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Piotr MOLERUS, Andrzej Rachwał

The Institute of Machine Technology
Silesian Technical University, Gliwice, Poland

APPLICATION OF CAD SYSTEM IN DESIGN PROCESS OF SOME CUTTING TOOLS

Summary: The paper presents a concept of semi-automatic computer aided designing of special cutting tools, as for example step drills, reamers, taps and spline shaft hobs. An original structure of the CAD system called as PROGO system is described for this purpose.

1. Introduction

The use of computer technology in the modern automated manufacturing is connected with employing two computer systems i.e. Computer Aided Manufacturing (CAM) and Computer Aided Design (CAD). The characteristic feature of modern methods used in designing of technological processes is their automation based on computer systems.

An important element of elaboration of such a process is the design of special tools, which are basically absent from the manufactured series of types. In a number of factories most work done by designers is the designing of non-standard dimensional tools. Additionally this type of design activities is more time consuming in relation to the design process using CAD and it also requires the employment of highly qualified specialists dealing with cutting tools problems.

Designing of various technological equipments, including cutting tools, is decisive in hastening the production start-up and reducing the costs. It seems that this situation fully justifies the application of computer technique in designing of special cutting tools.

2. Assumptions

The cutting tools are very complex geometrical objects and from this reason the design process involves the usage of following elements:

- tables of typical tools in order to check, if the given tool is manufactured as standard one.
- complex algorithms for calculations and design.
- taking into consideration the tabular data concerning particular functional elements of cutting tools as fittings, threads, shunks etc.
- multiple calculations verifying the strength of tools.
- making the drawing on the basis of the calculations including the changes of the shape and geometry of the cutting edge.
- the creation of the catalogue of the designed cutting tools in order to avoid the repetition of designing the same tools in the future.

It can be concluded that designing of special cutting tools does not consist only in the proportional changes of particular dimensions, including the ready functional elements or even in the parametric calculation of the elements. It is an interactive process which demands a continuous supervision by an experienced designer. All the above factors must be taken into consideration in the automation of the design work by means of a computer. It should be noted that the typical CAD systems (AutoCAD, LOGOCAD, Syscad) are not applicable directly. Those systems mostly assume the philosophy of "designing on the screen" and make a computer a highly automated drawing board which only to a certain degree aids and verifies the calculations, and consults the tabular data. It is very important that they do not facilitate the creation of design algorithms which describe all design process of cutting tools.

Although the standard CAD systems are compatible which such programming languages as Pascal or Basic and sometimes equipped with specialized programming languages such as AutoLISP, they are not "friendly" for the designer of cutting tools. They also lack the mechanisms aiding the design of complex geometrical objects and advanced programming tools for the creation of parametrical blocks i.e. for creation of fragments of a drawing in a number of variants for different dimensions on the basis of the calculations.

The new assumptions in relation to those described previously are the following:

- the system must be available for the designer who is not familiar with advanced computer programming.
- all the existent design algorithms, standards as well as manufacturer's recommendations must be taken into considerations (or tabled).
- the system has to work interactively and it must be possible to control the work by designer. The data should be verified by the system.
- the work of the system must result in a final drawing including the changes of shape, dimensions and the geometry of the cutting edge.
- the designed tools must be stored in the proper database, and in the case when an identical cutting tool appears in the future, the appropriate message data must be provided.

Consequently, it is established that, in general the proposed design system is the proper system for design of the following tools:

- special (multiface) drills,
- step drills,
- reamers,
- taps,
- gear hobs,
- involute shaped end mills.

The choice of the design system was connected with consideration of the universality and geometrical capabilities of existing

Computer Aided Design (CAD) or Computer Aided Manufacturing (CAM) systems as well as the possibilities of their application for special demands.

It has been decided that the design system to be used is PROGO system which is the programming system for the CNC machines which was elaborated in the Institute of Manufacturing Engineering, Silesian Technical University. The PROGO system, created for quite different purposes, is supplied with most of the functions necessary elaborate the system in question.

It is most important, that the system is geometrically oriented and supplied with the macroinstrucion system necessary to create and to solve the specific problems with respect in the design of cutting tools.

3. Structure of the system

The basic structure of the system is presented in Fig. 1. Figure 1 contains the following blocks:

- The geometrical processor (the kernel of the system).
- Source programs written in PROGO language together with the algorithms for calculations, design and conversation with the designer.
- Macroinstructions together with the library of drawing elements.
- Input/output programs for plotter and printer control.
- Data bases including:
  - catalogue data for typical tools (drills, reamers, taps).
  - dimensions of construction elements (threads, dimensional tolerances, fittings, shunks etc.)
  - geometry of cutting edge for the particular kinds of machining operations.
  - cutting materials strength and cutting data.
  - sets of data of designed tools in the form of the library including all previously designed tools at the Institute of Manufacturing Engineering.

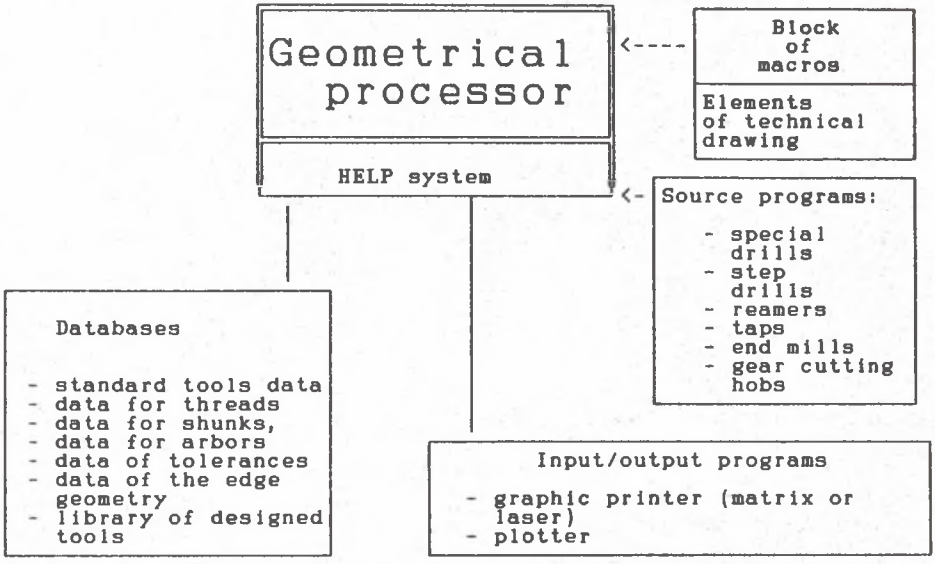

Fig. 1 Basic structure of the system

4. The characteristics of modules

4.1 The geometrical processor

This program is the interpreter of the geometrical programming language which enables: defining any geometrical elements, performing calculations and preparing and starting of programs written in the PROGO language. The set of instructions enables easy creation of conversational systems aided by the computer graphics as well as by database system. The above functions are all the necessary elements resulting from assumptions described detailly in chapter 2. It is also possible to create the macroinstructions, which facilitates the flexible handling of the parametrical data for the design of tools. It is also important, that according to own experiences the PROGO language can be easily used by technologists. This is motivated by the fact that the geometrical processor is a integral part of CNC programming system.

4.2 Source programs

Source programs contain complete subprograms for calculation and design of cutting tools. Each of the subprograms works conversationally thus enabling the input of all necessary data and their initial verification including the tabular data. The data input has been supplied with a help system which indicates and selects the options from the menu. The designer working with the system can verify his results or display the proportional drawing on the screen. A separate source program has been written for each type of special tools .

4.3. Macroinstructions

The mechanism for the creation of macroinstructions used in PROGO system is different from the typical systems of parametrization and subroutines. It's characteristic features are: easy transfer of parameters, the possibility of parametrization of fragments or even parametrization of blocks of designed objects. The mechanism enables the flexible and universal dimensioning and the basis of the given data as well as the parametrization of complete program statements. This possibility of creating macros has been used for creation of the technical drawings on the basis of calculations. The library contains all the standard elements of the technical drawing and additionally enables to create any auxiliary elements of the drawing (eg. title blocks).

5. Examples

As the final result of documentation of the design process some drawings of cutting tools are shown in Figures 2, 3, 4 and 5, respectively.

6. Conclusions

The above system facilitates the design of the selected cutting tools, follows all the assumptions and can be very helpful in the design of cutting tools, especially due to the possibility of the automatic technical drawing and the reduction of the amount of calculations. Thus it can be an integral element of the preparation of the production process.

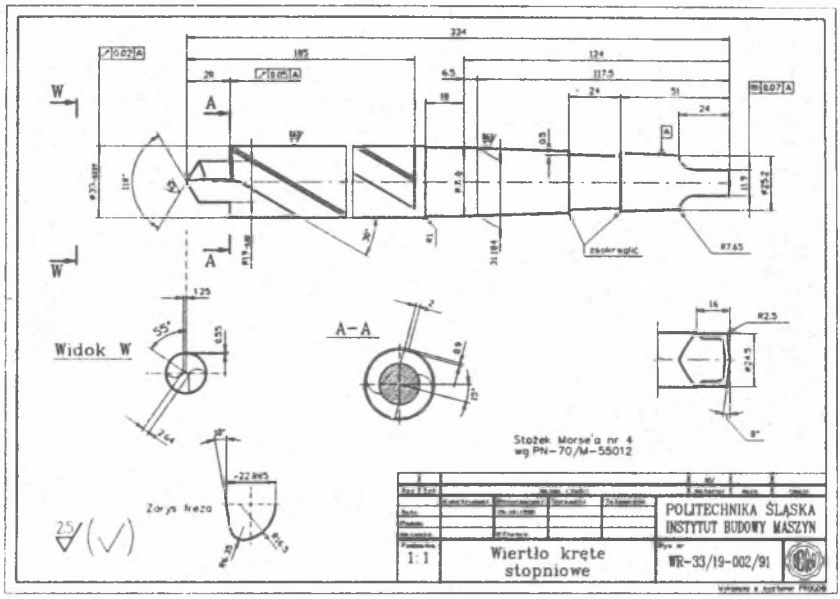

Fig. 2 Step drill

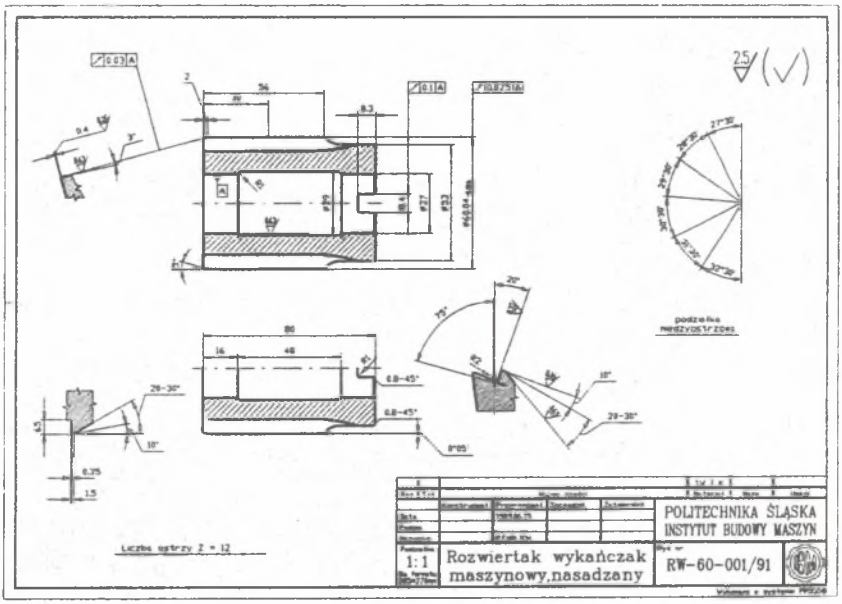

Fig. 3 Reamer

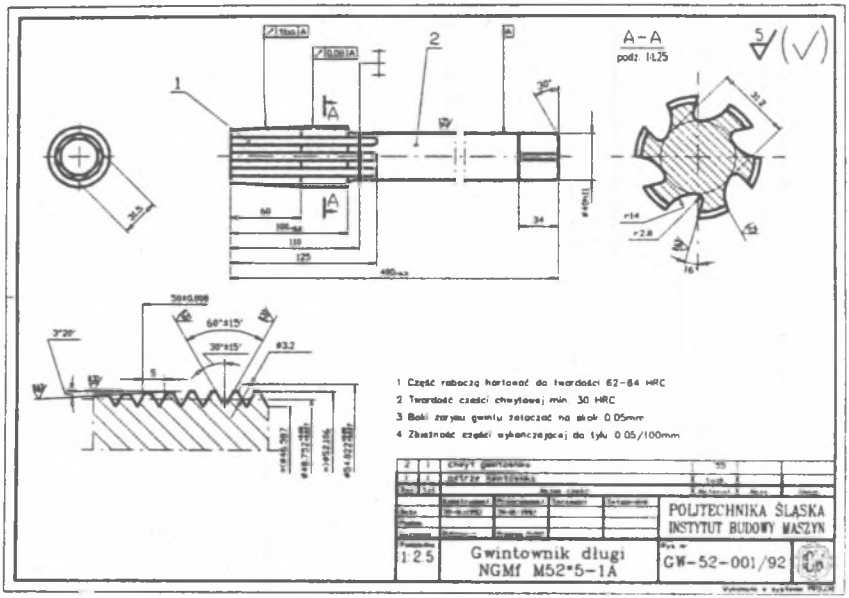

Fig. 4 Tap

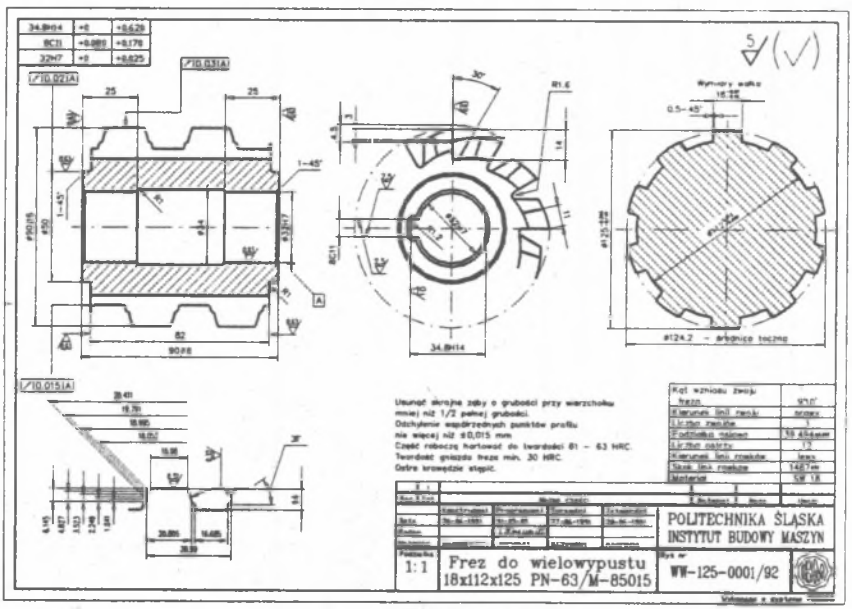

Fig. 5 Splines cutting hob

So far only a few cutting tools have been covered by the system. However, the obtained results indicate that assumptions and the general approach to the problem can create the basis for the future development of algorithms and programs for more complex cutting tools.

REFERENCES

1. P.Molerus, W.Sobczyk, Z.Kimel, A.Rachwał : "The PROGO system instruction manual", part.I to VI, Gliwice, 1989
2. Multi-author work: LOGOCAD - Instruction manual, Zakład Rozwoju Systemów CAD - Logotec Engineerging, Katowice, 1990
3. Multi-author work: AutoCAD Release 11 Reference Manual, Autodek Ltd, Publication AC11 RM-UK, 1990.
4. Andrzej Olak: SYSCAD, CAD - FORUM nr 1/91
5. Marek Chołda, Andrzej Kurleto: Computer Aided Designing of special tools on the example of mills and reamers, Computer Aided of Construction and Technology, Materials of 6-th Conference, IOS-Kraków, 1990.

ZASTOSOWANIE SYSTEMU CAD W PROCESIE PROJEKTOWANIA SPECJALNYCH NARZĘDZI SKRAWAJĄCYCH

Streszczenie

Praca przedstawia koncepcję wspomaganego komputerem półautomatycznego konstruowania specjalnych narzędzi skrawających na przykładzie wierteł stopniowych, rozwiertaków, gwintowników i frezów obwiedniowych do wielowypustów.

CAD TECHNIK in Projektierung der Zerspanwerzeugen

Zusammenfassung

In der Arbeit wurde eine Konzeption eines Computer unterstueztes halbautomatisches System fuer Projektienrung Specielzerspanwerzeugen dargestellt.

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