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Introduction

Together with science and technology knowledge expansion human's creative capabilities tend to develop as well. Contemporary enterprises operate in the environment of commonly introduced automation. The automation has resulted in the high growth in labour-consumption of technical preparation for production in comparison to labour-consumption of production itself. It is not easy to imagine large- scale production meeting quality standards and bringing profits without the use of computers.

The key condition affecting competitiveness of contemporary industrial enterprises is to respond to the market demands in possibly short time. Therefore the period in which a new product is being developed should be minimized as much as possible to avoid negative impact on its quality. The pressure to shorten production preparation cycle has resulted in automation of its stages by implementation of computer-aided design systems. In this way the following varieties of computer-aided systems has been developed:

- CIV – Computer Integrated Valuation,
- CIM – Computer Integrated Manufacturing,
- CAQ – Computer-Aided Quality Management,
- CAD – Computer-Aided Design,
- CAP – Computer-Aided Projects of Manufacturing Systems,
- PPC – Production Planing and Control,
- CAPP – Computer-Aided Process Planing,
- CAM – Computer-Aided Manufacturing,
- CAE – Computer-Aided Engineering,
- CIE – Computer Integrated Exploitation,
- CAR – Computer-Aided Repair,
- CAS – Computer-Aided Service,
- CDS – Computer Diagnosis Systems,
- CAU – Computer-Aided Using.

Obviously, not all systems has been established at once and not in the shape they takes today. The history of computer-aided design dates back to the 60's. The first programs developed were simple. They took advantage of data bases of e.g. standards valid in mechanics or typical objects libraries.

In the paper we are going to present utilities of CAD/CAM series of programs. AutoCad program facilitates making drafts to an engineer or graphic designer during the entire designing process. In the case of mass production the drawing can be used every few seconds in the further part of creating. Nowadays, Taiwan and China are the pioneering countries to apply designing technologies in factories.

1. Computer Aided Design

One of the most significant aspect of computer designing is possibility to reduce production costs and consequently speeding up final product production. All of these is a result of rising pressure by the market and a customer. Owing to opportunities AutoCad gives to its users and highly developed technology we are able to design and manufacture any object, device or tool that fills a gap in the market within a very short time.

AutoCAD has appeared to become a critical technological product within a short period of time. It has initiated creation of a separate field of designing with the use of personal computer. Today Autodesk range of products – AutoCAD originator – covers a full range of programs including multimedia ones.

Autodesk company was established in 1982. Since their beginning it has offered software to facilitate engineering works, which can be applied in the relatively cheap computers of PC class. It is crucial that their capabilities are much the same as in the case of solutions taking advantage of an extensive computer systems. AutoCAD is used in a number of disciplines as from architecture and mechanical designing to town-planning and calligraphy in the end. It sells better that any other CAD-range product in the world. Since AutoCAD launch in 1982, there has been sold over 1,4 mln copies of the program i.e more than seven times the nearest competitor – Bentley company has.

AutoCAD is now available in eighteen language versions. The program offers extension e.g. AutoCAD Designer is a parametric solid modeling software, AutoSurf aids surface designing. AutoCAD Data Extension helps to manage data compiled in a heavy files or in a number of drawings. Finished designs can be „enlivened" by AutoVision and 3D Studio programs. They facilitate easy animation and creation of environment by use of lighting effects. As far as Autodesk WorkCenter is concerned it helps to manage documents flow.

Machine and appliances designing, creation of technical documentation recorded and kept in an electronic form have become a standard in a number of companies and enterprices since many years. Technical documentation to be created on the basis of two-dimensional CAD techniques is not only requirement of cooperation, it is a necessity because of their ability to facilitate fast documentation exchange. This obviously saves time as early as at the stage of designing. Feature of making changes and amends without needing to re-create documents from the start is quite meaningful. One disadvantage of drafts made with the use of 2D techniques (like in the case of traditional documentation) is that to

read and make out the documentation in the form of flat technical drawings require appropriate qualifications mastered by a narrow circle of specialists.

Applications which aid spatial designing are not a technological novelty any more. Most of them has been evolving to the more advanced versions. Dynamic development of software proves that there is existing demand and keen interest by addressees in this kind of technology. The following functional division of designing accelerators seems to be forming:

– highly specialized software designed and suited to the needs of one, particular producer, being used to support designing of a particular type of devices. As an example one can give software used by such concerns as Boeing or Electric Boat Company (Pic. 1);

Pic.1. Computer aided designing of submarines by EBC

– advanced, technical software or packages dedicated to a particular industry: mechanics, electronics, construction etc. As an example one can mention packages by Autodesk, Pro Engineer applications or Solid Works;
– general purpose application software designed for modelling, visualizing and making presentations.

2. Computer Aided Projects of Manufacturing Systems

There is also an increase in interest and use of these software in Polish companies. Research conducted in 2005 by IDC Polska has shown, that among the main reasons for application of three dimensional systems by Polish industrial enterprises the following causes are to mention:

– Higher quality of designs (88% of responses),
– Less errors in drafts (72%),
– More effective way of presenting data (46%),
– Shorter time within which the product is delivered onto the market (14%),
– Simplified capability of sharing design data (22%).

By use of AutoCad software one can design three-dimensional objects, that can form a basis not only to draft two-dimensional technical documentation, but also can serve as a starting point for making endurance calculations or developing technology of treatment and generating control codes for numerical con-

trolled machine tools with the use of specialist, independent CAD/CAM programs or technological modules in integrated production planning systems. 3D modeling was enabled due to application of computer in the construction record process and introduction of sufficiently high-speed computers featuring sufficient operating memory and hard disc capacity. All of these became real not before the 90's of the twentieth century.

Traditional two-dimensional assembly drawings used for years do not ensure prompt capture of errors and discontinuities in the construction of particular parts. To control correctness of assembly and kinematic assumptions it usually was necessary to construct design of object model or even a prototype in working. Two-dimensional drawings often require very thorough, time-consuming revision which is hampered by the fact that each assembly parts had been designed by many people. 2-D technical documentation is very time-consuming to update. Every modification in the draft should be put onto several projections or even onto some supplementary sections and views. It is easy then to make a mistake or miss amend on the particular documentation part, which makes finished projections and sections unsuited one to another. Parts and sets designed with the use of classical 2D method usually prevent from making even the simplest kinematic or endurance analyses. More and more common use of 3D modeling systems facilitates process of production planning and generating necessary treatment data, making it easier and faster.

Three-dimensional modeling exclude the need for drawing another object projections and views, since the entire documentation is formed automatically. A designer is only to indicate particular views and sections, which are automatically generated on the basis of solid model and spaced over the flat drawing. Moreover, as far as solid models are concerned, making a change in model geometry does not entails the need to modify the other projections of a working drawing. The program updates them after any transformation made in basic geometry.

Contemporary designing methods do not mean just a transformation from a flat record of construction to the three-dimensional one. It is more and more common to dimension a design of parts in a parametric way. Parameterized models of parts or sets enable its user to make quick modifications in the draft, to analyze a number of variants to produce a part or constructional solution. Joining these values one with another can proceed in a different ways e.g. by joining dimensions with the use of relation or tying dimensions with aid of table of variables, built within the CAD system or by use of external applications (e.g. MS Excel).

3. Computer Aided Manufacturing

Today CAD/CAM systems are so multi-purpose, that constructional drawings developed in any CAD system convenient to a constructor can be saved in

a standard format, which is recognizable by CAM system (the most popular one is DXF – in fact almost all of known CAD systems are able to save drawings in this format). Compatibility between CAM and CAD system drawings is enabled by implementation of suitable interface.

The interface is a program that enables:

– To download geometrical data for the drawing saved in DXF format or in any other available one,
– To display separate layers of the drawing and to select a proper layer to continue works,
– Geometrical orientation of a drawing and implementation of coordinates set, mostly suited to treatment programming,
– Selection through indication by bullet point of elements (points, lines, circle), forming a profiles – to shaped treatment or of limited treatment area – while choosing surpluses or determining coordinate points – in openings treatment.
– To display and verify selected elements, created profiles and sets of points,
– Automatic creation of program lines for SN machine tools, responding to define chosen elements in a particular language and transmitting them to a particular processor.

If we move on to CAM module we have ready to use program designed for treatment, containing description of necessary geometrical parts, profiles, point sets. If needed, the program can be modified, supplemented (e.g. with surpluses) and some elements are able to be removed, the others can be added.

Above described system of cooperation between CAD and CAM should be treated as one out of many possible. Some of the systems are simpler to use, the other – more advanced, featuring larger data bases, able to process more factors affecting e.g. selection of surpluses. Many of CAD/CAM systems is so highly integrated that there is no need to converse drawings to a particular format.

Today there is a number of programs of CAD/CAM or CAE range available on the national and international market. It is quite common that one particular company takes advantage of some different systems. It forces its users to communicate between the systems and exchange data. It is particularly critical in the case of large companies of holding structures, which involves cooperation among several hundred or even more component suppliers.

Some of the systems comprise single specialist application designed to perform particular activities connected with computer aided construction planning, development of production process or generation of numerical controlled machine tools codes. The others include more complex integrated systems based on the common code, equipped with a set of specialist modules facilitating designing, planning, manufacturing (I-deas, Unigraphics, Pro/Engineer, CATIA etc.) Integrated systems provide capability to exchange data at every stage of work, starting from conception, through designing, analysis to complete documentation and pro-

duction (since they are based on the common file format, they usually allow to import and export data needed from the other programs). Unfortunately, for many years there has been any specialist, subject program to offer such capabilities.

CAD/CAM systems are constantly extended and suited to users' suggestions and needs. Each of them emphasize different elements; however all of them make their way to increase flexibility and variety of solutions, to provide expanded technological and tool data bases, to make organizational improvements and to tighten relations between the modules and towards building of user-friendly systems.

Although CAD/CAM systems become more and more extended, the program designers keep on striving for making them easier to use. The system featured with automated option requires simple use of a cursor to indicate area that one plan to cut out and given the command „do it" the system will define tool track for any complicated, multi-area solid. Thanks to these capabilities user determined to purchase CAD/CAM system does not have to waste many weeks for studying instructions how to use it.

In the thick of CAD/CAM range of products it is not so easy to choose the proper one which would help designer to perform a particular task effectively. The most simple and the most expensive at the same time solution is to buy „oversized" system enabling to create programs for treatment of freely complicated goods. Nevertheless such systems require highly expensive hardware, they are costly alone and when in use as well.

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Abstract

Advantages of CAD/CAM systems are unquestionable and they are the effect of above mentioned capabilities. However, before appointing any system for a particular use, one should carefully analyze their own current and future needs as well as the state and requirements of machinery one owes. An emphasis should be put on the fact that there are no ready to use integrated manufacturing systems, which are to be purchased and simply to be applied in the facility. Each user should look for his own way to solve the problem.

Key words: CAD/CAM, modeling, computer aided designing.

Systemy komputerowego wspomagania projektowania

Streszczenie

Zalety systemów CAD/CAM są niewątpliwe i wynikają z wielu wyżej opisanych możliwości, ale przed wytypowaniem systemu dla konkretnego zastosowania należy bliżej przyjrzeć się własnym potrzebom, aktualnym i przyszłym, oraz posiadanemu i planowanemu parkowi maszynowemu. Należy zwrócić uwagę na to, że nie ma gotowych zintegrowanych systemów wytwarzania, które można by kupić i bezpośrednio zastosować w zakładzie. Każdy użytkownik musi szukać indywidualnej drogi do rozwiązania tego problemu.

Słowa kluczowe: CAD/CAM, modelowanie, komputerowe wspomaganie projektowania.