CURRENT ASPECTS OF SOLID MODELING

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***Abstract**: Solid modeling is the most modern digital technology used nowadays in the most diverse industries related to mechanical components and assemblies, such as the automobile industry, aeronautic industry, maritime industry, medical technology industry, etc. Specialized software packs are constantly being improved, each year bringing about new versions, with modeling tools and capabilities that are faster, more spectacular and more efficient. The following article illustrates some of the development trends and directions of the solid modeling programs.*

***Key words**: MCAD, solid edge, solid works, solid modeling.*

1. SOLID MODELING

In short, solid modeling defines the use of computer - assisted design systems in order to obtain realistic images of the mechanical components and their corresponding assemblies. The aeronautic industry is perhaps one of the fields in which this approach is most frequently used, especially in combination with other analysis capabilities of the CAE programs.

A solid model is a complex database that contains information related not only to the form, dimensions and the image of the modeled body, but also to its physical and mechanical characteristics, its different ways of reacting when subjected to mechanical solicitation, mass characteristics, weight, moments of inertia, mass centers, etc. In other words, it is the essential link in the so-called "rapid prototyping", an up-to-date and irreplaceable concept in the race for production and processing, adaptive and elastic. Albert Kalman, in his article entitled ''Why 3D modeling", states: "it is estimated that in the last ten years around 100.000 designers from all over the world have changed their designing approach by shifting from 2D systems to 3D designing, with the use of solid modeling programs. Some specialists estimate that only after 2000, the 3D modeling software that is presently on the market and is destined to the large mass of users, will become more evolved." Needless to say that this prediction has already turned into a fact.

One of the many advantages offered by the solid modeling software packs is the fact that the creation of a solid model results in obtaining the 2D (double or multiple orthogonal projection) and the quote drawings of the solid model.

1.1. SOFTWARE COMPANIES AND PRODUCTS FOR SOLID MODELING

The development of the programs destined to this kind of activities is without any precedent.

A significant aspect that shows the development rate of the software products is that the CAD, CAM and CAE industries generated in 2000, in USA only, a five billion and a half dollar worth market of software products and services, with applications in the mechanical field. In 2008, these expenses almost doubled.

Autodesk - http://www.autodesk.com/ is considered the oldest and most popular company on the software market, its most

significant product being AutoCAD. Though not originally created for solid modeling, AutoCAD does offer this possibility by means of its Boolean functions. Moreover, the company has developed a series of approximately 40 software products, such as AutoCAD LT, which is a lower price version used in the educational field or the less complex, user-friendly Quick CAD version. Other known versions are 3D Studio, Autodesk Inventor or, the most advanced, AutoCAD Mechanical Desktop.

SolidWorks - http://www.solidworks.com/ specializes in building programs for mechanical design by means of solid modeling in the MS Windows operating system. It is easy to learn, highly interactive, user-friendly and it can be adapted to the parametered representations.

CADKey - http://www.baystate.com/ This company produces programs for the mechanical systems design in the PC industry. The web page of the company contains a comprehensive presentation of its products, the client also having the possibility to order a demo version. The CADKEY software line can also be used by mechanical designers, production engineers and technical graphicians working in specialized industries related to **air space,** automobile body, medical devices, calculus systems equipment, ships, furniture, toys, sports or electronic items.

Parametric Technology - http://www.ptc.com/ According to its webpage and the specialty literature, the producer of the CADDS and Pro/ENGINEER packs counts more than 30 000 clients. CADDS is destined to the automation of the mechanical design, being used in large scale projects involving **aircraft**, ships, and automobiles, with the concourse of hundreds of designers. The program uses both explicit and parametric techniques in order to create 3D models of solids, surfaces of "wire-frame" for cast-on, forged or welded parts. The Pro/ENGINEER 2002 is a CAD 2D/3D editor that allows a data exchange with CATIA, Pro/MECHANICA, Pro/DESKTOP, CADDS 5, CDRS and ICEM, and, through translation, with CADAM, Pro/PHOTORENDER, MEDUSA and AutoCAD.

2. COMMON ELEMENTS OF SOLID MODELING SOFTWARE PACKS

It can be assumed that the great and most popular solid modeling software products are each and everyone equipped with several programming environments (for parts modeling, assemblies making, 2D technical drawings elaboration, that can all be easily obtained as projections of the solid modeling), as well as with a series of other particular modules. Such is the case of the Solid Edge program.

This is one of the most spread and productive CAD systems on the *mid-range market* (belonging, just as SolidWorks, AutoCAD or Inventor do, to a middle zone, just like the Unigraphics solutions that represent *high-end* solutions). The open source variant, which is about to be installed in the IT laboratory of the Air Force Academy "Henri Coanda" in Brasov - courtesy of professors Radu Gheorghe and Mircea Badut, author of the course "The Fundamentals of the Solid Edge Program" - includes (starting with version no. 9) one separate environment for tin parts modeling (Sheet Metal), and another one for welded articulations modeling. All these are closely integrated, so that the designer can easily move from one environment to the other in order to complete the model with no difficulty at all.

2.1. THE SOLID EDGE MODULES

The free component of the Solid Edge pack includes two separate environments: the geometric body modeling module and the drawing module.

The first one, the **Solid Edge Part** module is used for the 3D modeling of the bodies of average difficulty. The bodies are modeled based on the most advanced methods nowadays in use in MCAD, with the help of the modeling features.

Figure 1 illustrates in a very suggestive manner how, of the three rectangular planes, presented first by the program, the most convenient one is chosen and how in the corresponding window of this plane, the basic modeling entity is sketched.

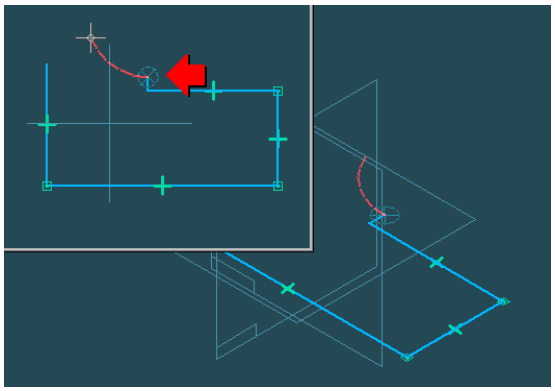

Fig. 1 The Part module of the Solid Edge pack

The modeling principle in this case consists in the sequencing of the different types of material additions (or removals) to the (or from) the solid body. To generate material one can extrude based on the given direction (for which, in the case of Solid Edge, the neologism protusion is used), the given revolution of axis, and the "sweep" and "loft" options. The removal of the material can be done through boring, wall thinning, edges blunting, joining, etc., as shown in figure 2, which was created on the basis of the modeling entity in figure 1. In addition to these modeling operations, one can use the following functions: the multiplying of the entities, plane or polar multiplying, or mirror copying (mirror), as illustrated in figure 2 with the four holes or the three ribs.

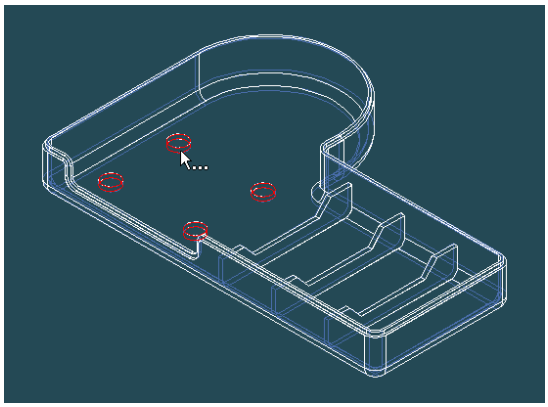

Fig. 2 The intermediate phases of the modeling

The second module, **Solid Edge Draft,** specializes in obtaining technical drawings, in double or multiple orthogonal projection, of both the quote drawings and the assembly drawings.

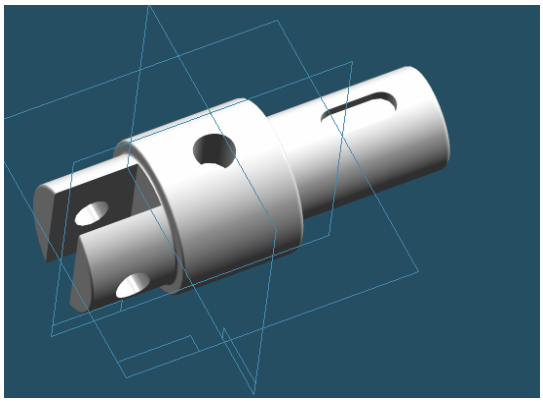

Fig. 3 Solid model of a shaft obtained with Solid Edge Part

Even though through the adopted convention the automation of this transformation process is not possible, it is worth mentioning that the 2D drawings can be directly generated from the 3D parts or assembly's models, with which they remain associated. This connection indicates even more effectively the way in which the conventional method of work – whose first stage was to draw the 2D views – has been altered by the capabilities provided by the CAD software in the sense that nowadays the 3D model is conceived first. Once the solid model is completed, one can automatically extract from it the side and front views, sections, and axonometric projections, or place quotas, technological recommendations, etc. This way, the work on the technical documentation is far easier and is constantly controlled or checked in a real time.

For example, figure 4 represents the image of the quote drawing of the shaft illustrated in figure 3.

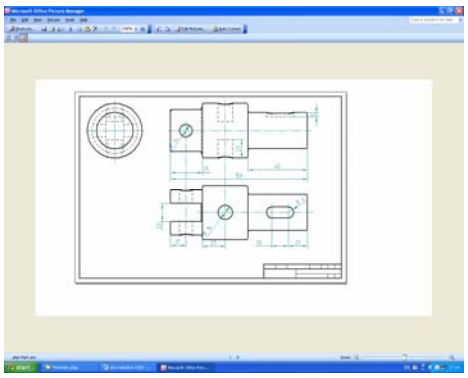

Fig. 4 The quote drawing of the shaft obtained from the solid model

Another example, with several more views and sections, all obtained automatically based on the 3D solid model, is presented in figure 5. we can observe the isometric view, accompanied by a normal positioning of the three main views, a section, detail and slant view.

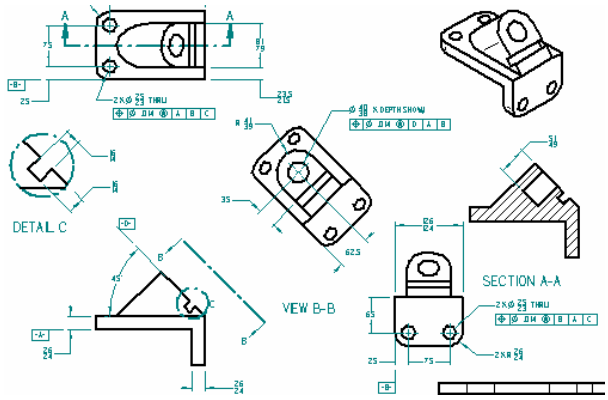

Fig. 5 How to obtain automatically quote drawings based on a solid model with the help of Solid Edge Draft

But working with these spectacular capabilities provided by the CAD software packs is not as easy as one might think. It requires solid knowledge of technical drawing, descriptive geometry, and technology.

In other words, no matter how advanced the software is, there is no substitute for the designer's experience, skill and talent.

The **Solid Edge Assembly** is used to create models that comprise several assembled bodies. There are two ways of building an assembly: either by merging individually created components (with the help of the moving and aligning commands along some surfaces or directions, or until some surfaces are connected, fig. 6), or by successively developing the assembly by interpolating new components inside it.

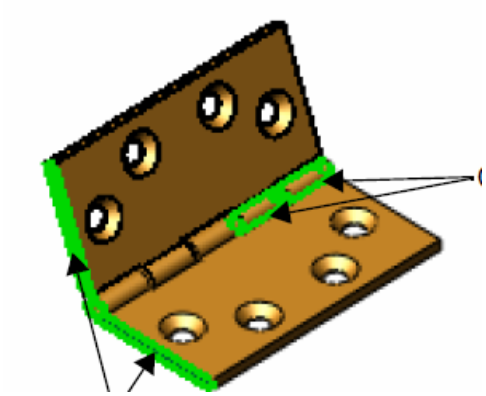

Fig. 6 *Coincidental* (left) and *concentric* (right) alignments of the components

Lastly, there is the **Sheet Metal** module, which is not covered in this article, is used for the modeling of the tin parts, with such modeling entities as level sections, crinkling, edges, carvings, distortions, etc.

REFERENCES

1. Badut, M., *The fundamentals of the Solid Edge program,* Editura Albastra, Cluj Napoca, 2003;
2. * * * EDS/Unigraphics Solutions Inc. *Solid Edge On-Line Documentation,* versions 7 and 9;
3. Badut, M., Articles on CAD and Solid Edge published in the *PC REPORT* and *PC WORLD* magazines;
4. * * * *Solid Edge Documentation.* Intergraph Corp.