COMPUTER AIDED MANUFACTURING - CAM SYSTEMS

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Abstract: The goal of this paper is too briefly and comprehensively describe the main features of computer aided manufacturing systems (CAM) and to decrease the lack of information in this area. Maximal production asset can only be achieved by complex application of computer aided manufacturing systems into the all activities related to manufacturing realization, which means that besides design this application should affect the choice of manufacturing technology, workplace project, tools and fixtures project and manufacturing realization itself followed by checking of product quality.
Key words: Computer Aided Manufacturing, CAM Systems, NC - Numeric Control, CNC - Computer Numeric Control.

1. INTRODUCTION

The history of computer aided systems is essentially identical with the history of computer aided design and construction which is primary related with the history of computer graphics. There was no possibility to create solids, to manipulate with them and to check them until computer graphics began. Computer aided design and construction only contained the computation execution.

Although the first project of calculating machine - calculator with the graphic mode was presented in 1945 by Vannevar Bush, it was never realized. First computers with the option of interactive graphic control on screen were produced in early 60's which was mainly the merit of General Motors, Lockheed, NASA and Bell Labs. Even though first systems of computer graphics and computer aided design and construction were developed using different computer platforms, the biggest producers of computer (IBM, DEC, Control Data, Texas Instruments) ignored this area. First steps in creating such systems made customers themselves. A lot of work has been done in famous research centres, for example Massachusets Institute of Technology, University of Utah and Xerox PARC v Kalifornii. Some systems solving the tasks of computer aided design were developed in 70's. They were of differet comprehensiveness and quality. Among them about fifteen of these solutions were notable used even out of research centres. In the early 80's a huge start of Unix was observed.

Computer aided systems, which din not keep up the trend, came to an end or hugely lost their positions. It is typical for 80's that large companies take the lead as they produce high-powered and comprehensive software systems of computer aided design and successive technical activities. Connection between the customer and company supplying CA system was very tight, some of these companies supported one customer only or were established as a division of huge industrial giants. As Europe wanted to keep up with the USA, there were companies doing the development of computer aided systems starting out mainly in France. Some of them still have the great position in the area of CA systems [5].

2. REASONS OF INSTALLING CA SYSTEMS

Current situation in industrialy advanced countries can be described as the infiltration of microelectronics and microprocessors into the all industrial divisions. Technical progress is accompanied by the raise of product's sophistication, pressure on the producers raises as well as the products should by developed and manufactured in shorter time, with minimal cost and required quality. Pressure of abbreviation of innovation cycle is oriented on those who are not satisfied by serial made product. Manufacturing company has to compete having wide scale of products. Variety of manufactiriung program gives rise to difficulty of premanufacturing and manufacturing phases. Meeting the requirement of manufacturing time abbreviation, starting from its design to the delivery to customer with minimal production cost, is the most important condition of company succes. Alongside that the competitive surrounding with all of its specifications has to be taken in consideration. The customer requires quality product with a good price. To make this possible there must be low production costs reached. If the product shoul be manufactured in shorter cycles and with lower cost, the producers must seek the reserves in shortening the expenses and therefore use modern information technologies which allow bringing demanded product to the market in short time period. Standard attitudes used in industrial companies are nowadays insufficient as they can not provide the strong manufactuirng in tough competitive conditions. In last years that was one of the reasons why our economy was delayed from industrialy advanced countries [4].

Competition's able product have to meet the requirements of quality and functionality, must have low price, good design, meet the safety and ergonomics requirements and all the other aspects of product's marketability.

These circumstances launched looking for ways of rationalization of ingeneer work. When the computers reached reasonable price and higher perfomance, first computer aided

systems were composed. In the beginning they substituted administrative work, later they improved and as for today, they represent top-class software equipment which allows the producers flexibly react to variable customer's demands. In addition a positive economic result flows from using these systems [4].

3. CA SYSTEMS

Computer aided systems are in general called Cax, Cai or CA.

CA abbreviation (*Computer Aided*) indicates that the operation, method, technique or system is aided by computer. In past it was understood as assistance, help or guide (Computer Assisted), today it is known as the synonym for computer aided term with an identical meaning.

Although there is a huge number of computer aided (CA) systems, only the well-known will be mentioned as they in large extent impact the rationalization of engineer work, cost reduction and production time shortening.

CAM (Computer Aided Manufacturing) - name for computer aided areas of manufacturing. CAM systems include computer numeric control (CNC) of manufacturing technology, robots, interoperational transport of products, workpieces, tools etc. Here belongs computer aided production control of workroom, numerical controled manufacturing systems, automated conveyors, automated storehouses etc.

CAM can be understood in two levels - as a physical system (CNC control and NC machine) or as some complex view on computer aid in manufacturing. Therefore to CAM belongs the wide complex of machine, handling, transport, measure, checking, control and instrumental devices, which are aided by a computer during the realization of product's manufacturing.

CAM as a software serves for CAD data formulation in manufactuirng process and for realization of simulation of this process. From a distant view it is the use of computers anywhere in manufacturing.

CAD/CAM - (Computer Aided Design / Computer Aided Manufacturing) - is computer aided system with integrated design and manufacture support. The abbreviation CADM is used rarely (Computer Aided Design and Manufacturing). Gradually with the evolution of CAD, CAPP and CAM systems new systems started to be developed which should integrate this chain of activities: *part design - technology project - manufacturing* into one system. CAD/CAM systems integrate part modelling, part construction plan,

techonological documentation project in the form of NC programs and manufacture control into one computer system. CAD/CAM systems are very popular today as they are getting their "boom". Their advantage lies in ability of finfing solutions on comprehensive and difficult tasks. Integrated part of CAD/CAM systems is created from part model and internal system database.

From a different view there is a completion of CAD (or some else CA system CAPP, CAA etc.) solved in CAM. That is about using of model created in CAD. The same CAD model can be used in CAM to formulate NC program for CNC machine control as well as in pre-manufacturing phase to make the simulation analyze by the way of finite elemetns method etc. [2,4,5].

CAM systems outputs are NC programs controling the operation of NC (Numeric Control) and CNC (Computer Numeric Control) machines. Work cycle of these machines is automatically, based on the information which are present in NC control program. CNC machines are most common in the field of manufacturing technologies. Construction of these machines and their control systems allow simultaneously relative motion between the tool and the workpiece usually in three axes or even in more directions.

In the development of NC and CNC technology there were different periods, in which the radical progress was made:

- 1952 first installations of numerical control machines (NC),

- 1960 start of computer numerical control (CNC),

- 1970 formation of CNC and DNC machines structure,

- 1980 realization of flexible manufacturing points, setting up group technology and flexible manufacturing systems,

- 1990 first CAM's (CAD and CAD/CAM systems as well).

4. CAM SOFTWARE CATEGORIZATION:

Current CAM softwares can be due to their extent and purpose divided into the following categories:

- small CAM softwares,

- medium CAM softwares,

- large CAM softwares.

Small CAM softwares represents simple applications for NC programs creation usually for exact manufacturing technology (turning, milling, …) with the small scope of tehcnological options and lower level of program sophistication which are able to effectively solve the simulation of 2.5D manufacturing with output in the form of NC program. Part model is taken from some CAD application. They are most cheap and have minimum hardware requirements.

Medium CAM softwares are more expensive and require better hardware especially in the field of graphic support. They can do the computation and simulation on acceptable proffesional level.

Main characteristic of *large CAM systems* is tha they can effectively and easily solve 3D-5D manufacturing (5 axis controled, for example: x, y, z, spindle position, rotary teble position) of 3D complex surfaces with the number of technological variations and wide technological support of choosing the tool, cutting parametres etc. They are on the high level of current programming. Yet the part model has to be taken from CAD application. Most popular softwares in the field of milling are CAM PowerMill, SmartCAM or SurfCAM.

Manufacturing CAM softwer can be known according to the manufacturing methods as CAM for:

- turning,

- milling and hole making,

- wire cutting,

- electroerosive drilling.

These are the most usual ways of manufacturing included in CAM softwares by the mean of all in one CAM or CAM systems which are specialized in one manufacturing method.

It is rather difficult to asiign these CAM systems into the groups and to judge them according to their similar functions as they have differnet history and their formation and design were conditioned by different facts. Still the features can be found on closer study that assigns these systems into the one of the imaginary group.

The main differential feature for putting them into the categories appears to be their comprehensiveness and interconnection to another CA (mainly CAD) system. Using this criterium, CAM systems can be divided into two big categories:

1. CAM systems integrated in the scope of complex CAD/CAM/CAE systems.

To this group belong mainly the products known as „large" CAD/CAM/CAE systems, for example CATIA Solutions (Dassault Systemes), Unigraphics (Unigraphics Solutions), Euclid Quantum (Matra Datavision), Pro/Engineer (Parametric Technology Corp.), I-DEAS Master Series (Structural Dynamics Research Corp.), as well as medium-class complex CAD/CAM systems, for example Cimatron it of Israel company Cimatron, or VISI-CAM etc.

Advantage of these systems according to their comprehensiveness and interconnection of the CAD, CAM and CAE modules (Computer Aided Engineering) is that there are no problems with the data tranfer between modules while using them. Disadvantage, especially on applications under the Unix platform, is higher hardware cost. This handicap can be reduced if the systems are installed on efficient personal computers with Windows NT.

2. Special CAM or CAD/CAM systems.

This second and numerously better presented category of CAM systems can be divided into the groups:

a) Complex CAM systems designed for computer aid of technology group - for example SURFCAM (Surfware Company), SmartCAM (CAMAX), Mastercam (CNC Software), AlphaCAM (Licom Systems) etc.

b) Specialized CAM systems designed for computer aid of one technology - for example PowerMILL from Delcam Company and WorkNC from SESCOI company for milling, ECAM 350 (Advanced CAM Technologies Company) for production of printed circuit's boards etc.

c) superstructural CAM of specialized CAD systems - most popular is HyperMILL from german company OPEN MIND, which presents a superstructure of AutoCAD and Mechanical Desktop from Autodesk company and provides computer aid of manufacturing which is represented by the possibilities of NC code generation for manufacturing machines (drilling machines, milling machines, CNC electroerosive wire saw machines, CNC cutting machines).

Mentioned CAM systems are characteristic by their maximal orientation to the computer aid of manufacturing while the part design module is on low level, often they don't

support CAD sphere and models taken from CAD systems at all (for example Solid Edge, Solid Works, Cadkey etc.).

Most known CAM systems of the best quality are modular concept systems which allow creation of NC programs from 2 to 5 axial milling machines, lathes, wire saws, watter cutting devices, laser cutters, plasma cutters etc. They include postprocessor libraries which are serving for translation of generated tool's paths into the shape which is understandable to control system of the manufacturing machine. Moreover they include modules for computer simulation of the manufacturing process what gives a chance for NC program error detection (model hit by a tool, material entry disruption of sppedshift caused by wrong workpiece definition, possibility of watching the manufacturing process from a different points of view transparently even in the section) [1,3,5,6].

5. CONCLUSION

The history of computer aided manufacturing starts in 50's, when the concept of numerical controled machines was made. That was the first sign of electronics, later computer technics in the production support. Yet the greater development in the field of computer aided manufacturing could not be done until the conception of CNC machines in 1970. As there is possibility of effective use of part geometrical data created for NC programs formation in CAM systems, huge and comprehensive systems covering the field of computer aided design and computer aided manufacturing are created in 80's. They are called CAD/CAM systems. The most important company producing extensive and axpansive CAD/CAM system was Computervision, which has dominant position in the aviation and car industry. IBM had CAD/CAM system itself which was later joined with with CATIA. In the early 90's there were six companies producing systems comparable in price and performance working under Unix: four of them american (Computervision, EDS/Unigraphics, SDRC, PTC) and two of them french a (Matra Datavision a Dassault Systemes with the major control of IBM). These companies produced modular systems designed mainly for the field of engineering. They still dominate when talking about current field of large CAD/CAM systems [5,6].

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