The NIST MTCs
CAD/CAM Selection Tool
7/22/92

This paper will be presented at AUTOFACT in November 1992 at a session on CAD/CAM system selection.

ABSTRACT

Three of the NIST Manufacturing Technology Centers (MTCs) have recorded their best practices for helping manufacturers choose CAD/CAM systems. These selection practices form a unified methodology: the MTC CAD/CAM Selection Tool. This paper presents the design of the Selection Tool and a brief example of its use.

The Selection Tool is being used by MTCs to assess the needs of machine shops and other CAD/CAM users and to make recommendations about selection and use of CAD/CAM systems. The Tool is targeted primarily for small companies (<50 employees) with little or no expertise in CAD, and limited resources for training. The Tool aids an MTC expert in matching a customer's needs to "solutions" in the form of commercially available CAD/CAM products. It standardizes, among MTCs, the way user description and requirements data is gathered, and describes a decision process for recommending a range of products and techniques. The client makes the final choice. MTC recommendations cover, in addition to narrowing product choices, techniques, cultural impact and management issues, training, and continuing costs.

The Tool allows MTCs to share experience, methods, and product data, to make them better at helping their clients. Clients benefit from this collection of best practices and receive solid recommendations that should increase their productivity and competitiveness.

Outline

INTRODUCTION

The use of computers and software tools in manufacturing provides the potential for greatly increased productivity, the ability to effectively use new processes such as numerical control, and the opportunity to enter new product markets. In fact, in today's highly competitive and technical conditions, some manufacturers who do not use computer technology, or who use it poorly, will go out of business.

Computer technology is providing users with constantly improving microcomputers, minicomputers and workstations at decreasing prices. There is a rich product market for manufacturing software that runs on these machines. In the areas of design, drawing, and manufacturing data generation, there are currently at least 250 commercial products available. New products and revisions of current products are introduced frequently.

The challenge for manufacturers is to harness this hardware and software technology to increase their productivity and competitiveness. The problems are: becoming educated about capabilities of computers and software tools and their application to manufacturing, surveying the large offering of commercial products, surveying what tools and methods others have used and what works, and finally, acquiring and using products that address a company's process and business needs.

It is difficult for many manufacturers to begin using software tools, and to stay current with the rapidly changing offering of products. The NIST MTCs were established to help manufacturers with such problems.

Three of the NIST MTCs have collaborated to record their best practices for helping clients to choose CAD/CAM systems. These practices have been formed into a unified methodology, the MTC CAD/CAM Selection Tool. The Selection Tool is being used by MTCs to assess needs of machine shops and other CAD/CAM users and to make recommendations about selection and use of CAD/CAM systems. In addition to product choice, MTC recommendations cover product use, cultural impact and management issues, training, continuing costs, and impact of the learning curve. Lessons learned by constructing this tool may help in building other tools in future joint MTC efforts.

The Tool is targeted primarily for small companies (<50 employees) with little or no expertise in CAD, and limited resources for training. The Tool aids an MTC expert in matching a customer's needs to a range of "solutions" in the form of commercially available products. The client makes the final choice of a specific product.

THE NIST MANUFACTURING TECHNOLOGY CENTERS

This section is excerpted from reference [1] .

The United States' long-dominant position in the world's marketplace is declining due to increasingly sophisticated foreign competition and the swiftness of changing technologies. There are more than 350,000 manufacturing firms in the U.S. with less than 500 employees. These firms employ 11 million workers and account for over 50% of the total of this country's value added to goods and services. While many small manufacturing firms have been able to maintain their competitive edge in smaller domestic markets and in specialized technology areas, some simply have not kept pace with the rapidly changing,

computer-driven, global marketplace of the past decade.

To address this problem, the Omnibus Trade and Competitiveness Act of 1988 established the Manufacturing Technology Centers (MTC) program as a new initiative at the National Institute of Standards and Technology (NIST). The charge of the program is to contribute toward improved U.S. industrial productivity and competitiveness in the growing international marketplace.

In January of 1989 three centers were established: the Great Lakes Manufacturing Technology Center (GLMTC) in Cleveland, Ohio; the Northeast Manufacturing Technology Center (NEMTC) at Rensselaer Polytechnic Institute in Troy, New York; and the Southeast Manufacturing Technology Center (SMTC), with headquarters at the University of South Carolina in Columbia, South Carolina. Since beginning operation in 1989, these three centers have achieved an estimated economic impact of more than $130 million for the more than 5000 small business firms that they have assisted.

In the spring of 1991 two new centers were established. They are the Mid-America Manufacturing Technology Center (MAMTC) located in Kansas City, Kansas, and the Midwest Manufacturing Center (MMTC) in Ann Arbor, Michigan.

The centers are designed to bridge a technology gap between sources of manufacturing technology and the small and mid-sized companies that need it. Sources of technology consist of a number of Government research and development laboratories, universities, and other research-oriented organizations as well as commercial sources. Although the basic charge to each center is the same, "to transfer advanced manufacturing technologies to small and medium sized manufacturers to improve their competitive position," each center's approach is unique, tempered in many respects by the locale and the type of manufacturing firms being assisted.

The centers provide a wide range of services including individual project engineering, training courses, demonstrations, and assistance in selecting and using software and equipment. All centers have established large data bases of computer-aided design (CAD) and computer-aided manufacturing (CAM) software packages as well as a wide variety of PC-based hardware systems, workstations, and mini-computers which use the software. This provides small manufacturers an extensive selection of state-of-the-art systems with which they can gain hands-on experience. This allows them to make intelligent decisions on the system selection that is best suited for their applications. In addition to the computer demonstration facilities, the centers also have demonstration facilities which display various types of automated metal working equipment (lathes and milling machines), robotics, and state-of-the-art coordinate measuring machines which are used to demonstrate automated machining. Two of the centers (NEMTC in New York and MAMTC in Kansas) have mobile demonstration facilities under construction which will allow demonstrations of automated equipment at some of the more remote manufacturing firms, technology symposia, and other events. These types of facilities should be extremely useful where larger territories are being served.

THE MTC CAD/CAM SELECTION TOOL

Benefits

Before July 1992, the MTCs each used different approaches for helping clients select systems and for recording product and experience data. Their knowledge of products was limited to the packages they could acquire, install, and test locally.

The Tool standardizes the gathering and storage of information about users and their needs, products, recommendations and results of past selections. It prescribes guidelines for analyzing client needs and for making recommendations. These formulations were based on extensive discussion, among experts with years of experience, of the best practices at each of the MTCs.

The standardization of decision steps and of data formats allows MTCs to easily share experience, methods, and product data, to make them better at helping their customers. The Tool does not replace MTC expertise--it stores past experience and augments the knowledge of any individual MTC staff member. Clients benefit from this collection of best practices and get recommendations based on the latest knowledge of a wide range of products and on methods that have worked in the recent past.

Design of the Tool

The following numbered items refer to the drawing "CAD/CAM Selection Tool Design". This section is excerpted from reference [2].

1. QUESTIONNAIRE

The Questionnaire is used by experienced MTC staff to:

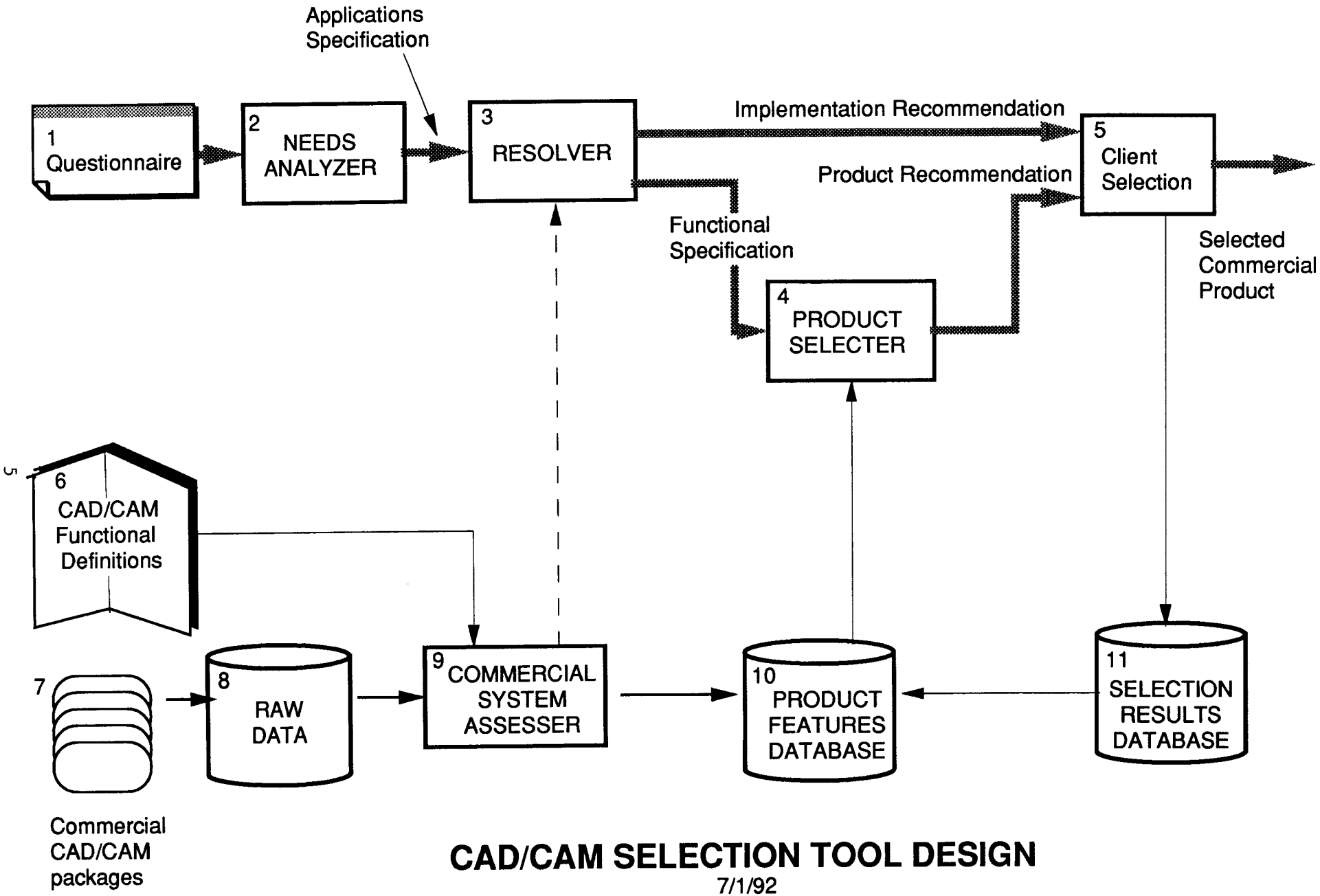
1) gather a description of the company, and its operations

2) gather information that the Needs Analyzer will use to identify the company's productivity goals and/or strategic business goals.

Some of the areas covered are: company size, degree of current modernization, current CAD/CAM experience, type of customers, clients' CAD/CAM level, products, processes, complexity of parts, lot sizes, recurring jobs vs. long runs vs. no recurring jobs, etc.

2. NEEDS ANALYZER

The Needs Analyzer uses information from the questionnaire and observations made by MTC staff. It identifies opportunities for using CAD/CAM systems to improve existing manufacturing operations or to implement new ones. These operations are called applications. The output, the Applications Specification, recommends applications that the client should emphasize in using CAD/CAM. For example a mold maker could improve its surface machining capabilities by using CAD/CAM.



CAD/CAM SELECTION TOOL DESIGN

7/1/92

3. RESOLVER

The Resolver selects CAD/CAM techniques that can be implemented using commercial packages. The solution at this point is not a specific product, but a method for the client to use CAD/CAM system features. For example, the mold maker who performs surface machining needs a CAM system that has gouge checking and solids modeling features.

There are two outputs of this process: the Implementation Recommendation, and the Functional Specification. Since these are both related to capabilities of available techniques, there is a link between the Resolver and the Product Features Database. The format for these outputs is standardized among the MTCs.

The implementation recommendation describes how a commercial system should be used. Areas include: facilities, training, life-cycle costs, maintenance, effects on organizational structure and culture, operational procedures, and business impact.

The functional specification describes the required and/or recommended features of a commercial CAD/CAM system that the client will use to address their needs. The format for this specification is identical to that of the Product Features database (item 10). Since the format is standardized among the MTCs it is easy to compare case studies generated by different staff and by different MTCs.

4. PRODUCT SELECTER

The Product Selecter matches the requirements described by the functional specification to commercial products. The output is an acceptable group of packages: the customer will make the final choice.

Product selection is a two-step process. The first step weeds out packages that do not have mandatory features ("pass-fail"). The second step is a numerical scheme to pick a group of useful systems and allow the customer to rank them, for example according to 10 basic qualities, or results of effectiveness calculations, ROI, etc.

5. CLIENT SELECTION

The client makes the final selection from a number of recommended best fit packages. The process may include having vendors do benchmark demonstrations using the client's actual products.

6. CAD/CAM FUNCTIONAL DEFINITIONS

These definitions describe applications and CAD/CAM package functionality. The value of the CAD/CAM definitions is that they serve as a standard that can be used rigorously and unambiguously by MTC staff, users, and vendors.

7. COMMERCIAL CAD/CAM PACKAGES

These are commercial software products for manufacturing applications.

8. RAW DATA

This block is a repository of information, supplied by vendors, describing commercially available CAD/CAM products. No data reduction is done other than all entries in the repository use the definitions in the Functional Definitions document. The data is collected and maintained via a formal methodology defined in this functional block. This is broken out as a separate function due to the volume of data and the effort of collection and maintenance (an initial database identifies over 250 commercially available packages for mechanical components alone).

9. COMMERCIAL SYSTEM ASSESSER

Using Raw Data as an input, MTC staff make entries into the Product Features database using first-hand experience gained from a detailed review of each package. The assessment process will be ongoing, since new packages and features are introduced frequently.

10. PRODUCT FEATURES DATABASE

This information is a fully qualified database of features and applications that individual CAD/CAM products address. MTC staff members will validate the entries through experience, vendor demonstrations, internal testing, and user feedback. This includes more information and greater depth than the Raw Data. All entries in this database are as defined in the Functional Definitions. This database reflects the ongoing process of updating the information as products are continually updated and revised.

11. SELECTION RESULTS DATABASE

This database holds the recorded MTC experience from consultations and client experience with the system that was implemented. It is used by MTC staff to continually improve the CAD/CAM selection process and to educate new staff. Specifically, it will be used to: improve analysis done by the Needs Analyzer and the Resolver, improve decisions made by the Product Selecter and Client Selection, qualify the Product Features database, and monitor Tool effectiveness and MTC performance.

This database includes: results of the client selection (software and hardware), usage volume of the system per application, comparison of client actions to the implementation recommendation, a comparison of current and previous productivity, comparison of initial expectations to actual results, number and identity of users, basic company information described by the questionnaire, and the implementation recommendations, features recommendations and products recommendation. Confidentiality of this information is maintained by the MTCs, and no information may be released without the client's consent.

Example of CAD/CAM Selection Process

BGNS MACHINING COMPANY

BGNS is a small job shop consisting of 20 employees. They have limited CAD/CAM capabilities. There is no internal support staff, and employees have limited computer knowledge. One of BGNS's customers would like them to accept product data electronically. BGNS would also like to increase their machining capabilities.

Questionnaire

An experienced MTC staff member fills out the questionnaire through client contact and site visits.

Needs Analyzer

The questionnaire data is reviewed and an application specification is generated. The BGNS needs that can be addressed by CAD/CAM include surface machining capabilities, limited drafting, analysis of part properties, and sharing files with outside CAD systems.

Resolver

The Resolver's output, the functional specification, designates ANSI standard drafting, and mass properties capabilities for weights and volumes. Multiple system capability will be addressed through IGES/DXF file transfer. The surface machining need should be addressed through automatic roughing, surface offset, and automatic gouge checking capabilities from a 3-D wireframe model. These techniques are available on commercial CAD/CAM packages.

The implementation recommendation states that two CAD/CAM system seats should be purchased and that training should include basic computer literacy. A tool and die maker or machinist should handle CAM functions. This person understands machining techniques, and use of CAM will enrich their job skills. A designer with the willingness to adapt to job duty changes should handle CAD functions.

Product Selecter

Commercial products which fit the client's needs are chosen using the Product Features database. We have recommended two high-end, workstation based packages, and two low-end, PC-based packages. This will allow the client the option of being very ambitious or conservative in their next step. We also recommend purchasing a pen plotter, printer, and a digitizing plotter.

Client Selection

The client chooses among the four recommendations using benchmarking and cost analysis. The client may perform these alone, or with MTC participation.

SUMMARY

The MTC CAD/CAM Selection Tool is a standardized methodology being used by the MTCs. It's design has drawn upon the best practices of the MTCs, who have extensive experience in analyzing client manufacturing needs and choosing products and methods that make clients more productive. An inherent feature of the Tool's design is the accumulation of experience data that is being used to continually improve the quality of selection results for clients. The product database allows MTCs to share authoritative, tested information about commercial packages nationally. The Tool is modular, so that it's components can be improved, or tailored to particular applications, while allowing the continuity of a standardized methodology.

The resources of this diverse national program of manufacturing technology transfer organizations can be harnessed by visiting any of the five MTCs. The benefits of the MTC CAD/CAM Selection Tool are available today from these experienced MTC organizations who measure their accomplishments largely by how well their clients make use of commercial CAD and CAM packages.

REFERENCES

[1] Suenram, Richard, "The Manufacturing Technology Centers Program, A Sampling of Individual Case Histories", NIST Special Publication 830, February 1992, page 1.

[2] "Reference Manual for MTC CAD/CAM Selection Tool - 7/1/92", an internal document of the NIST MTCs.

KEYWORDS

CAD/CAM; CAD package evaluation; computer aided design; computer aided drawing; computer aided manufacturing; Manufacturing Technology Centers; technology transfer