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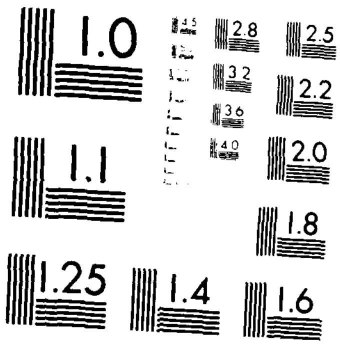

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MEMORANDUM REPORT ARLCB-MR-83018

GROUP TECHNOLOGY OF WEAPON SYSTEMS

J. COCCO

MAY 1983

U.S. ARMY
ARRADCOM
US ARMY ARMAMENT RESEARCH AND DEVELOPMENT COMMAND
LARGE CALIBER WEAPON SYSTEMS LABORATORY
BENÉT WEAPONS LABORATORY
WATERVLIET N.Y. 12189

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18. SUPPLEMENTARY NOTES

Originally submitted as an MM&T project to the U.S. Army Armament Materiel Readiness Command in September 1982.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Group Technology	Part Families
MICLASS	Rotational Parts
Manufacturing Cells	Standard Process Planning
Part Coding	Automation

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Group technology provides a method of classifying manufactured parts such that pertinent information concerning the parts is retained in the assigned code number. This study investigated the effect a group technology system would have upon the manufacturing of parts used in armaments. Conclusions drawn indicate a potential productivity improvement could be realized if group technology were employed.

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INTRODUCTION

In all manufacturing systems, one of the major problems encountered is the proliferation of designs and parts. The Army is no exception to this manufacturing ailment. Technologies are now being introduced in industry and in some government installations which classify designs and parts so they may be grouped into so-called families.

Benet Weapons Laboratory has been actively engaged in the field of Group Technology since 1971. The purpose and structure of the Manufacturing Methods and Technology (MMT) Project titled, "End Item Manufacturing Guide" had a definite group technology approach. In that project, a method of viewing machining processes in a technology-independent manner utilizing what we termed a functional analysis structure or classification scheme was developed.

Meanwhile, a more formalized procedure was being developed and used by manufacturers. The major thrust of these developments was seeking out similarities among parts and among methods for producing these parts, and then using similarities to increase the size of the batches for production purposes. In other words, the purpose was to bring mass production economics to batch or small lot manufacturing.

The Army embraced the concepts of Group Technology in an attempt to reduce the cost of weapon systems. ARRADCOM Headquarters in Dover, New Jersey, contracted the Organization for Industrial Research (OIR) to install their coding and classification system (MICLASS). This system was also available to all other Army installations.

In FY79, an MMT Project entitled "Group Technology of Weapons Systems" was funded at Benet Weapons Laboratory for use at Watervliet Arsenal. The scope of work was to apply the concept of group or family-of-parts manufacture which would aim at improving production methods. Thus, a demonstration of a manufacturing cell would be used to show which manufacturing elements or areas would offer the greatest potential for improvement of processes, tooling or equipment.

To satisfy the objective, the manufacturing cell was to demonstrate savings in the following areas:

1. Reduction in set-up time.
2. Reduction in cutting tools.
3. More efficient machine tool use.
4. Reduction in through-put time.

To accomplish the identification of a manufacturing cell, it was necessary to code and classify parts, perform analysis of the product mix, and identify part families and machine tools required.

APPROACH

A contract was let to the Organization for Industrial Research, Inc. (OIR) to code, classify and analyze a group of Watervliet Arsenal's parts for the identification of part families, a manufacturing cell or cells, and make/buy parts.

PROCEDURE

The procedure for the manufacturing cell identification comprised three major steps:

1. Benet Weapons Laboratory (BWL) would provide OIR with the required data.

2. OIR would perform contracted work.

3. BWL would evaluate identified manufacturing cell or cells.

Step 1. Furnish Required Data.

OIR requested the following data:

a. Machine Tool Data:

The machine tool data comprised a list of all machine tools available at Watervliet Arsenal, including the DIPEC code and machine specifications.

b. Material Data:

The material data contained a list of all materials used in the manufacture of parts at Watervliet Arsenal. Included in this list were material composition and material configuration.

c. Parts Data:

The following data would be required concerning each part submitted for analysis:

(1) Drawing number

(2) Part Nomenclature

(3) Year of manufacture or purchase

(4) Quantity manufactured or purchased

(5) Set-up time

(6) Piece rate

(7) Departmental code

To provide the required information, it was necessary to obtain a complete machine tool listing, materials listing, routings and engineering drawings.

Step 2. Work Performed by OIR.

OIR created three data files to perform a comparative analysis.

a. The Machine Tool File (MTF) is a binary file used by the MICLASS analysis programs to determine individual machine costs and loadings. The MTF for the Watervliet Arsenal includes information for machine codes, machine tool name, the number of machines in the category, and the total available hours within the release period.

OIR developed a four-digit machine tool code based on the size of the part and the machining characteristics that had to be performed.

Through consultation with Watervliet Arsenal planning personnel, a machine cost of $35.00 per hour was determined and used in developing manufacturing cost information; and the available hours for a release period of one year were set at 3,552 hours, using a 2/8/5 labor shift standard.

b. The Material File consisted of material names and a code number. The material name specifies both the composition and the general shape of the raw material. An established index of values by Watervliet Arsenal, comprising 120 different material categories, was coded by the MICLASS System and entered into a binary data file.

c. The Parts File was split into two sub-files. The first consisted of parts that were never purchased. The second contained purchased parts that may or may not have been manufactured in-house.

Included in both were the MICLASS code number, part drawing number, part nomenclature, year of manufacture or purchase, quantity manufactured or purchased, along with set-up time, piece rate, machine code and department numbers.

OIR used the code number analysis technique to perform the analysis. This involved employing the MICLASS code number to find families of similar parts. Since the basic design of the MICLASS coding system relates part characteristics to machining requirements, this technique can also be applied to find manufacturing families.

The MICLASS code number consisted of 18 digits. The first 12 digits were in reference to the geometry of the parts, i.e., form, dimensions, tolerances and materials. The remaining 6 digits depicted annual lot sizes and releases, additional dimensional information and manufacturing operation codes.

A net total of 474 rotational parts were coded, classified and analyzed.

The comparative analysis performed on the MICLASS code number was illustrated in histograms on each element of the code. Some of the interesting points revealed were:

a. The highest concentration of sizes was about 1 inch to 1.5 inches diameter.

b. The majority of parts were made from steel, bar stock.

c. The most common machining operation was turning.

d. The general shapes and machining operations to be performed between the buy/make parts had a high degree of similarity.

Eight different part families were identified which comprised 171 parts total. Along with each part family was the identification of a potential manufacturing cell.

Step 3. BWL Evaluation.

The part family which contained the most parts required for current production was evaluated by BWL. A manufacturing cell was identified which consisted of:

a. 20 different rotational parts.

b. 3 machine tools

(1) 1 Automatic Screw Machine

(2) 1 Feed-Thru Cylindrical Grinder

(3) 1 In-feed Cylindrical Grinder

RESULTS

OIR reported the following results from their study:

1. There was a considerable variation in manufacturing process plans for the same or similar parts. A computer-assisted process planning system could eliminate this costly and unnecessary duplication by establishing standardization in manufacturing.

2. Grouping similar parts, routing via standardized process plans, and the use of dedicated machine tools would result in:

a. Savings due to elimination of operations.

b. A significant savings in set-up time. (OIR estimates conservatively that the savings in set-up time at Watervliet Arsenal would be at least 20%.)

c. Establishment of a semi-mass production process which would virtually eliminate queues in front of machine tools.

3. OIR estimated that the reduction in the through-put time at Watervliet Arsenal would be between 15% and 20%.

4. The breaking down of the total parts base into families that are manufactured with specific machines gives Production Control personnel a better grasp on the location and status of parts required for assemblies.

5. Machinists continuously producing the same or similar parts do not have to go through a learning curve for every batch. This results in a considerable reduction in scrap and rework.

6. The reduction in the set-up time will automatically increase the availability of machine tools for production purposes. In other words, a savings of 20% in set-up time will result in an increase in the capacity of that machine tool.

7. The increased availability of machine tools for production automatically has a beneficial impact on the machine tool investment budget.

8. Introducing a computer-assisted process planning system will result in increased productivity of the process planning engineers, a reduction in the time required to understand manufacturing process plans on the shop floor, reduction in the time spent writing the manufacturing process plan, and in less confusion on the shop floor before the part is actually made.

9. Retrieving the same part by part number, or similar parts by code number, one also has a valuable tool for estimating manufacturing costs based on previous experience.

10. Using a part recognition system such as the MICLASS classification and coding system, it is possible to search the design data file for similar or identical parts before a new design is made. It was estimated that approximately 4% to 8% of Watervliet Arsenal's existing drawings could be used for new design requirements.

Based on several samples within the data files, OIR estimated that about 10% of the 474 parts could have been designed by modifying previously existing drawings.

11. Drawing standardization would yield additional benefits due to a decrease in manufacturing tooling costs. When design engineers have the option of revising rather than creating a drawing, the number of unique tolerances, finish requirements, and dimensional characteristics created is reduced.

12. When groupings of the same or similar parts are routed with standardized process plans across dedicated machine tools, it is cost effective to design special jigs, fixtures and tools specifically dedicated to those families of parts.

An evaluation by BWL of the part families and manufacturing cells identified produced the following results:

a. Only one part family contained enough parts of current production to permit a valid analysis.

b. Some of the characteristics of that part family were:

(1) The machining being performed utilized 4 automatic screw machines, 1 engine lathe, 1 turret lathe, 1 collet lathe and 2 cylindrical grinders (a through-feed grinder and an in-feed grinder).

(2) There were some inconsistencies in the process routings.

c. The manufacturing cell identified consisted of three basic machine tools which illustrated the following:

(1) Nine machines could be reduced to three machines (1 automatic screw machine, 2 cylindrical grinders) required to machine parts. This would:

(a) Affect machine tool investment.

(b) Increase availability of machine tools for production.

(c) Reduce maintenance of the number of machine tools.

(2) Standard tooling could remain set up and be utilized more efficiently.

(3) The utilization of automatic screw machines prevented a great deal of savings on tooling, fixturing, and set-up time because an automatic screw machine requires a unique set of form tools and cams for each part manufactured. However, the reduction of all the automatic screw machines and various types of lathes to one screw machine was a true indication of the possible savings to be realized.

For the following reasons, the manufacturing cell demonstration never materialized:

(1) The unfortunate circumstances involving the automatic screw machine prevented demonstration of a savings in tooling, fixturing, and set-up time.

(2) Watervliet Arsenal was deeply involved with their REARM program which created many projects of a higher priority.

(3) Arsenal personnel were unavailable to operate the manufacturing demonstration cell machine tools.

(4) Watervliet Arsenal felt that the paper study performed by OIR was sufficient enough to convince them that there was reason enough to pursue Group Technology.

(5) Watervliet Arsenal felt that our efforts should be directed to the implementation of a computer-aided process planning system.

Since the manufacturing cell could not be physically set up, such elements as through-put reduction, part status, and reduction in scrap and rework were impossible to evaluate.

CONCLUSION

The OIR study results and the BWL evaluation showed that there is a definite potential for improvement of productivity at Watervliet Arsenal through the implementation of Group Technology. Also, because of Watervliet Arsenal's desire for a computer-aided process planning system, efforts were directed to pursuing its implementation.

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