Concept of Group Technology in the Field Of Cellular Manufacturing & Design of Manufacturing System

Rohit Pandey¹, Mahendra Agrawal², Arvind Singh Tomar³  
¹, ², ³ Assistant Professor, Department of Mechanical & Automation Engineering, Amity University Gwalior (M.P.) - 474005, INDIA.

Abstract: In this paper we reviewed of group technology (GT) and its principle of implementation in the field of cellular manufacturing to achieve the drastic change in output of production. One of the most significant changes in the global economy over the last few decades is the shift of power, in shaping the market demand from producers to consumers. In the ever growingly competitive environment, manufacturers are forced to continuously respond to market changes for their survival. The pressure of competitive pricing, short delivery dates, and high customization has shifted the manufacturing system design emphasis to flexibility and responsiveness. It has reduced traditional manufacturing systems to sub-optimal and paved the way for newer ideas of technical and managerial innovations. A number of newer manufacturing system paradigms have emerged over the years to cater to these modern day manufacturing challenges. Group Technology, the management philosophy of handling common problems together, has found central place in most of these paradigms. The present paper is an attempt to provide a succinct review of the Literature on this issue in three parts. First part deals with review of drawbacks of various classical manufacturing system paradigms. In the second part the Emergence of various modern manufacturing system paradigms is chronologically discussed in the light of drawbacks of classical paradigms. The second part will also attempt to bring out how Group Technology has emerged as the backbone of all these paradigms. In the third part of the paper, an exhaustive review of the research works on part classification (and/or machine groups’ formation) used across various modern manufacturing systems has been presented. Literature is classified chronologically as well as on the basis of various approaches such as coding and classification, clustering, knowledge based systems, heuristics, soft computing, simulation etc. The paper also attempts to classify the literature on the basis of parameters used, objectives considered and the focus orientation. Finally, it sums up with a vision for future research in this area.

Keywords: Group Technology, Cellular Manufacturing Systems.

1. INTRODUCTION:-

Group Technology or GT is a manufacturing philosophy in which the parts having similarities (Geometry, manufacturing process and/or function) are grouped together to achieve higher level of integration between the design and manufacturing functions of a firm. The group of similar parts is known as part family and the group of machineries used to process an individual part family is known as machine cell. It is not necessary for each part of a part family to be processed by every machine of corresponding machine cell. This type of manufacturing in which a part family is produced by a machine cell is known as cellular manufacturing. The manufacturing efficiencies are generally increased by employing GT because the required operations may be confined to only a small cell and thus avoiding the need for transportation of in-process parts. Group Technology benefits manufacturing in many ways. It reduces the number and variety of parts. Process planning for the remaining parts is easier and more consistent. Computer Aided Process Planning (CAPP) is an important tool for this. It uses the coded similarities to plan consistently, standardize and accurately estimate costs. It then assigns the part to a GT manufacturing cell. Group Technology cells reduce throughput time and Work-In-Process. They simplify schedules, reduce transportation and ease supervision.

2. CLASSIFICATION & CODING:-

Among the range of materials that manufacturers handle—raw materials, purchased components, fabricated parts, subassemblies, and complete items—GT is predominantly applied to purchase items and fabricated parts. We will concentrate our discussion on these groups.
When engineers are classifying parts and assigning those with closely related attributes to a particular family, they can determine similarities between items in several ways. From a design standpoint, for example, similarity can mean closely related geometric shapes and dimensions. From a manufacturing point of view, similarity between two parts means that they are processed through the factory in the same or almost the same way. Of course, parts that look alike are not always produced in the same way (it depends on variations in raw materials, tolerances, dimensions, and so on), while parts that are routed through the same machines can be quite dissimilar in geometric form.

The Langston Division of Harris-Intertype Corporation in Camden, New Jersey, one of the early users of GT in the United States, took Polaroid snapshots of every seventh of some 21,000 fabricated parts. When inspected from a production processing point of view, about 93% of the sample could be allocated to five part families.

While informal ways of grouping parts are not uncommon, the greatest potential of GT comes via a formal coding system in which each part gets a numeric or alphanumeric code describing the attributes of interest. For the widest use, the code should be able to describe the part from both a design and a manufacturing point of view. Such characteristics as the external and internal shapes, dimensions, and any threads, grooves and spines describe the geometric form. The shape and chemistry of the raw material, the surface finish and tolerance requirements, the need for special processes like heat treatment, and parts demand—all these are manufacturing attributes. Exhibit I offers a simple example of a coded part. Clearly, to capture all significant attributes, a large number of characters are needed.

Simple, informal parts classification techniques have been employed in companies where the sole intent was to identify families with similar manufacturing requirements to create dedicated lines or cells of machines.

Although many areas of business operations can benefit from GT, manufacturing, the original application area, continues to be the place where GT is most widely practiced. Two important tasks in manufacturing planning and manufacturing engineering are scheduling and process planning. Job scheduling sets the order in which parts should be processed and can determine expected completion times for operations and orders. Process planning, on the other hand, decides the sequence of machines to which a part should be routed when it is manufactured and the operations that should be performed at each machine. Process planning also encompasses tool, jig, and fixture selection as well as documentation of the time standards (run and setup time) associated with each operation. Process planning can directly affect scheduling efficiency and, thus, many of the performance measures
normally associated with manufacturing planning and control.

3. GROUP TECHNOLOGY IN PRODUCTION PLANNING AND CONTROL:-

Grouping parts with similar manufacturing characteristics into families will reduce the time spent on setups of parts and tools. In small-to-medium batch manufacturing, striving for setup reduction is most important. This type of parts production usually is carried on in a job shop environment where general purpose machines are grouped according to function, such as lathes in one cluster and grinders in another. Job shops also usually have high work-in-process inventories, long lead times, and an extremely low productive use of the time a part spends on the shop floor (normally no more than 5% of the total shop time). The following are among the ways GT can be carried out in production planning.

I. SEQUENCING OF PARTS FAMILIES:-

The simplest—and a highly informal—application of GT in a job shop setting is to sequence similar parts on a machine. This procedure, followed daily by foremen in most machine shops, often means overriding formal dispatch lists, which are made up with no consideration of efficiency. The saved setup time from running two or more related parts in a row can be converted to productive time.

II. CELLULAR PRODUCTION

The most advanced GT application is through the creation of manufacturing cells. A cell is a collection of machine tools and materials-handling equipment grouped to process one or several part families. Preferably, parts are completed within one cell. (The Japanese make much use of such cells, but apparently without formal classification and coding systems.) The advantages of cellular manufacturing are many, especially when the cells are designed with one dominant materials flow and with a fixed conveyor system connecting the work stations. A cell represents a hybrid production system, a mixture of a job shop producing a large variety of parts and a flow shop dedicated to mass production of one product. Exhibit II illustrates the difference between a job shop, based on a functional layout, and a cell shop. The allocation of equipment to a subset of parts will reduce interference, improve quality, make materials handling more efficient, cut setup and run times, and therefore trim inventories and shorten lead times. Shortening parts manufacturing lead times can reduce the response time to customer orders and thus lead to smaller finished-goods inventories as well. These benefits are likely to be greater with a physical rearrangement of machinery into cells.

Manufacturing cells also change the tasks production planners, schedulers, and manufacturing engineers perform and, most dramatically, alter the role of the foreman. This, too, affects accountability. In a job shop environment it is always possible to pass the buck by blaming other foremen for not having parts ready on time. With cells, timely completion becomes a responsibility solely of the cell foreman.

4. GROUP TECHNOLOGY IN PROCESS PLANNING:-

Some of the largest productivity gains have been reported in the creation of process plans that determine how a part should be produced. With computer-aided process planning (CAPP) and GT it is possible to standardize such plans, reduce the number of new ones, and store, retrieve, edit, and print them out very efficiently.

Process planning normally is not a formal procedure. Each time a new part is designed, a process planner will look at the drawing and decide which machine tools should process the parts,
which operations should be performed, and in what sequence.

There are two reasons why companies often generate excess process plans. First, most companies have several planners, and each may come up with a different process plan for the very same part. Second, process planning is developed with the existing configuration of machine tools in mind. Over time, the addition of new equipment will change the suitability of existing plans. Rarely are alterations to old process plans made. One company reportedly had 477 process plans developed for 523 different gears. A close look revealed that more than 400 of the plans could be eliminated. Another company used 51 machine tools and 87 different process plans to produce 150 parts. An investigation determined that these parts could be produced on only 8 machines via 31 process plans. Process planning using CAPP can avoid these problems. Process planning with CAPP takes two different forms:-

A. With variant-based planning, one standardized plan (and possibly one or more alternate plans) is created and stored for each part family. When the planner enters the GT code for a part, the computer will retrieve the best process plan. If none exists, the computer will search for routings and operations sequences for similar parts. The planner can edit the scheme on the CRT screen before printout.

B. With generative planning, which can but does not necessarily rely on coded and classified parts, the computer forms the process plan through a series of questions the computer poses on the screen. The end product is also a standardized process plan, which is the best plan for a particular part.

5. GROUP TECHNOLOGY WORK CELL EXAMPLE FOR CELLULAR MANUFACTURING:-

This cell has the classic U-shape but it does not operate like a Toyota Cell. This cell produces about 85 different turned parts. These are shafts and shafts with integral pinions and/or spines. Arrows show the sequence for three of these many parts. All parts have dedicated carts for handling and storage. They serve as material handling devices, containers and kanban. Perimeter carts are a kanban stock point. The internal lot size (transfer batch) is one cart (16 parts). External lot size varies from 16-48 parts in multiples of 16. Work times are highly variable and unbalanced. The hobbing machine (7-1) is extremely slow while the NC lathe is fast. The product mix was carefully selected to include some parts that require hobbing and many others that do not. Operators schedule their work from kanban signals. They must schedule non-hobbled parts immediately after a hobbled part. If they did not, the slow hobbler would bring output to a crawl.

6. BENEFITS OF GROUP TECHNOLOGY IN MANUFACTURING:-

Manufacturing industries are under intense pressure from increasingly competitive global marketplace. Shorter product life-cycle, time-to market, and diverse customer needs have challenged manufacturers to improve the efficiency and productivity of their production activities. Manufacturing systems must be able to manufacture products with low production costs and high quality as quickly as possible in order to deliver the products to customers in time. In addition, the systems should be able to adjust or respond quickly to changes in product design and product demand without major investment. Traditional manufacturing systems, such as job shops and flow lines, are not capable of satisfying such requirements. There are many benefits of GT in cellular manufacturing for a company if applied correctly. Most immediately, processes become more balanced and productivity Increase because the manufacturing floor has been reorganized and tidied up. There are some costs of implementing cellular manufacturing, however, in addition to the set-up costs of equipment and stoppages noted above. Sometimes different work cells can require the same machines and tools, possibly resulting in duplication causing a higher investment of equipment and lowered machine utilization. However, this is a matter of optimization and can be addressed through process design.

7. CONCLUSION:-

This study brings the attention towards the need for designing the cellular manufacturing system with GT for optimal performance as most of has been concentrated to the machine and parts into cell with part families. The study brings the attention towards the need for designing the manufacturing system for most favourable performance and how the Group Technology is still the backbone of every manufacturing system existing in any organization. Most of the past research work has been concentrated to the clustering of the machine and parts into cell and part families. So, acute need is to develop the models to specify the optimal number of groups and optimal production mix
subject to technological and logistical constraints for optimal performance of cellular manufacturing system. There is a need to develop more efficient tools enabling manufacturing system designer to achieve optimal solution in reasonable processing time.

REFERENCES:


