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INTERNET - MOŽNÝ PRÍSTUP K VÝVOJU TECHNOLOGICKÉHO PROSTREDIA CAM SYSTÉMOV PRE MALÉ A STREDNÉ PODNIKY

INTERNET - ENABLE APPROACH TO DEVELOPMENT OF TECHNOLOGICAL ENVIRONMENT OF CAM SYSTEMS FOR SMES

Na zlepšenie ekonomických aspektov CAM aplikácií, hlavne v oblasti malých a stredných podnikov je potrebný nový prístup pre vývoj CAM systémov. Technologické prostredie je jeden z faktorov ovplyvňujúcich efektívnosť využívania CAM. Článok predstavuje prístup ku tvorbe distribuovaného technologického prostredia dostupného v prostredí WEB.

A new approach to CAM system development is necessary to improve economical aspects of CAM applications particularly in SMEs. Technological environment is one of the factors influencing effectiveness of CAM exploitation. The paper present a promising approach to creation of distributed technological environment available on the Web.

1. Introduction

Effective exploitation of CAM system is a very important feature particularly for small and medium enterprises (SMEs). Therefore, a new approach to CAM development is necessary to improve economical aspects of CAM products addressed to SMEs. Considering CAM class software products addressed to SMEs two group of products should be taken into account, i.e.

- CAM system solutions available on the market
- Technological environment of CAM system supporting CAM usage.

To fulfil SMEs requirements new CAM systems should be easy in exploitation, with a friendly designed man- machine interface, as powerful as possible, with functions configured on request according to a problem to be solved, extendable, not only to buy but also to rent, able to solve technological problem at as low cost as possible. In other words, a new generation of CAM systems should be adapted to new forms of manufacturing process organisation, which has to assure high productivity, flexibility and ability to fulfil customers' expectations as quickly as possible. However, there is a difference between SMEs expectations and available on the market, costly and sophisticated software products, developed according to quite a different philosophy. Technological environment is one of the main factors influencing effectiveness of CAM exploitation as well. The distributed technological environment (DTE) available on the Web will support SMEs in NC programming, making possible technology transfer and distributed collaboration of SMEs. The Internet technology applied to DTE establishing assures cost-effective, easy available, open technological environment on the Web. The approach supports flow of technological experience inside big organisations using Intranet or between SMEs using Internet. The distributed technological environment concept is very promising for SMEs which will be supported by constant and independent development of Internet technology with a growing number of services. The Internet databases, recommendations of cutting parameters selection, group and typical technology available on the Web will support SMEs in manufacturing process preparation thanks to distributed and low-cost support. The Internet technology makes possible CAM exploitation on different hardware and software platforms what practically means wide access to technological environment of CAM systems.

Another feature of CAM system desired by SMEs is openness to easy customising to real SME machining environment which assuring adaptation of technological performances of CAM system to factory requirements and decrease costs of its application.

2. Low-cost NC Programming system KSP-OSN/WIN for SMES

The interactive NC programming system KSP-OSN/WIN is developed in the Institute of Metal Cutting (IOS) in Cracow, Poland. The system shows necessity of system reconfiguration and customisation. It takes into consideration new circumstances appearing in manufacturing philosophy and to meet SMEs expectations [1], [2], [3].

Industry exploitation of the KSP-OSN/WIN system also showed importance of customisation of technological environment of

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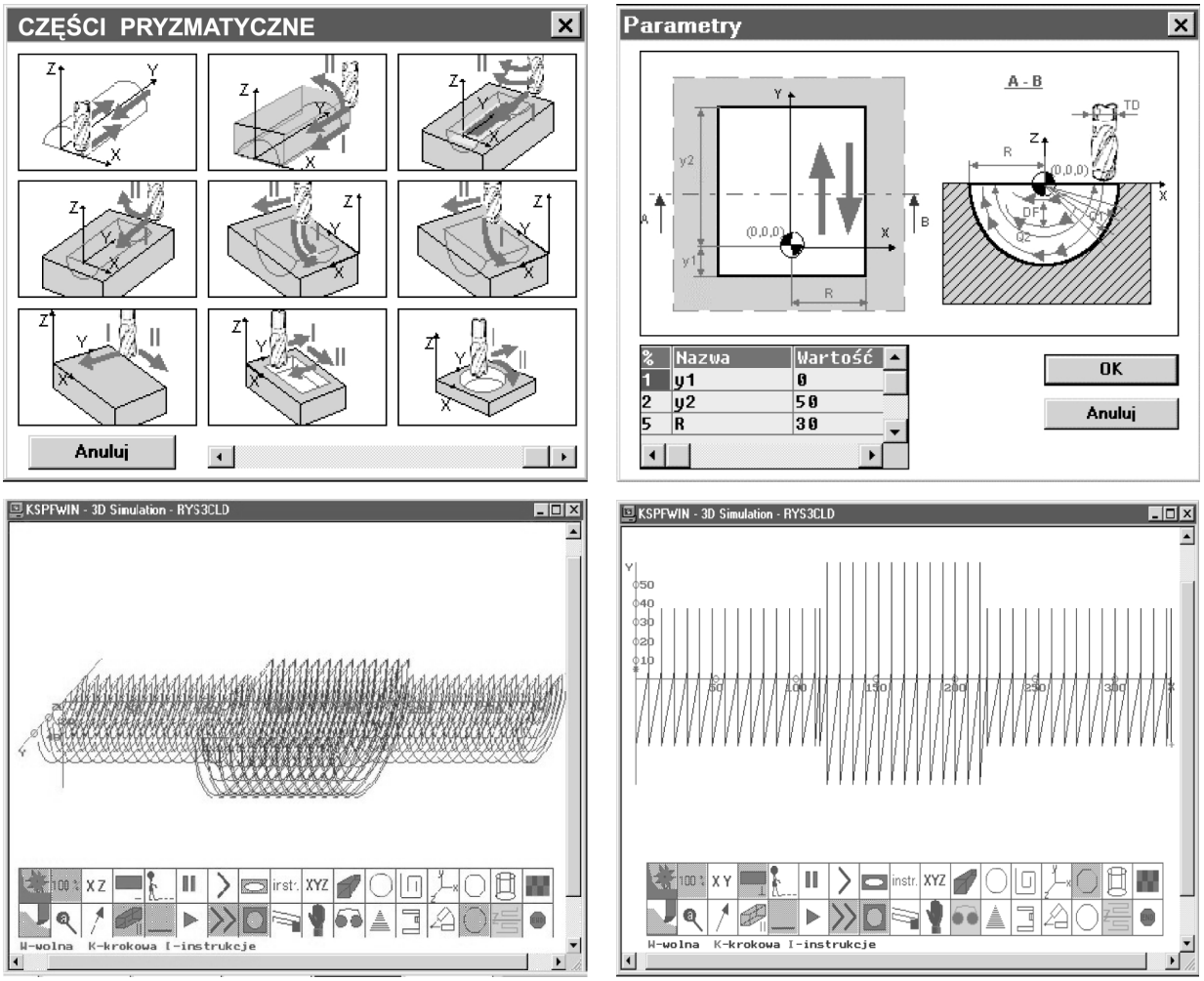

Fig. 1. Programming method of 3D machining in interactive NC KSP-OSN/WIN system.

CAM system and its influence on effectiveness of exploitation. Facing the above mentioned problems, R&D works have been undertaken in the IOS to develop a new generation of interactive NC programming system KSP-OSN/WIN with distributed technological environment using up-to-date information technology.

The objective of the KSP-OSN/WIN system transformation is:

- Replacement of monolithic architecture of the KSP-OSN/WIN system by open component-based architecture using Microsoft Common Object Model (COM) [4] and Distributed Common Object Model (DCOM) standards [5], [6], [7]
- Development of virtual version of the KSP-OSN/WIN system in which exploitation properties of the system will be formed by customers according to requirements necessary to technical problem to be solved in constantly changing manufacturing environment (machine tools, tooling and tools, etc.),
- Development of Internet-enable features of the KSP-OSN/WIN system suitable for distributed manufacturing. The Internet-enable version of the KSP-OSN/WIN should be available to rent by SMEs, not only to purchase
- Development of distributed technological environment including former implemented Internet tool databases for KSP-OSN/WIN.

The last aspect of a new approach to KSP-OSN/WIN development will be discussed below as a very important from SMEs point of view.

3. New approach to technological environment development for KSP-OSN/WIN system

3.1. General remarks

Technological environment (TE) of a CAM system has to contain all information and data necessary for NC programming presented in a friendly way and available remotely from the CAM system. Incomplete data, decrease efficiency of CAM system exploitation. Therefore TE should contain among others:

- machine tool databases,
- cutting tool and tooling databases

- tool manufacturers and factory recommendations of cutting parameters selection,
- general-purpose technological components databases supporting NC program designing process.

DTE also contains group technology (Fig. 12) for CNC lathes implemented in Internet technology and available in user browser. This new approach of technology presentation makes easy access to parametrised technological chasses that assist designing process of CNC programmes.

Distributed technological environment (DTE) available on the Web will support SMEs in NC programming, making possible technology transfer and distributed collaboration of SMEs. As a first step in DTE creation Internet tool databases for the KSP-OSN/WIN system have been established.

A traditional access to data presented in the form of tables in catalogues is unconvenient and decreases CAM effectiveness of exploitation. Effective management of tool sets, circulating on the workshop, needs introducing into CAM system tool reservation and monitoring functions presenting tool position and its exploitation features at any time during its life what is helpful in NC program preparation. Cutting parameters used in machining process have to be selected to assure high productivity and economics of machining process for selected cutting tool and machine tool applied. To do it reliably, recommendations of cutting parameter selection have to be used. Correct selection of cutting parameters for previously selected cutting tool and machined workpiece material assures the tool life requested in the given conditions of machining and quality of cutting process. NC programmer has to get an easy and friendly access to cutting tool manufacturer recommendations at each stage of machining process planning. Unfortunately, the most often issued recommendations are not complete and user experience is necessary in cutting parameters selection. Hence, the recommendation supports only a system user in decision making process in the final cutting parameter selection but the user is responsible for the selection. A wrong decision will result in low effectiveness of cutting process or lower degree of reliability of cutting process.

3.2. Internet-enable tool databases

To improve cutting tools selection for the machining process to be performed and cutting parameters selection to be used during the exploitation of the KSPT/WIN and the KSPF/WIN systems the Internet-enable databases have been developed as the first step in distributed technological environment establishment for standard and component-based KSP-OSN/WIN system [11], [12], [13], [14]. An example of internet database KSP-IBD/WIN for NC lathes is presented below.

Searching of the databases can be started either from BAILDONIT [8], [9] tools database or from PAFANA [10] inserts database. In the BAILDONIT inserts database recommendations of insert shape selection is available. A lot of Web pages illustrate the recommendation of insert shape fitting to machining operation considered which are on the top of the Web document hierarchy (Fig.2), according to P, S, C clamping system and external or internal machining. When clamping system, for example P, and external machining are selected, one obtains a set of documents presenting tools and inserts available in the production programmes and recommendations of insert shape fitting to shape of a machine workpiece. Using the active area with image of an insert, one comes to the table containing dimensions of the selected inserts and grades available in BAILDONIT production programme (fig. 3).

Selection of the insert type makes possible to come to the next phase of database searching, i.e. chipbreaker and shimes selection on the basis of documents called out from the help system. In the same way the information about clamping system elements can be obtain-

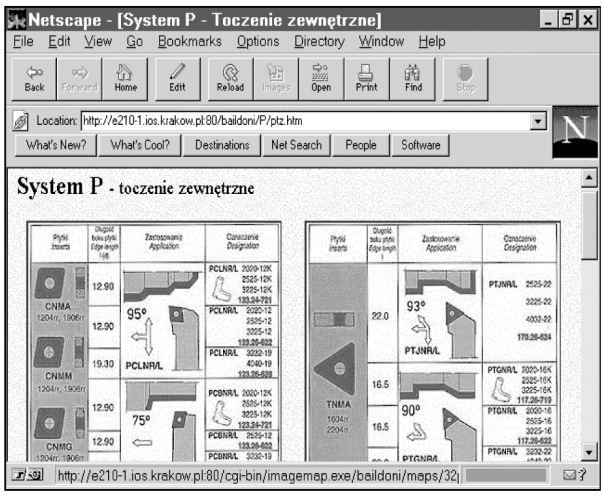

Fig. 2. Recommendations of cutting insert and tool selection in external turning [8], [9]

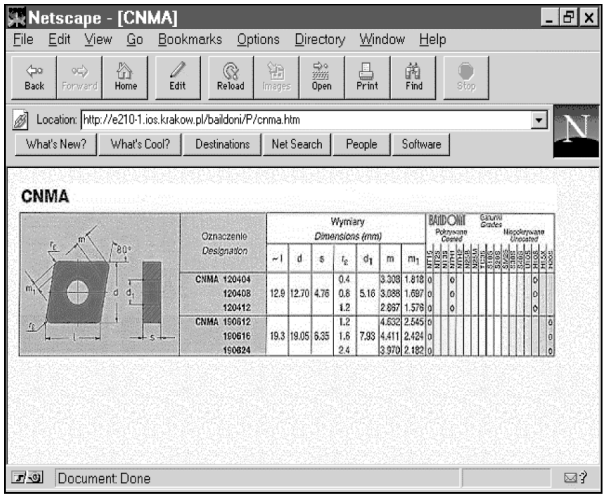

Fig. 3. Document presenting dimensions of inserts and grades available in BAILDONIT cataloque [8], [9]

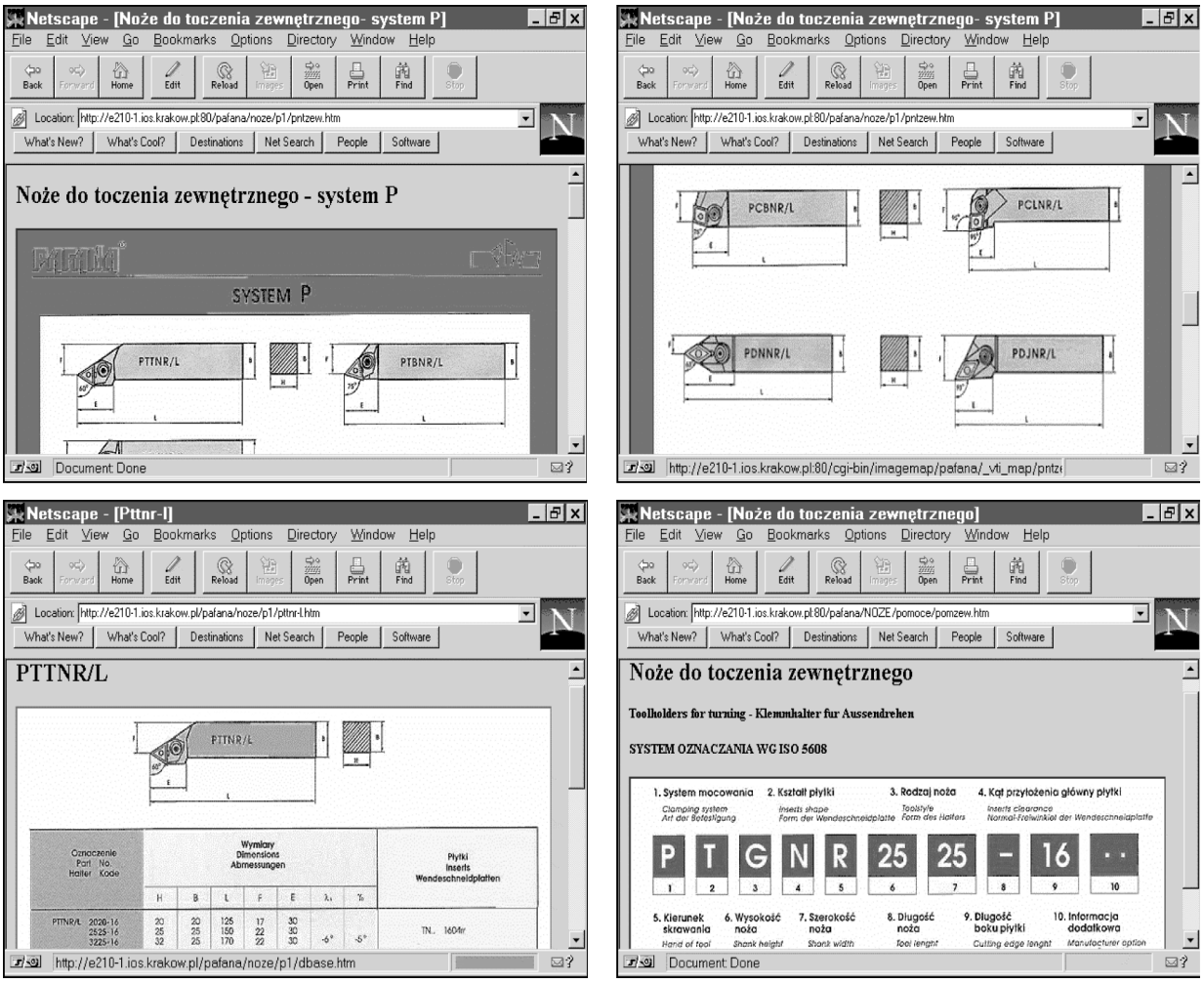

Fig. 4. Document presenting assortment of tools for P clamping system in external turning [10].

ed. The selection of the insert grade can be done directly from the table containing insert dimensions. The selection of coated or uncoated inserts can be supported by recommendations included into the help system. When teh final selection of cutting inserts is finished, the database operator can get back to the dimension table. When the designation of the insert is completed and prepared to later print out of a tool list the next tool selection procedure can be started as the switching to PAFANA tool database is possible and tool selection can be made (Fig. 4). The Internet-base solution of databases shows a hierarchical structure of the HTML documents linked together forming a tree of database searching. The database searching of HTML user interface makes easy as reviewing database contents presents system user only the alternatives which are available at the considered level. Web pages contain a certain number of make active areas and pushbuttons which possible bidirectional communication between Windows applications and Internet environment.

Similarly, after the completion of a tool selection process, cutting parameters recommendations can be called out supporting the operator in selecting the recommended cutting parameters for selected cutting insert and material to be machined (Fig. 5, 6). Cutting data are entered as well to the intermediate table and can be exported to the KSP-OSN/WIN system on operator's request and placed in the NC program being created.

The Internet database (IBD) is available in the KSPF/WIN interactive NC programming system for milling machines and machining centres from TECHNOLOGY menu (Fig. 7, 8, 9, 10). Cutter selection for programmed machining operation is possible from the first document presented just after coming to the IBD. Bitmaps present cutters available in database. Cutter selection is supported by recommendations and data description of recommended range of cutter application including insert geometry and cutter diameter. As the main cutter parameter angle Kr is used according to BAILDONIT catalogues [8], [9]. After the selection of a cutter type clicking active area of the document user comes to the dimension table of the selected cutter.

At this level of the IBD documents searching system operator can select:

- cutter revolution direction (R or L),
- cutter dimensions

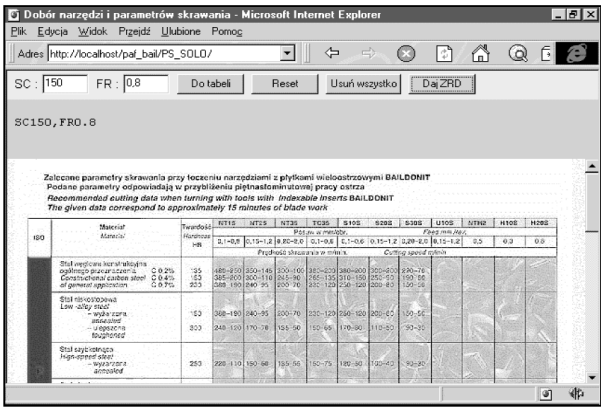

Fig. 5. The Web page supporting cutting parameters selection in turning [8], [9]

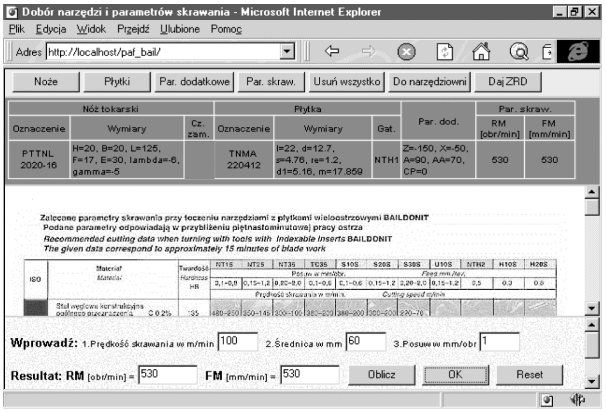

Fig. 6. Cutting parameters selection supported by company recommendations [8], [9]

Fig. 7. The Internet database for interactive NC programming system KSPF/WIN for milling machines and machining centres

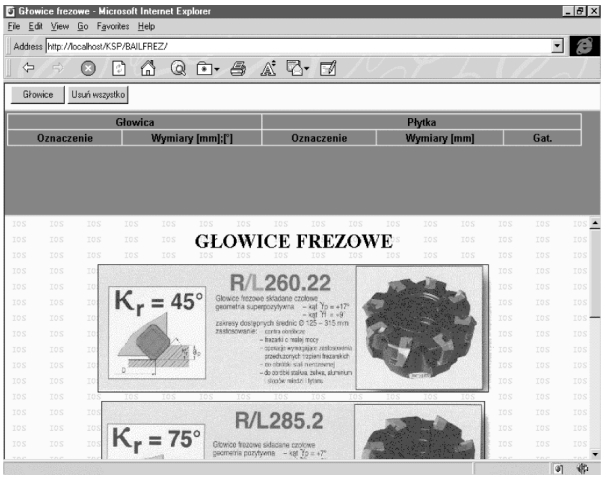

Fig. 8. The HTML document presenting cutters available in the KSPF-IBD/WIN database [8], [9]

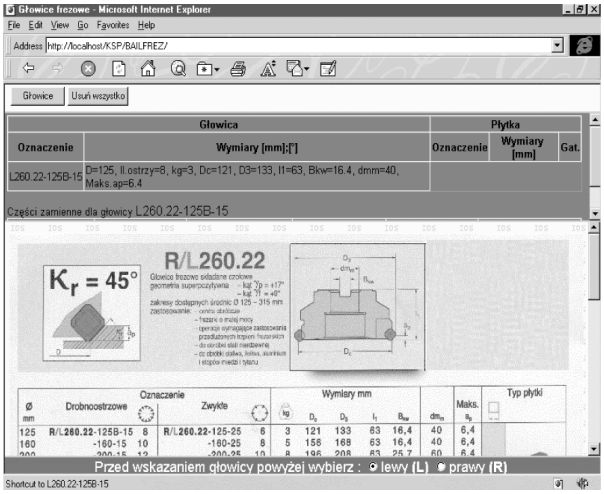

Fig. 9. The HTML document presenting dimension table of cutters [8], [9]

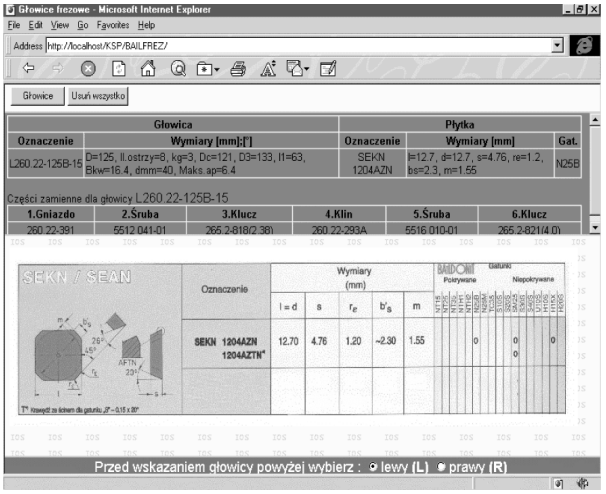

Fig. 10. The HTML document presenting dimension table of inserting [8], [9]

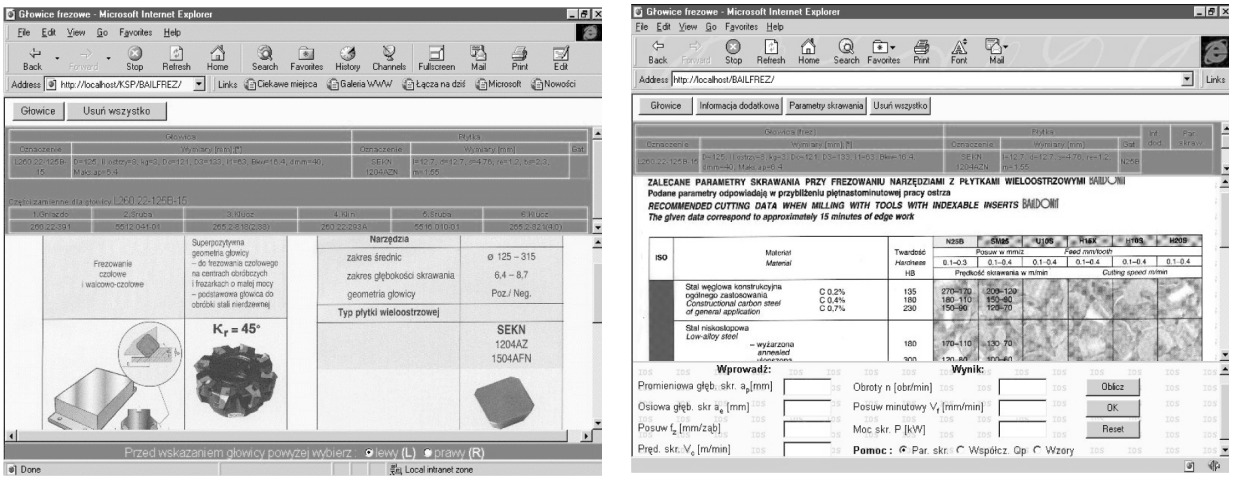

Fig. 11. Cutting parameters selection in KSPF/WIN system supported by company recommendation.

After the completion the data can be sent to the intermediate table which contains the data prepared to later print out (Fig. 9). And finally, the insert dimension and insert grade can be selected from the next document (Fig. 10). Also spare parts necessary to assemble the tool can be added to the intermediate table. The help system incorporated into the database system searching available from the presented document supports the IBD operator in searching of database in a friendly way.

One of the most important features of the CAM system is the possibility of a cutting parameters selection. A lot of system implementations are based on Taylor's formula in different areas of applications, specifying workpiece materials to be machined and listing cutting tools for which the the coefficients in Taylor's equation are known. But cutting tool manufacturers usually issue only recommendations giving the ranges of recommended cutting parameters, i.e. cutting speeds and feeds without any Taylor's coefficients Taylor's coefficients make any kind of process optimization impossible. Tables containing recommended cutting parameters are also divided into HTML documents on the Web server which are structured by hyperlinks forming a tree of document searching. The cutting data selected for a given machined material and a cutting insert are entered by a system operator to dialog boxes on the WWW pages and transferred to the KSP-OSN/WIN system. The examples of pages supporting cutting parameters selection and assuring database communication with the KSP-OSN/WIN system are presented in Fig. 11.

The method of cutting parameter selection mentioned above means the computer assisted process but not its automation. A great number of data presented in different ways, their incompleteness, make an approach to the problem more effective. The operators' knowledge, his experience and skills are useful in a decision making process. The final selection of the cutting parameters based on the operator's interpolation and extrapolation can be used additionally.

3.3. General-Purpose Technological Environment

Efficiency of the KSP-OSN/WIN system exploitation can also be increased by consolidating general-purpose technological components with KSP program reducing programming effort.

As an example of the above mentioned approach Internet group technology can be presented in the SMEs technology domain. Some HTML documents [14] of Internet group technology for interactive NC programming system for CNC lathes are shown in Fig. 14. The workpiece icon corresponding to workpiece shape to be machined.

After assigning workpiece dimensions to parameters in KSP language one obtains NC program which can be viewed and corrected by a NC programmer. To customise the typical technology to real machining conditions the programmer has to interact with the Internet tool database to select the cutting tool and cutting parameters adequate to workpiece material to be machined and complete the NC program. The Internet-enable group technology is implemented for three classes: shaft, sleeve, disk. It means that about one hundred typical parameterised NC programs are available to support a NC programmer in the machining process design.

3.4. Customised Factory-Formed Technological Environment

Technological performances of the KSP-OSN/WIN system can be extended by a set of specialised and customised KSP components written in the problem oriented - language KSP and ISO components written in ISO code of CNC controller for a given CNC machine tool on which the machining process is to be performed. Untypical machining operations, as probe measurement cycles, palette positioning, etc. can be programmed in advance as KSP or ISO components, thus forming a customised technological library of product-oriented technological components.

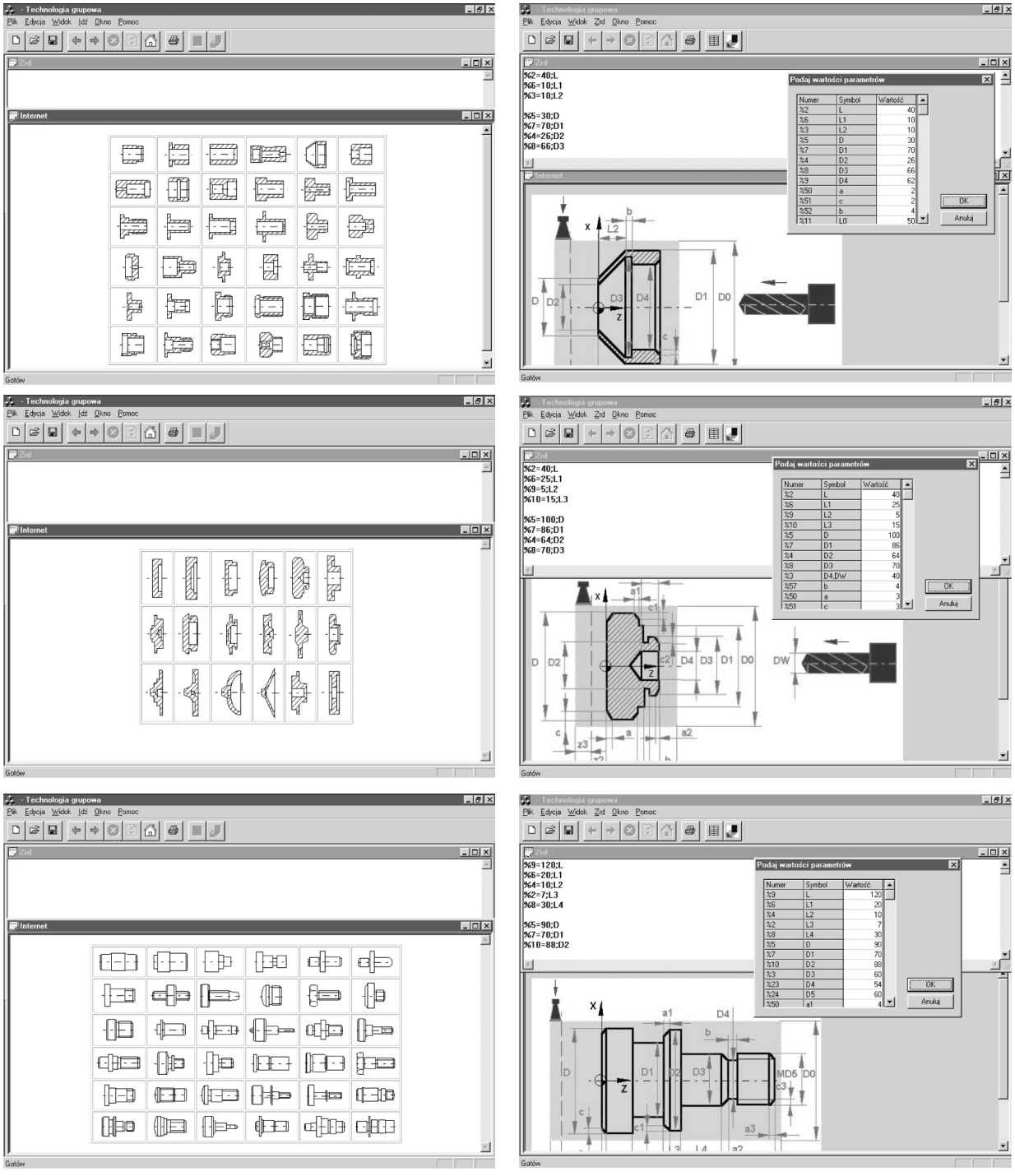

Fig.12. Examples of documents of the Internet-enable group technology for turning operations

In this approach the following several customising levels can be distinguished:

- Custom-oriented functionality of the system is formed by specification of software components necessary to program a machining operation to be performed,
- KSP-language problem-oriented technological components, implemented in advance by the customer himself, to meet specific technological requirements of the manufacturing processes,
- ISO code problem-oriented technological components implemented also in advance, typical for machine tools and CNC controllers M-G functions used by customers.

The library of KSP and ISO oriented technological components can be created by customers themselves on the basis of practical experience or can be supported by technological research centres like the Institute of Metal Cutting, developer of the KSP-OSN/WIN system.

4. Conclusion

The new technology applied to DTE establishing assures cost-effective, easy available, open technological environment on the Web. The approach supports flow of technological experience inside big organisations using Intranet or between SMEs using Internet. DTE is open. Both tool databases, cutting parameter selection and parameterised technology can be entered to the DTE on the basis of CAM system exploitation and as a result of customisation of CAM users according to real needs. The distributed technological environment is very promising concept for SMEs which will be supported by a constant development of Internet technology. Internet databases, recommendation of cutting parameters selection, group and typical technology available on the Web will support SMEs in manufacturing process organisation and low-cost exploitation. Another advantage of the Web technological environment is its extendibility and centralised maintenance. Upgrades installed on the Web server are immediately available to all customers. Besides, Information technology makes exploitation on different hardware and software platforms possible what practically means a wide access to the technological environment of CAM systems. The problem of SMEs support is noticed and the trial of its solution is undertaken in the frame of 5th Framework Programme of the European Community for Research Technological Development and Demonstration Activities in which special SMEs support is arranged.

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