ZESZYTY NAUKOWE POLITECHNIKI ŚLĄSKIEJ 1992
Seria: MECHANIKA z. 108 Nr kol. 1161

International Conference on
COMPUTER INTEGRATED MANUFACTURING
Internationale Konferenz über
RECHNERINTEGRIERTE FERTIGUNGSSYSTEME
Zakopane, March 24-27 1992

Andrzej KASPRZAK, Jerzy SIKORA

The Institute of Metal Cutting, Cracow, Poland

INTEGRATED SOFTWARE MODULES FOR COMPUTER-AIDED TECHNOLOGICAL PRODUCTION PLANNING OF MACHINE PARTS

Summary. In the paper the operation principle of the software modules is presented, as well as the results of investigations and experiments related to their implementation in some industrial plants together with propositions concerning their further development as the first stage of the introduction of CIM-systems in Polish industry.

1. Introduction

Production automation is a very complex problem, requiring the cooperation of specialists in many disciplines, such as mechanical engineering, computer systems, machine design, robotics, informatics, telecommunication, etc. By solving automation problems one has to face not only their technical, but also organizing aspects. Actual world tendencies are showing that automation is aimed at Computer-Integrated Manufacture (CIM). The complexity of CIM problems, together with the experience gained in operating Flexible Machining Systems (FMS) have instigated to undertake the research program called ESPRIT (European Strategic Program for Research in Information Technology). Several years' research led to the development of the ESPRIT Pilot Project (No. 5.1/34): "Design Rules for Computer Integrated Manufacturing Systems". This project recommends among others to apply for manufacturing process control in CIM-system a model according to the reference model given in fig. 1. This scheme seems to be sufficiently clear not to need a separate description. As it can be seen, one of the blocks corresponds to the planning process in its most general sense, involving also process planning. In this very block can be located the modules for assisting process planning elaborated at the Institute of Metal Cutting,

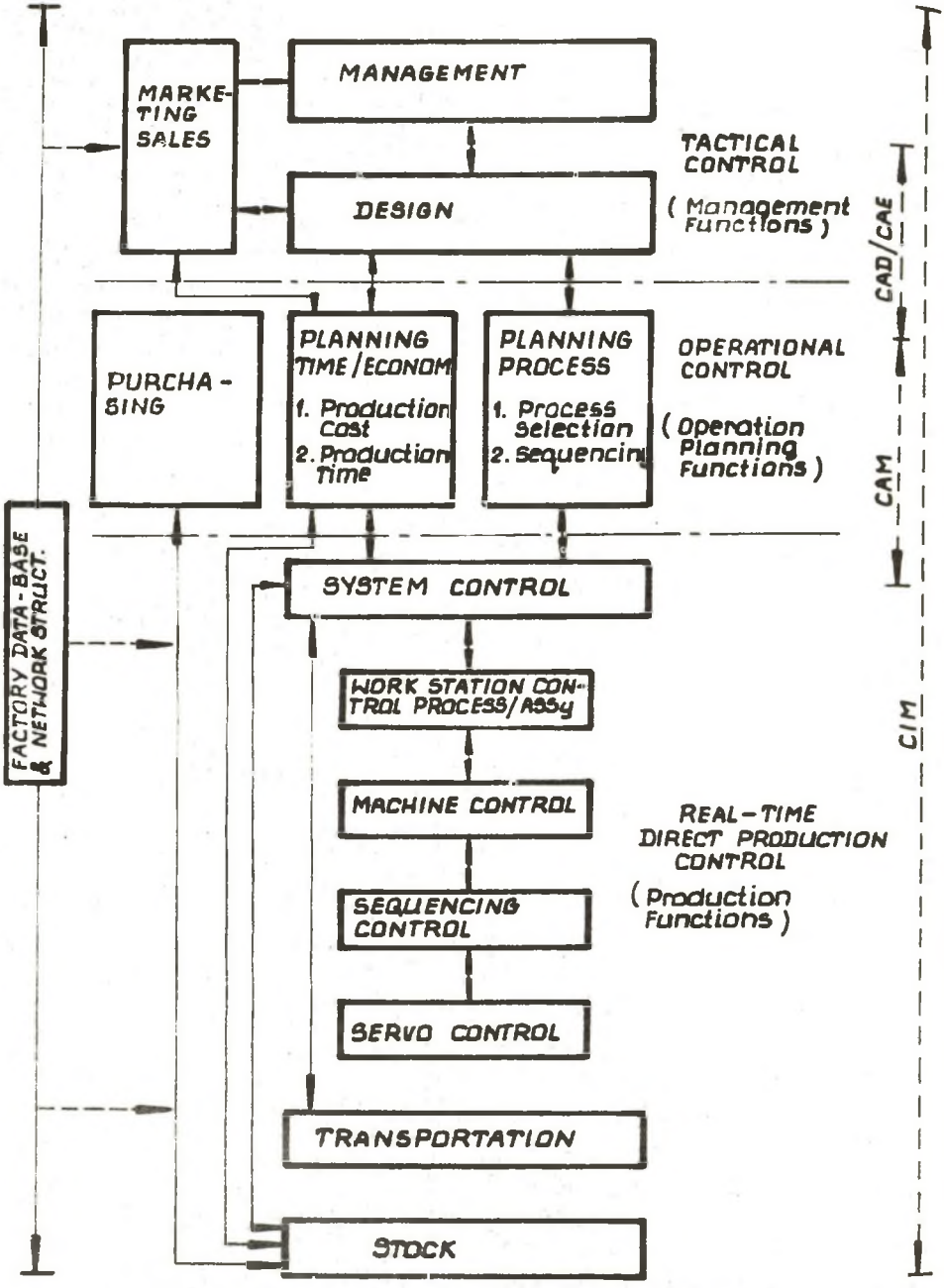

Fig. 1 Reference Model of Manufacturing Control System

Cracow, described in this report. This module is the result of works undertaken within the Central Research and Development Program 6.1, basing on several years of cooperation with machine-building industrial plants.

For achieving this package the rules of technological typification were assumed. Such an assumption was the result of many years of technological experiments and investigations led by production engineers in the mechanical engineering industry. The conventional system of process planning consists essentially in selecting a proper "standard" process and to adapt it to the actual task. This method of development of the reproducing computer program was securing its relatively easy implementation. Good accessibility of the data base with entered engineering knowledge of the plant, together with modules assisting rapid adaptation of this knowledge to a given technological task, are characteristic for this module.

2. Modules description

2.1. Modules flow chart

The modules flow chart is presented in fig. 2. The broken lines represent the links between modules, or modules not yet realized. The double arrows between modules indicate that the operator can actuate the module following that being currently realized and then come back to the first. Let us now explain the different blocks of the flow chart in fig. 2.

2.2. Part description representation

It is assumed that the part description is in the computer memory under such a form, that its analysis is possible. It may be for instance a file with extended DXF or any other representation.

Recognition of technological and geometrical features

Automatic recognition of geometrical and technological features is a difficult task. Many research centers are working about its solving, or more precisely about the design of a feature recognition algorithm. One should here quote [1], [2], [3] and also the works of the Institute of Metal Cutting [4], [5]. In the present package version the features are recognized from the part drawing by the production engineer and formulated under the form of a technological and design code, for instance such as given in the Technological Classifier of Machine Parts, or any else, for instance the classifier standing in the involved plant.

2.3 Group selection

The basis for selecting the group of technologically similar processes is the mapping:
(geometrical and technological features) ⟶ process group
In the described program package this mapping is:
(design and technology code) ⟶ process group.

2.4. Process selection in a group

From the experiments performed up to the present its results that the groups of similar processes are not numerous (less than twenty), which enables an effective look through the processes within a group, and next determination of the most similar in the production engineer's estimation to the process required for machining the foreseen part. For this purpose it is sufficient to review the processes in their abridged form, for instance: operation name - machining station.

2.5. Process adaptation

The selected process can be adapted in this way, that the production engineer can change the operation names, machining station codes, tooling codes, scheduling classes, setup times and cycle times. It is also possible to cancel or to add operations.

Operation adaptation.

This module enables to adapt the operation in the following way:

1 - Changes of cuts in conventional machining operations. More precisely speaking it is possible to change the name of the cut, the dimensional parameters, tooling and tools symbols and machining parameters.

2 - Modifications in the source program if the operation is to be performed on an NC machine. After modification the program is translated using the design module for operations on NC machine. It is also possible to add or cancel some cuts or to write new machining programs.

2.6. Elaboration of operation scheme

If the scheme for the adapted operation was elaborated earlier, it may be modified when the cuts are changed or the machining program modified. The scheme elaboration is performed using the AutoCAD module.

2.7. Process, operation, scheme, program recording

As a result of the utilization of the preceding modules a new process is developed. If the production engineer decides to locate it in the data base, corresponding modules enter the process into the process group base, operations into the operation base, schemes into the operational schemes and programs into the machining program base.

2.8. Selection of tools and attachments

This module gives to the production engineer facilities for selecting tools and attachments basing on the cut features, for instance: shape of the machined surface, dimensions, requirements of accuracy, etc.

2.9. Definition of machining parameters

This module assists the production engineer in the definition (selection or computation) of recommended or optimal machining parameters.

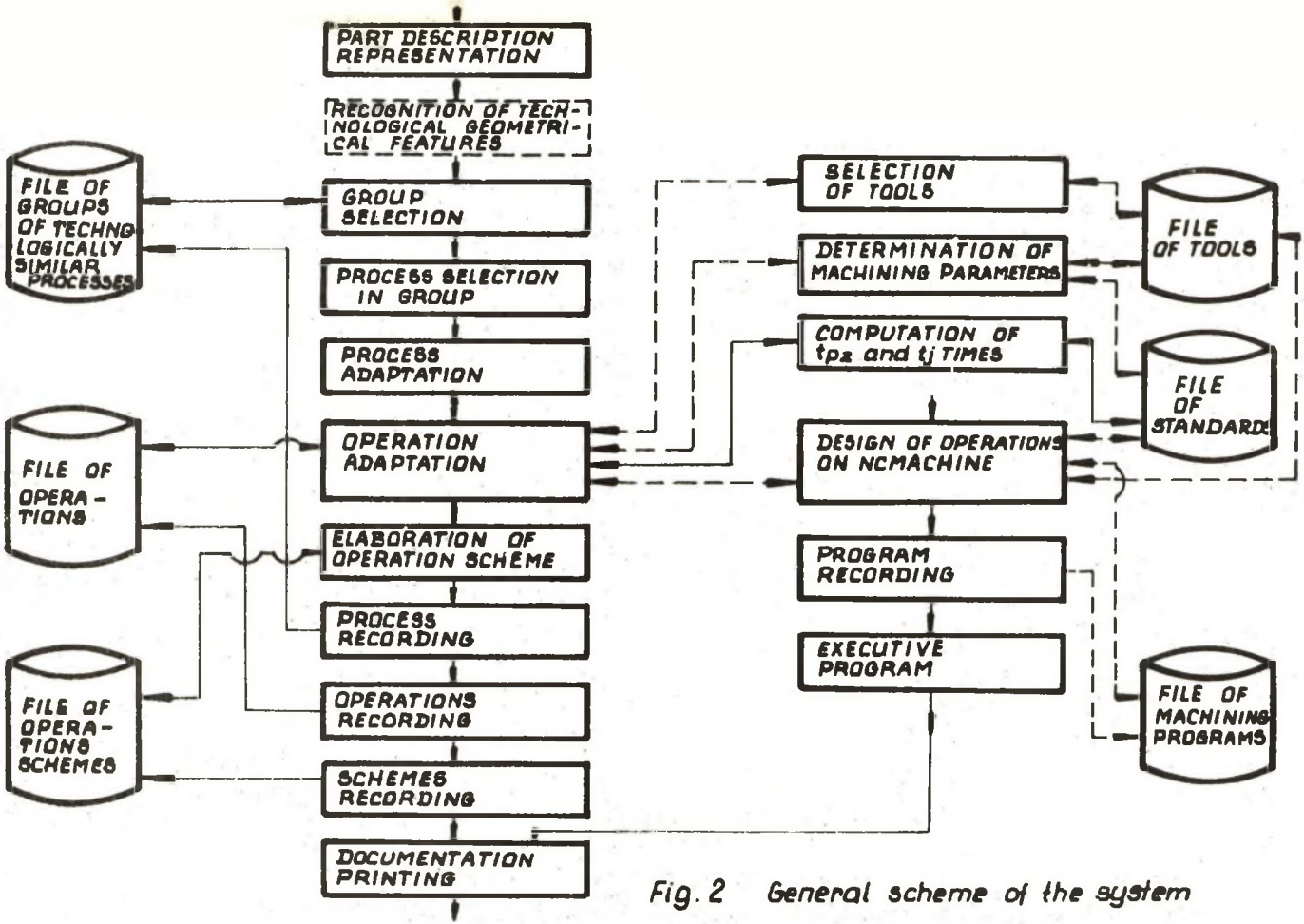

Fig. 2 General scheme of the system

2.10. Computation of setup and cycle times (t_{pz}, t_j)

This module enables to compute the t_{pz} and t_j times when the machining parameters or the dimensions of the machined surface have been changed in the cut.

2.11. Design of operations on NC machines

This module enables to adapt the machine source program realizing the operation on an NC machine or to write a new program and then to transform it in view to obtain the executive control program for the machine. Two design modules for operations on NC machines, called GTI and KSP, have been elaborated and implemented by the Institute of Metal Cutting in many plants.

2.12. Documentation printing

Various technological documents may be emitted, depending on the needs of the production: operation sheet, machining specification, operational scheme, tool setting sheet, etc.

2.13. Data base

The data base is made of the following files:
- file of technologically similar processes groups,
- file of operations,
- file of operation schemes,
- file of tools and fixtures,
- file of standards,
- file of machining programs.

Basical are the files of process groups and operations. The processes present the operation sequences, while the operations present the cut sequences. The relations between processes and operations are defined under the form of a hierarchical structure, as shown in fig. 3. To the process operations are linked the operation schemes located in the file of schemes. The schemes may be modified or new schemes may be developed using the AutoCAD package. The file of tools is organized hierarchically, according to the obligatory Standard Tool Classifier. This file with its corresponding module makes easier the selection of the proper tool to perform a given cut. The file of fixtures is organized under the form of a relational data base. The file of standards contains source data for computing machining parameters, setup and cycle times, machining allowances, etc.

Conventional machining operations are recorded in the proper file as cut sequences, whereas the operations realized on NC machines are located under the form of source programs, constituting machining specifications sequences.

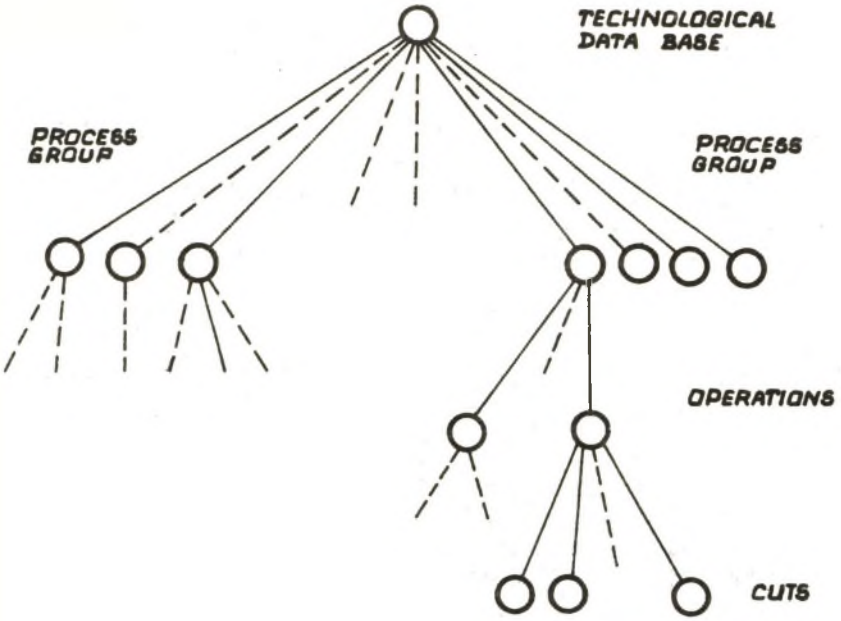

Fig. 3 Structure of the technological data base

3. Conclusions

The modules are developed in Clipper language and realized on IBM PC/AT computer. As it has been already mentioned, not all the modules have been elaborated. A number of them presently independently used will be incorporated into the package. Testing of each module separately before its inclusion into the package was admitted as a basic principle during all the time of its development. The different modules were tested in a number of plants, for instance Agromet - Strzelce Opolskie, Glimag - Gliwice, H. Cegielski - Poznań, and later integrated. The level of integration in the various workshops is different. It is the most advanced at Agromet - Strzelce Opolskie, where efforts are continued for incorporating further elements for a CIM system. It seems that this way of proceeding step by step for solving CIM problems is a convenient method to progress in this field in Poland, especially if taking into account the actual state of industry.

REFERENCES

[1] R. Jakubowski, A Theoretic Framework for Structural Representation and Recognition of Machine Parts Features in Rotational or Box-Type Cubic Parts, Arch. Informatyki Teoret. i Stosow., tom 1, (1989), z.1-4, pp.3-33.

[2] K.K. Cho, S.H. Lee, J.H. Ahn, Development of Integrated Process Planning and Monitoring System for Turning Operation, Annals of the CIRP, Vol.40/1/1991, pp.423-427.

[3] M. Shpitolni, A. Fisher, CSG Representation as a Basis for Extraction of Machining Features, Annals of the CIRP, Vol.40/1/1991, pp.157-160.

[4] A. Kasprzak, Syntaktyczna metoda wykrywania quasi-symetrii konturów otwartych, Arch. Informatyki Teoret.i Stosow., tom 1, (1989), z.1-4, pp.65-78.

[5] J. Sikora, Applicability of Some Technological Methods in CAD/CAM and CIM Systems, Materiały Seminarium n.t. CIM zorganizowanego przez Komisję Ekonomiczną ONZ dla Europy, Bułgaria 1989.

INTEGRIERTE MODULEN VON RECHNERUNTERSTÜTZTE TECHNOLOGISCHE PRODUKTIONVORBEREITUNG DER MASCHINENTEILEN

Zusammenfassung

In der Arbeit wurde das Prinzip der Modulen, Erfahrungserfolge von Einleitung in einigen Anstalten, und auch Folgerungen von seinen Entwicklung als die erste Stufe der Einleitung von CIM-Systemen in polnischer Industrie dargestellt.

ZINTEGROWANY MODUŁ WSPOMAGANIA TECHNOLOGICZNEGO PRZYGOTOWANIA PRODUKCJI CZĘŚCI MASZYN

Streszczenie

W referacie przedstawiono zasadę działania modułu oraz wyniki badań i doświadczeń z wdrożeń w kilku zakładach przemysłowych, a także wnioski dotyczące dalszego jego rozwoju jako pierwszego etapu we wprowadzaniu systemów CIM w polskim przemyśle.

Wpłynęło do redakcji w styczniu 1992 r. Recenzent: Jan Darlewski