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PRINCIPLES OF COMPUTER MODELLING OF THE SOLID PRODUCTS LEARNING

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ABSTRACT

The key condition for the realization of successful product's development and technological excellence is creation of a simple access to transition from the domain of designing to the domain of product's manufacturing. Nowadays, there are a lot of possibilities for this condition to be fulfilled and they depend on the level of organizational contemporariness which has to possess tools and skills in order to fulfill the demands of a superb production.

KEY WORDS

modelling, solid, CAD, computer aided design, 3D/2D, constructive element, parent/child relationships, drawing, part, assembly

CLASSIFICATION

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INTRODUCTION

The beginnings of computer designing in applications of CAD (Computer Aided Design) were based on 2D modelling of solids: machine-made elements, constructions, standard and non standard elements. 2D projections of a model are directly suitable for making the technical documentation: working and assembling drawings. However the main difficulties of such approach of designing aided by a computer were caused by a procedure of making 3D model out of already existing 2D projection in full display. Because of such difficulties, we were often obliged to hide or suspend certain displays on 2D models (such as dimensions and specific details) in order to do a process of third dimension extrusion. Such approaches were often the cause of technical mistakes and making of an unforeseeable time for their noticing, correction, removing, or at the worst case working out the existence of such a model.

When a new approach of solid products modelling appeared in CAD/CAM/CAE software family, a reversed procedure of modelling was created. First you create 3D model (which is a model that can be physically accomplished) out of which 2D projection is automatically created for the needs of technical documentation where there is no possibility for a mistake to appear and unnecessary losing of time and at the same time each change in 3D model is automatically reflected on all the applications derived from the model and there is no need for data interpretation. Therefore, when there is a need for certain modification of a project, for example an assembly (Figure 1) it is possible to make corrections without returning to the beginning and to each model (part) individually, but one can directly make the corrections on the assembly itself [1].

Figure 1. Assembly of a diesel engine.

SOLID PRODUCTS MODELLING

Parametric solid modelling by means of constructive elements implicates that parts and assemblies are created by defining of the elements of a higher level with clear physical meanings. The term clear physical meaning implicates defining of the elements suitable for the third dimension extrusion, extrusion along the curve or some other trajectory, for defining of the cuttings, orifices, incisions, roundness and the like [2, 3].

Using this approach to modelling a designer observes his model with a high level of abstraction. Elements are defined by determining of a corresponding values and references for different kinds of constructions such as referential surfaces, planes, directions, parameters of similar elements series, shapes, dimensions, etc. At element modelling a material is added or subtracted to the parts, whereas such elements can be geometrical forms such as referential axes or planes.

Changing or defining of dimensions and other attributes of an element can be done at any moment but one should keep in mind that such changes are automatically transmitted to the whole model.

Solid modelling of a created computer model contains all the information of a real object. Those are models with cubic capacity which can have mass and inertia if specific solidity of the material is defined in advance. The important difference of this kind of modelling in relation to surface modelling is that orifices and holes in the model of solid automatically create new surface so that one can precisely determine which side of surface represents solid material.

PRINCIPLES OF REALIZATION AND MODELLING ACCOMPLISHMENT OF SOLID PRODUCTS

At the very access to software for 3D modelling of solids such as: ProENGINEER WILDFIRE (which is applied in this work); Solid Works; Solid Edge; CATIA; Autodesk Inventor, etc. in which one wants to create a model by means of constructive elements [5] he or she has to keep in mind that a model which cannot be physically accomplished also cannot be projected in the applications mentioned above or some of them can be projected but one should pay attention to estimation of its probability to be manufactured in machine made process.

The displayed model in Figure 2 represents an object which resembles three-sided spatial object but on the occasion of solid modelling it is not possible to create such a model which is ambiguous and cannot exist physically [4]. However such a model is very simply suitable for creation in 2D, wire and surface models.

Let us observe the part of a model in figure 3 which can be physically accomplished and can be modelled by means of computer as a solid product but there is a question imposed whether the machines can make such orifices inside the displayed model the estimation of which is the authority of a person who designed this model [1].

THE PRINCIPLES OF CONSTRUCTIVE ELEMENTS' RELATION

Constructive elements represent basis for solid products modelling and they possess reciprocal relations which are practically called Parent/Child relationship.

Constructive element "parent" is the element that represents the base, that is to say a reference for the creation of a new element which will have the characteristic "child" because of the subordination which is created by its existence. Parents and children can be surfaces of some models, planes, angles, axes, points, and the like, which are reciprocally subordinated in such a way that if, for example one deletes the element "parent", its elements "children" will also disappear.

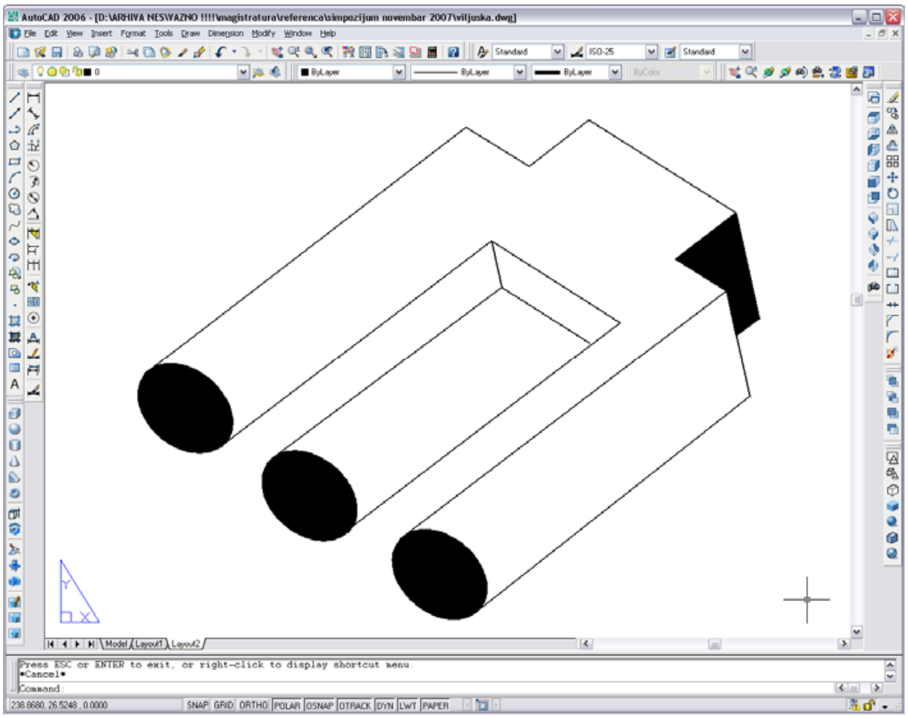

Figure 2. Unusual three-sided spatial object created in AutoCAD.

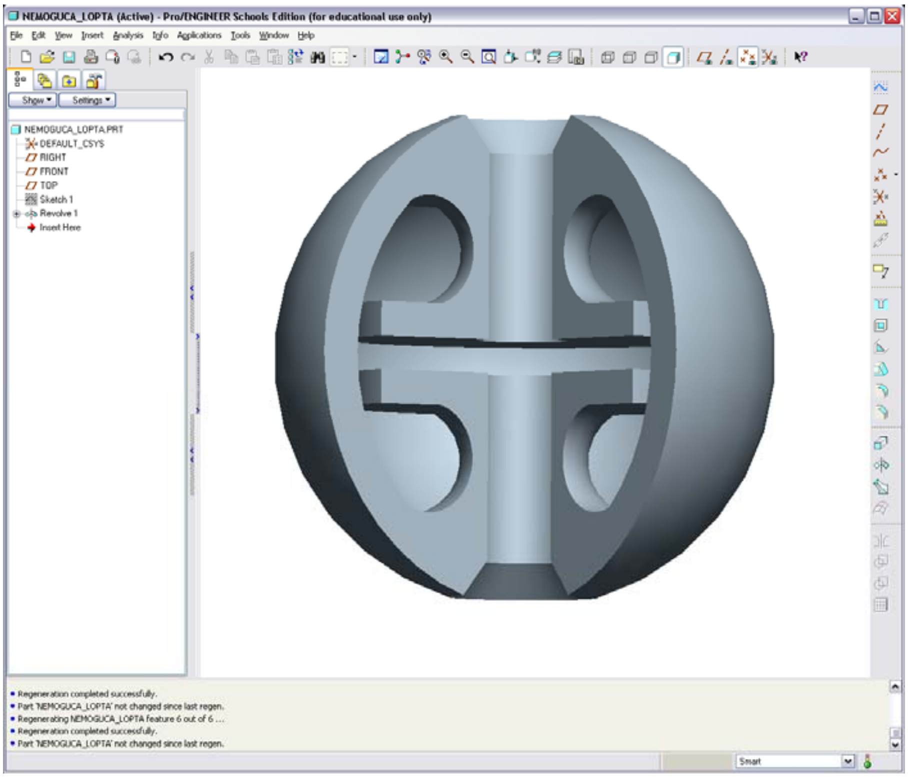

Figure 3. Part of a solid model created in ProENGINEER.

At solid product modelling it is very important to be careful about these relationships and principles for their creation because on the contrary a seemingly simple constructive problem can turn into an extremely complicated one especially at the moments when one changes or deletes some elements which possess parent/child relationship.

The applications mentioned above for 3D modelling mainly possess special functions for the work with parent/child relationships which have to be studied well before engaging in modification of a project.

In Figure 4 one can observe the relation of referential surface of prismatic part which represents the element "parent" on which there is a constructive element created of the circle "child" for the extrusion of cylindrical part.

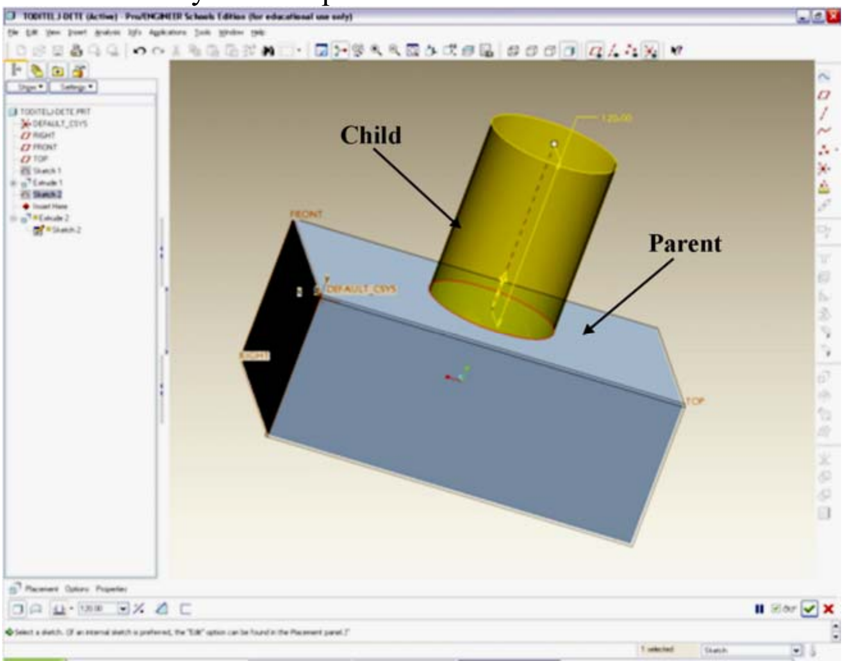

Figure 4. Parent/Child relationships.

THE PRINCIPLE OF PRACTICAL OBSERVATION OF A CONSTRUCTIVE ELEMENT

In this part of the work there will be described the principle of observation (recording) of a solid product's constructive element which is suitable for the creation in 3D applications on the basis of which a real model is reached.

The transition from 2D to 3D modelling can cause certain difficulties especially because of the practical speculation over the elements out of which the third dimension should evolve. In 3D modelling the creation of constructive element is done in the sketching part (2D projection) and the problems often appear on the occasion of sketch's confirmation and the impossibility of 3D projection creation. Here one should think of the difference between 2D technical drawing in display and the sketch for 3D modelling which resembles that drawing but without certain segments which would prevent forming of 3D dimension (diagonal lines, lines with an interval, axes, details, etc.).

That means that recording of constructive element of a geometrical form which has to be worked out in 3D is not as same as the recording of the view and looks of the form in technical drawing in 2D projection. Constructive elements should be regarded as a reflection of shadow's contour, for example the shadow of our profile (Figure 5) on the wall of a certain object on which one can see only the silhouette, that is to say outward lines of his or her looks where one cannot see the features of the face, eyes, mouth, ears, and other parts inside the shadow. So, on the basis of this example the other details (holes, orifices, grooves, roundness and the like) inside the observed geometrical form should be separately created in the same way when we make a model according to a certain technological procedure and use clay or wood (from a sample to a completed part).

Figure 5. The example of shadow's contour.

While working with applications for 3D modelling of solid elements at some moments one can come across conclusion that can refute the claims mentioned above especially with extrusion but the possible problems appear with an effort to change of delete certain displays (orifices, holes, grooves, roundness, prostrated angles, and the like) which did not evolve separately but they were created inside the main constructive element.

When one finishes with model making according to the mentioned principle he or she can begin with making 2D technical drawing in standard format which is performed almost automatically and on which there are all necessary views, details, and looks displayed. The model and the drawing are connected with two-direction association so that each change of dimension on the technical drawing will automatically be reflected onto the model and reversely which proves the presence of parent/child relationship.

CONCLUSION

Everything that is described in this work represents the decadal experience of engaging in this problem as a teacher of a subject modelling of machine made elements and constructions in technical school. With an intention to present the simplest access to computer modelling to students and the beginners of the course by means of this kind of lecturing I managed to explain to students and people who had foreknowledge about this matter the relations which are present and make an important basis in further work.

REFERENCES

[1] Nestorović, G. and Bjelaković, M.: *Modelling of machine made elements aided by the book of reference WILDFIRE 3.0*. TEHDIS, Belgrade, 2008,

[2] Bjelaković, M.: *Modelling of machine made elements*. Trstenik, 2005,

[3] Mirkov, G.: *Modelling of machine made elements and constructions*. Institution for textbooks and teaching means, Belgrade, 2002,

[4] Toogood, R.: *ProENGINEER WILDFIRE 3.0*. Computer library, Belgrade, 2007.

[5] -, *AutoCAD, Autodesk VIZ Architectural Desktop, 3D Studio VIZ, Autodesk Inventor, CATIA, I-DEAS, IronCAD, Mechanical Desktop, SolidWorks, Solid Edge, Land Development, MicroStation, Revit, Silverscreen, Thinkdesign, Unigraphics NX*, Catalogues at Internet sites.

PRINCIPI UČENJA RAČUNALNOG MODELIRANJA ČVRSTIH TIJELA

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SAŽETAK

Ključni uvjet za realizaciju uspješnog razvoja proizvoda i tehnološku izvrsnost je stvaranje jednostavnog pristupa prijelazu iz domene dizajniranja u domenu proizvodnje proizvoda. U današnje vrijeme mnogo je mogućnosti za ispunjavanje tog uvjeta. Oni ovise o razini organizacijske suvremenosti koja uključuje i alate i vještine potrebne za ispunjavanje zahtjeva vrhunske proizvodnje.

KLJUČNE RIJEČI

modeliranje, čvrsto tijelo, CAD, *computer aided design*, 3D/2D, konstruktivni element, relacija roditeljstva, dio, sklop