasks and roles . Adding more team members will start to degrade overall team performance to the point where , at about 20 people , the team will start to break into smaller units .

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[10] Ibid. p. 56

2.8.4 Accountable for Producing Finished Quality Products

Another thing that really delivers results in team-based cells is that the people have accountability for output of a finished quality product. In a typical manufacturing business a finished product can be family of components defined by geometry , or an assembly defined by the nature of the assembled product. The way that the product of each cell is defined will effect planning activity and this has to be taken into account .

Giving team members access to all the processes required to produce the product and making sure they have the breadth of skills needed to complete the task means that you can put accountability where the action is : at cell level . The cell team can carry out operator approval , can set and monitor achievement of targets for quality and output , because they know they have the authority to take on these issues .

Putting the accountability for quality with the operator brings out the issue of operator approval and this means that the operator has to be trained and then given real responsibility to inspecting their own work . When people work as a team , and are responsible for inspecting their own work , they no longer tolerate defects .

Making the team members responsible for quality and output leads to interesting questions of how to reward them for their efforts . Cells and piecework do not go together , but piecework is a powerful motivator and has to be replaced with something .

2.9 Objective of Performance Measure

The prime objective of a team-based cell is 100 percent customer service . Performance measures have to be designed to indicate whether the cell team is achieving this objective (fig. 2.10)

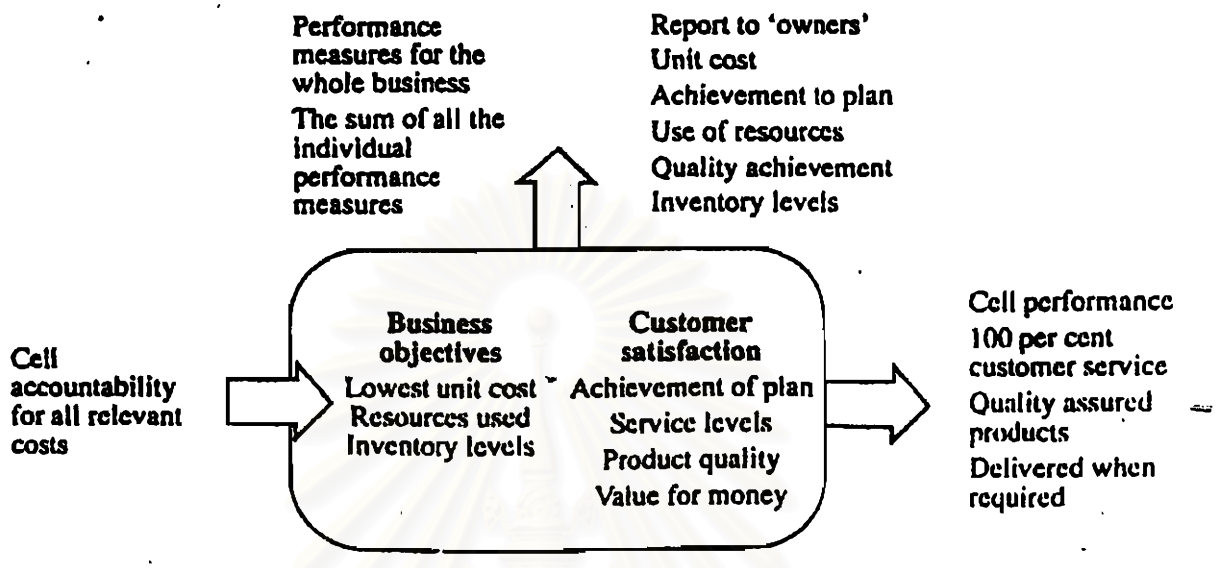

Figure 2.10 Objectives of cell performance measurement [11]

The objective of performance measurement in a cell environment is reporting to the company on the satisfaction of the customer . Measures that ensure the well-being of the business are :

1) Lowest unit cost

2) Resource consumed

3) Inventory level

To be effective , the cell has to have responsibility and accountability for all the costs associated with the targeted performance in these area .

2.10 Wage Payment

The principle objectives of wage payment is to increase productivity and lower unit cost, this allowing more goods and/or services to be produced for more people. The ability to produce more for less will result in more jobs for more people

[11] Ibid. p. 136

for a greater number of hours per year. It is through the intelligent application of the principles of wage payment that there can more producers of goods and services while, at the same time, the purchasing potential of all consumers is increased. It is through the exercise of these principle that unemployment and relief rolls can be minimized, this reducing the spiraling cost of economic support to non-producers.

Corollaries that apply to the principle objectives are : minimize the time required to perform tasks, conserve resources and minimize costs by specifying the most appropriate direct and indirect materials for the production of goods and services. Maximize the safety, health, and well-being of all employees. Follow a humane program of management that result in job interest and satisfaction for each employee. Produce with a concern for the availability of power. Provide an increasing reliable and high-quality product. And produce with an increasing concern to project our environment.

2.10.1 The Classification of Wage Payment

The wage payment activity is performed by the same group responsible for the method and stands work. The objective of incentive plans is tend to increase the employee's production will fall under one of the following three classes :

1) direct financial plans.
2) indirect financial plans.
3) plans other than financial.

1) Direct Financial Plans

Direct financial plans is the plans that the worker's compensation is commensurate with his output . In this category are include both individual incentive plans and group plans . In the individual incentive plan, each employee's compensation is governed by his own performance for the period in question. The

group incentive plans are applicable to two or more persons who are working as a team on operations that tend to be depend on one another.

In these plans, each employee's compensation within the group is based upon his or her rate and on the performance of the group for the period question . The incentive for high or prolonged individual effort is not nearly as great in group plans as in individual plans . Hence , there has been a tendency for industry to favor individual incentive methods. In addition to lower overall productivity , group plans have other drawbacks : (1) personnel problems brought about by nonuniformity of production coupled with uniformity of pay, and (2) difficulties in justifying base rate differentials for the various opportunities within the group.

Of course, group plans do offer some decided advantages over individual incentive, of which these are noteworthy : (1) ease of installation brought about through ease of measuring group rather than individual output ; and (2) reduction of cost in administration through the reduced amount of paperwork , less verification of inventory in process, and less in process inspection .

In general, the individual incentive plans give the higher rates of production and lower unit cost of the product than the group incentive plan. If practical to install, the individual incentive plan should be given preference over group system. The group approach has more application when it is difficult to measure individual output and where individual work is variable and is frequently performed in cooperation with another employee on a team basis.

2) Indirect Financial Plans

The indirect financial classification of the company tend to stimulate employee moral and result increased productivity, it is not designed to bring about a direct relation between the amount of compensation and the amount of production.

The indirect financial plans are concern with relatively high base rates, equitable promotion practices, suggestion systems, a guaranteed annual wage, and relatively high fringe benefits will lead to building healthy employee attitudes which stimulate and increase productivity.

It have the weakness on the gap between the employee benefits and productivity. After a period of time , the employee takes accept the benefits five him and fails to realize that the means for their continuance must result entirely from his productivity.

3) Plans Other than Financial

It is a non- financial incentives. It include any rewards that have no relation to pay, and can improve the spirit of the employee to such an extent that added effort will be evidenced. By this category the company policies are interested in a periodic shop conferences, quality control circles, frequent talks between the supervisor and the employee, proper employee placement, job enrichment, job enlargement , non-financial suggestion plans, the maintenance of ideal working conditions , the posting of individual production records, and unbiased managers.

2.10.2 The Principles for Wage Incentive Installation and Administration

Incentive principles have been applied in both job shops and production shops. It have been used to increase productivity, improve the quality and reliability of the product, reduce waste, improve safety, and stimulate good working habits, such as punctuality and regularity of attendance. The following 16 fundamental principles are recommended as a guide for sound practice in wage incentive installation and administration.

1) Management and labor should be agree with the general principles involved in the relationship between work and wage.

2) Quality Control and Improvement. The desirable and economical degree of quality should be determined and maintained, tied in with bonus payment where advisable.

3) Individual, Group, or Plant-wide Incentives. It is generally conceded that standards, applied to individuals or to small integrated groups, are most effective. The larger the group , the less the individual response.

4) The Production-Incentive Relationship. When production standard are properly set, and based upon well-engineered conditions, good practice has demonstrated the desirability of adopting an incentive payment in which earnings above the established standard are in direct proportion to the increased production.

5) Simplicity . Workers should be able to understand the effect of their own effort on their earnings

6) A foundation of Job Evaluation. These should be a sound wage rate structure, based upon an evaluation of the skill, responsibility, and working condition inherent in the various jobs.

7) Through Understanding of Human Relations Involved.

8) Based on Proven Industrial engineering Techniques. A table of basic standard times prepares the way for proper introduction of technological improvements. Standards should be developed from detailed time studies, basic motion data, standard data, and formulae.

9) Based on Normal Operation under Normal Conditions. In general, the production standard should be established by management up the amount of

work performed per unit of time by a normal qualified operator under normal condition.

10) Changes in standards. The plan should provide for the changing of production standards whenever changes in methods, materials, equipment, or other controlling conditions are made in the operations represented by the standards.

11) Counting. There must be accurate control of piece counts, unmeasured work, setup, and downtime.

12) Keep Temporary Standards at Minimum. The practice of establishing temporary standards on new operations should be kept at a minimum. It should , in any event, be made clear to all that the standards are for a reasonable short period only.

13) Guarantee of Hourly Rates. Under ordinary circumstances, the employee basic hourly rates should become guarantee rates.

14) Incentives for Indirect Workers. By this incentive indirect labor cost may be kept under control.

15) Considerations in Changing Standards. Except to correspond properly with changed conditions, production standards once established should not be altered unless by mutual agreement between management and labor representatives.

16) Improved Methods and Procedures . To secure the lowest costs and to prevent uneven standards and inequitable earnings, which lead to poor labor relation, the establishment of production standards should be preceded by basic

engineering improvements in design, equipment, methods , scheduling, and material handing.

2.11 Productivity

It may also be defined as human endeavor (effort) to produce more and more with less and less inputs of resources as a result of which the benefits of production may be distributed more equally among maximum number of people .

Productivity must be measured in such a way that it clearly reflects the important , and there must not be any ambiguities about the measurement of inputs and outputs .

Productivity index = Output / Input

Hence the output and input may be of various kinds e.g. cost , man , hours etc. When outputs and inputs measured in term of money , then

$$\text{Productivity} = \frac{\text{Outputs in revenues from production}}{\text{Expenditure on labor , capital or raw material}}$$

It may also be measured as follows :

$$\text{Productivity} = \frac{\text{Profit}}{\text{Investment}}$$

Main Contributors to Productivity Improvement

Following are the main contributors to productivity improvement in large number of industries :

1) Productivity improvement by work consideration

- Work study

- Ergonomic

2) Productivity improvement by technology consideration

- Computer Aid Manufacturing
- Computer Aid Design
- Computer Integrated Manufacturing
- Flexible Manufacturing System
- Group Technology

3) Productivity improvement by employees consideration

- Human relations
- Incentives

4) Productivity improvement by product consideration

- Value engineering
- Standard product

5. Productivity improvement by material consideration

- Material Requirement Planning
- Just In Time

This thesis used incentives and group technology for improve productivity of the cutting die process . The Chapter 3 is a case study for the improvement in the department of cutting die of PF Intertech Co.,Ltd.