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PREPARATION OF NC PROGRAMS BY GROUP TECHNOLOGY THEORY APPLICATION

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ABSTRACT
Group technology (GT) has a great significance in the engineering industry. There is the greatest utilisation of GT in planning activities, especially in process planning and in layout machine design. GT is a manufacturing philosophy that has proved successful by grouping parts into families to speed production and reduce costs. In addition, the application of GT can lead to reductions of in-process inventory and tooling costs as well as CNC programming costs. Manufacturing engineers also apply GT to improve CNC utilisation.
Keywords: Group Technology, NC programming, CAM systems

1. INTRODUCTION
Group Technology is a manufacturing philosophy and strategy that assists a company in understanding what it manufactures and how those products are then manufactured. GT provides a means to identify and exploit the "underlying sameness" or similarities of parts and processes. Once identified, it is possible to capitalize on these similarities by processing together groups of similar parts (families), by standardizing and simplifying closely related and repetitive activities to avoid unnecessary duplication of effort and by efficient storing and retrieving of information related to recurring problems, thereby avoiding solving the same problem again and again.

2. BASICS OF GROUP TECHNOLOGY THEORY
When one looks at the parts that construct the product, the number is exceptionally large. Each part has a different shape, size, and function. However, when one looks closely, one may again find similarities among components; a dowel and a small shaft may be very similar in appearance but different in function. Spur gears of different sizes need the same manufacturing processes and vary only in size. Therefore, it appears that manufactured components can be classified into families similarly to biological families or library taxonomies. Parts classified and grouped into families produce a much more tractable database for management.
Although this simple concept has been in existence for a long time, it was not until 1958 that S. P. Mitrofanov. Group technology (GT) has been defined as follows [2]: Group technology is the realization that many problems are similar, and that by grouping similar problems, a single solution can be found to a set of problems thus saving time and effort.
For manufacturing purposes, GT represents a greater importance than simply a design philosophy. Components that are not similar in shape may still require similar manufacturing processes. For example, in Fig. 1, most components have different shapes and functions, but all require internal boring, face milling, hole drilling, and so on. Therefore, it can be concluded that the components in the figure are similar. The set of similar components can be called a production family. From this, process-planning work can be facilitated. Because similar processes are required for all family members, a machine cell can be built to manufacture the family. This makes production planning and

control much easier, because only similar components are considered for each cell. Such a cell-oriented layout is called a group-technology layout or cellular layout.

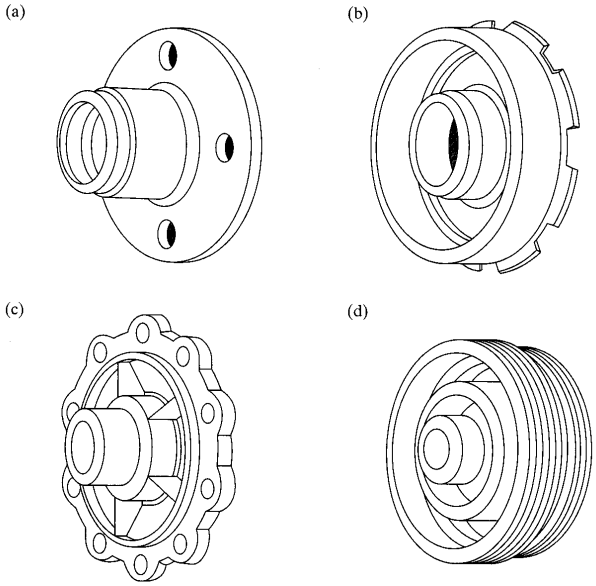

Figure 1. A production family

The following techniques are employed in GT [1]:

1. Coding and classification.
2. Production-flow analysis.
3. Group layout.

Although both production-flow analysis and group layout are based on coding and classification methods, they still can be distinguished as different activities. In the following sections, basic group-technology concepts are discussed in detail.

2.1. Classification and Coding of Parts

In group technology, parts are identified and grouped into families by classification and coding (C/C) systems. This process is a critical and complex first step in GT. It is done according to the part's design attributes and manufacturing attributes:

1. *Design attributes* pertain to similarities in geometric features and consist of the following:
   a) external and internal shapes and dimensions,
   b) aspect ratios (length-to-width or length-to-diameter),
   c) dimensional tolerances,
   d) surface finishes,
   e) part functions.
2. *Manufacturing attributes* pertain to similarities in the methods and the sequence of the manufacturing operations performed on the part. As we have seen, selection of a manufacturing process (or processes) depends on many factors, among which are the shapes, the dimensions, and other geometric features of the part. Consequently, manufacturing and design attributes are interrelated. The manufacturing attributes of a part consist of the following:
   a) the primary processes used,
   b) the secondary and finishing processes used,
   c) the dimensional tolerances and surface finish,
   d) the sequence of operations performed,
   e) the tools, dies, fixtures, and machinery used,
   f) the production quantity and production rate.

2.2. Production-flow Analysis

One of the more effective approaches to forming cells in facilities design is Production Flow Analysis (PFA), developed by Burbridge in 1975. Production Flow Analysis is a structured technique used for

determining part families and machine groups simultaneously by analyzing route sheets for parts (or assemblies) fabricated in the shop. PFA groups into families parts that have similar operational sequences and machine routings; grouping the machines that perform these similar operations into cells. The PFA technique has several advantages as a means to identity potential workcells:

1. this technique can be used when the shape of the parts has little or no relation with the manufacturing methods needed to produce them; thus, the tendency to identify part families solely on the basis of similar function, part names or physical appearance is avoided,
2. PFA can identify workcells more quickly and with much less effort than can the classification and coding system,
3. because PFA is based on routing sheets, the technique focuses solely on current manufacturing methods and uses existing processing equipment and tooling,
4. PFA offers a way to reorganize existing facilities and gain some advantages of cellular manufacturing with the least possible investment.

2.3. Group Layout

A typical company makes thousands of different parts, in many different batch sizes, using a variety of different manufacturing operations, processes and technologies. It is beyond the capability of the human mind to comprehend and manipulate such vast amounts of detailed data. People still need to make decisions regarding how to run a manufacturing company and success in today's competitive environment at home and foreign markets. The pressures on management are continuing to escalate as global competition drives the need for producing a greater variety of high quality products, in smaller lot sizes and lower costs. These outgoing demands continuously increase the level of complexity present in a manufacturing environment. What is needed, are both the strategy and a tool that can be used to achieve such a purpose.

3. PREPARATION OF NC PROGRAMS ON THE BASE OF GT THEORY

Many manufacturing companies made products, which were already made in the past or they produced similar products. On the source of quickest possible customer reassure is needful by production of products with complex shape using CNC machines to obtain CNC program for production of these components is shortest time. Because available production machines have limitation for certain group of products, it is probabilistic, that produced parts can be, according to their features (geometric, technological etc.), divided into groups, in which they have similar features. Manufacturing of these parts is very often realized using similar CNC programs. If mentioned CNC programs are made by manual programming always from the beginning, or if for creating of CNC programs using CAM systems, this process is protracted. Even by similar components firstly it is necessary to modify shape of parts in CAD system a then realize whole process of CNC program generation using CAM system. Such procedure by CNC program generating for production of similar product is improper. In this case it will be suitable if programmer on NC machines have opportunity to use softer application, which could allow according to existing database of NC programs automatic generation of new NC programs for production of similar parts on NC machines. Group technology shows as a suitable tool for evaluating of existing CNC programs in company with character of iterant production. This technology represents coding and classification system for components grouping into groups with similar production characteristics, which are set by their shape, size, used material, technological process etc. Each production company has to create its own classification system according to structure of its parts [3].

By generating of CNC program using group technology regular procedure contains of proposing of type representative of manufactured parts, it is a component, which contains all types a shapes of surfaces, which occur on components of production assortment. This is followed by manual or CAM system aided creation of NC program for production of type representative. Next step is analysis of created program and allocating of single subprograms to appertaining parts of type representative. Consequently it is possible to create special program, or use program environment to create new programs based on shape modification of produced components, with aid of combining each part of NC program. Example of type representative for manufacturing of rotary parts is described on Fig. 2, part of developing program for generating of NC programs using group technology in shown on Fig. 3. On Department of Manufacturing Technologies of Faculty of manufacturing Technologies of TU of

Košice with a seat in Prešov is prepared program for creation of CNC programs with use of group technology theory named GroupNC. First windows of GroupNC program is showed in Fig. 4.

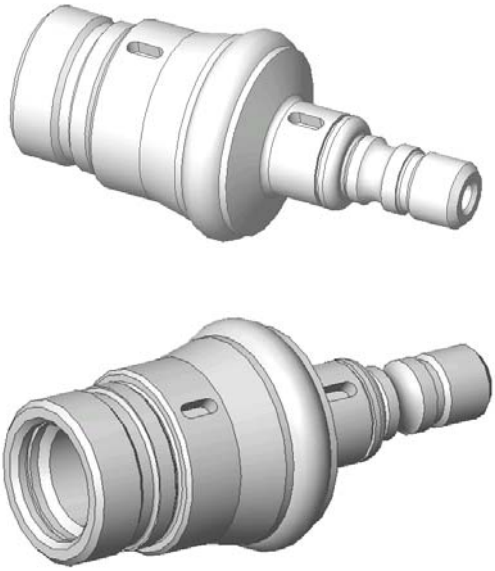

Figure 2. Complex part for NC cutting

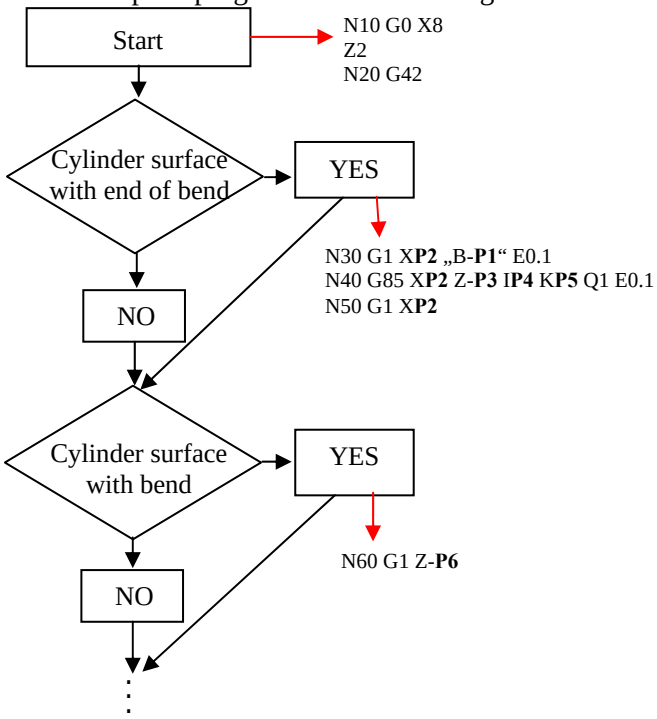

Figure 3. Algorithm for NC program creation

Figure 4. Windows of GroupNC program

4. CONCLUSION

It is essential to realize, that design-technological standardization can carry full effect till case of complex application (by current use in all processes of company: design, technology, material supply, quality management, production management), which lay high demand on resources (financial, staff, technological and technical equipment, realization time) at the process implementation beginning.

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5. REFERENCES

[1] Kalpakjian, S., Schmid, S. R.: "Manufacturing Engineering and Technology". Prentice-Hall, New Yersey, 2001, 1148 p.

[2] Kuric, I.: "Theory of group applications". In: Proceedings of 6th International Conference "Advanced Productional Operations", Varna, 2001, pp. 105-110.

[3] Marcincin, J. N., Petik, A.: "Theoretical Base of Computer Aided Manufacturing Engineering". FVT TU Košice, Prešov, 2000, 157 p.