Software for Discrete Manufacturing

Edited by

J. P. Crestin and J. F. McWaters

SOFTWARE FOR DISCRETE MANUFACTURING

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PREFACE

PROLAMAT 85 is the sixth in a series of triennial meetings devoted to manufacturing automation - 1969 Rome, Italy; 1973 Budapest, Hungary; 1976 Stirling, Scotland; 1979 Ann Arbor, U.S.A.; 1982 Leningrad, U.S.S.R. - organized by IFIP, the International Federation for Information Processing, and IFAC, the International Federation of Automatic Control. Papers deal with advances and new results and applications in software aspects and computing methods and techniques for design and planning in discrete manufacturing (from machining to assembly). Discrete manufacturing includes manufacturing of all products except those made by continuous processes - mechanical parts and systems, electrical parts, furniture, clothes, etc...

The name of PROLAMAT originates from Rome's conference title "Programming Languages for Machine Tools". Since then, the title has moved towards "Software for discrete manufacturing". This evolution denotes the evolution of production automation as well as the interests of IFIP and IFAC in it.

In the sixties, engineers and scientists involved in production automation were mainly interested in numerically controlled (NC) machine-tools and associated software: NC processors and post-processors, computer aided planning, technological data bases, direct and adaptive numerical control. Computer applications to manufacturing have rapidly developed: computer aided drafting and design, scheduling, production planning and management, technical computations such as structural analysis and simulation, robotics. Present trends are towards high level man-machine communication including realistic graphical output and interactive processing, and towards integration of software and hardware tools: integration of CAD and CAM, of workshop planning and NC, robots and assembly subsystems planning. Artificial Intelligence is becoming one of the prominent tools of that evolution.

Advances in manufacturing automation is presented following the 5 themes:

- design and implementation of CAD/CAM systems
- computer aided design
- computer aided process and production planning and optimization
- robotics and automated manufacturing systems
- artificial intelligence in CAD/CAM

Each theme is introduced by an invited paper. Three general invited papers were presented during the opening and closing sessions, about "integrated factory automation systems" (Prof. SATA), "CAD/CAM in the automotive industry" (S. PARIZOT) and "Research and prospects in CAM" (Prof. SPUR).

44 papers have been selected from 200 proposals. They originate from 12 different countries, representing most industrial nations: Belgium, Czechoslovakia, Egypt, France, FRG, GDR, Hungary, Japan, Soviet Union, Switzerland, U.K., U.S.A..

4 panel discussions have been organized, on Economical and social aspects of CAD/CAM, International cooperation, Communication in CAD/CAM systems, Medium and Small Sized industries. Syntheses of discussions are given thereafter.

My thanks must go to those who contributed to the success of PROLAMAT 85, the members of the International Program Committee and of the French Organizing Committee, the staff of AFCET in charge of the organization of the conference, the National Patron Committee chaired by Professor BEZIER and whose members represent main French administrations, research institutions and industrial firms involved in manufacturing automation and helped to promote and organize the conference, and to the French Minister of Research and Technology who gave his sponsorship.

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Approaches to Highly Integrated Factory Automation

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ABSTRACT: This paper describes industrial experiences from the past and present state of factory automation. Also focused upon are the tasks required to realize a more highly integrated and automated factory. Key subjects related to this development include flexible automation of production processes, integration of material and information flow, utilization of integrated CAD/CAM systems, and education and training programs. Theses subjects are discussed from the point of view of increased productivity, decreased lead time for new product development and better utilization of human capabilities.

INTRODUCTION

Recent dramatic progress has been made in many engineering fields. Computer and so-called "mechatronics" technologies have greatly changed all manufacturing activities in the mechanical industry, in order to meet the requirements of customers who seek a wide variety of advanced industrial products at lower prices. Flexible factory automation is being introduced in production processes to increase the productivity of batch type production. Installation of information networks is also required to coordinate these manufacturing activities. The design of manufacturing processes are realized through the aid of computers in order to shorten the lead time for developing new products. Continued progress in these areas will result in highly integrated and automated factories.

In this paper, four important areas contributing to the development of a modern automated factory are discussed. These areas are: (1) Flexible automation of production processes; (2) Integration of material and information flow; (3) Utilization of an integrated CAD/CAM system and; (4) Education and training of engineers and operators. Experiences from both the past and present states leads to a discussion of the tasks which exist for the future.

FLEXIBLE AUTOMATION OF PRODUCTION PROCESSES

Automation of batch type machining operations was first realized through the computer control of several NC machine tools. The degree of automation of the system was increased by providing it initially with workpiece transportation sub-systems and then with tool transportation sub-systems. Automatic palletizing machines were installed with some systems. Epoch making progress was realized through the success of unmanned machining system operations. This was achieved by providing the system with the capability to monitor both the cutting state and machine operation. This kind of flexible manufacturing system was most successfully introduced initially for the machining of heavy industrial parts such as machine tools, construction machinery and heavy electric machinery. These machines consist of several large box-like and flat-type parts, which allowed easy retrofit of conventional machining centers. Such centers usually machined the large parts in time periods ranging from several tens of minutes to a few hours. A view of one of these systems is shown in Figure 1.

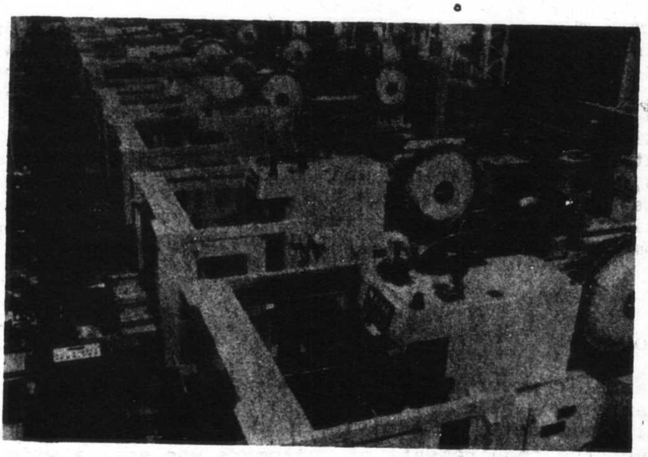

Figure 1: Flexible Manufacturing System for Small Lot Batch Type Production

In the case of machining many small parts which require rather short machining times, some are fixed on the faces of a square-shaped jig and mounted on a pallet, which extends the total machining time per pallet. Through the success of unmanned operations however, the total operating time/month for many current flexible manufacturing systems comes to over 600 hours. This results in a system up-time of more than 80%. The remaining period, 20%, is spent for NC operation check, maintenance and others. In addition, the current mean time between failures of systems consisting of about ten machine tools ranges from 250 to 500 hours. This means that such a system malfunctions once or twice a month.

The causes of the system break-downs were examined. As shown in Figure 2, the examination disclosed that human error was the main reason for system break-downs, about 85%. Operators' errors comprised 60% of the total and included misloading of tools, errors of pallet coding and loose fixing of the workpiece. Engineers' errors such as NC programming errors and poor selection of cutting conditions or cutting tools resulted in 25% of the break-downs.

Tool failure itself, which was expected to be the key factor, was found to cause only 15% of the total system break-downs. From these analyses, we suggest the following measures which should be taken to extend the operating time of flexible manufacturing systems: (1) To provide it with some functions to confirm or verify manual operations; and (2) To prepare better engineering simulation and confirmation programs for NC machining operations.

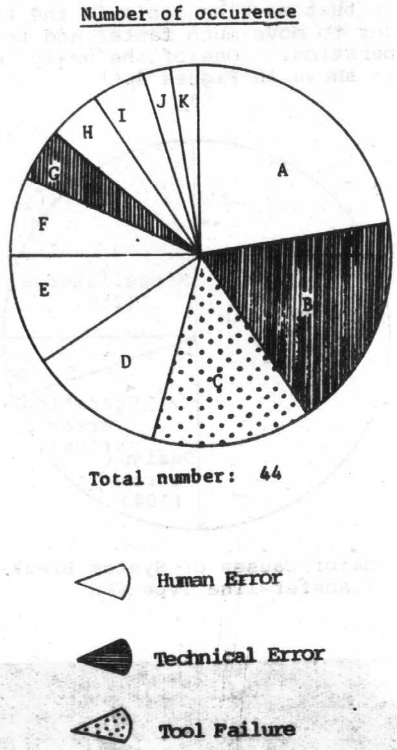

Figure 2: Major Causes of System Brank-down for FMS

In both the present and the near future, similar flexible automation of machining operations is going to extend not only to small lot, batch-type production, but it will also gradually spread to medium lot production. Even in the automobile industry, which seems to be engaged in mass production, they have many different kinds of products which are produced in medium volumes, ranging from several hundred to a few thousand in a month. For production of these parts there is a strong need to construct transfer-line