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COMPUTER AIDED MODELING TO SOLVE CERTAIN DESIGN PROBLEMS

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Abstract: The model of concurrent design and engineering assumes that all people involved in the design process work interchangeably together in a team. The three areas of the design process, which are ideation, refinement of a product and its implementation overlap with each other [1]. To complete the work it is necessary to use most efficient computer programs for the specific design purpose. In practice it shows up that available CAD/CAM software is still not compatible and that using certain computer programs means knowing limitations of them. The most popular CAD software used for design purpose in Poland today is AutoCAD or Archi-CAD. In the paper some discussion on properties and capacity of the two of listed above CAD programs will be discussed based on the design experience of the author.

Keywords: CAD, Engineering Education

1. Introduction

It is known that the shape of an object is the most important information needed to visualize the final construction and to determine possible interference between related components. Today it is the most common that designers use **geometric models** [4] as a supplement to the design project to aid visualization. Rendered images together with animation serve visualization purpose. Students of civil engineering and architecture are increasingly expected to master computers as drawing tools when producing their design and architectural projects [2]. Most common software used by architects and civil engineers in Poland today is either AutoCAD2000 or ArchiCAD 6.5, while some other programs like Microstation or CADKey are used specifically by mechanical engineers. For animation and presentation purpose very often they use 3DStdioMax. Capabilities and compatibility of different programs are usually limited. In the following some design limitations will be presented.

2. 3D Modeling with help of AutoCAD package

In practice two methods to create a 3D model are implemented: Constructive Solid Geometry (CSG) method or Boundary representation. CSG method is such a modeling technique in which a new volume is created by application Boolean operations of union, intersection or difference to two specified volumes. A CSG application starts with an initial set of three-dimensional objects (primitives) such as blocks, pyramids cylinders, cones and closed spline surfaces. In AutoCAD package the software as menu selections has provided a set of specific primitives. Technology of 3D objects' creation is very specific [4]. There are certain recommendations and activities, which we need to remember about, while creating 3D models to construct a real and well-constructed object. These recommendations are as follows:

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1. use a local coordinate system as often as you can because it enables you easier orientation with reference to the object,
2. use an adequate viewing method to rotate an object so that it is accessible in most convenient way to construct its internal parts,
3. use a lot of zooming and shading commands to check if the object is constructed correctly,
4. save an object as often as you can to protect your files from loosing them.

In Fig.1 an example of 3D staircase created with aid of AutoCAD with the use of CSG method has been shown. The most difficult part of the object was to create the internal stringer as the constructed parts overlapped and did not let see clearly important points of the structure. The second difficult part was to create a handrail for the stairs. The stair treads were first created by use of extrusion command on the ground level, then they were moved at the 3D position of the stairs and finally provided with the toe plates.

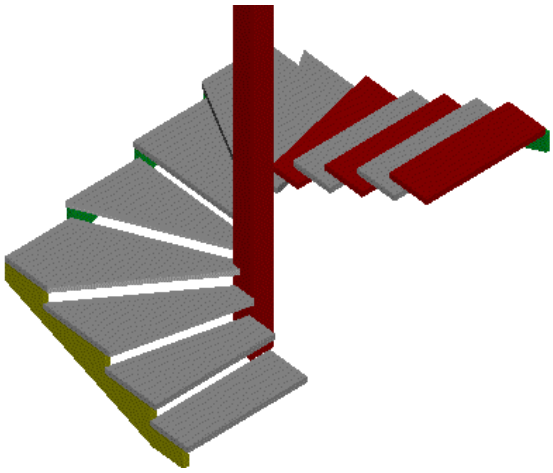

Fig. 1. Example of 3D Staircase Modeling in AutoCAD

The author has taken a few examples of students' works, which have been done during the 2000/2001 course of Engineering Graphics Course. These particular examples provide an illustration to a certain idea of realization of an engineering graphics course. To complete the design project it is necessary for a student not only to use proper drawing techniques but also to dimension it accordingly to drawing standards and to use "layers" and all the other tools available in AutoCAD (Fig.2).

Since two years it has been possible at CUT to provide our computer lab with ArchiCAD educational package. Today our students are modeling 3D structures with the use of ArchiCAD 6.5. The capability to create a 3D model based on a 2D drawing became a big advantage to a designer. The procedure employed here is easy. At first a 2D drawing created in AutoCAD has been saved in a *.dxf format. As ArchiCAD has an option with opening *.dxf format, the drawing has been opened in this package and then saved as a *.pln file. Remarks, which one should make while transforming the files between the programs, are as follows:

- all layers are transformed into ArchiCAD from AutoCAD
- one needs to remember what units were used when doing a drawing in AutoCAD and transform it adequately into ArchiCAD
- Designing philosophy in ArchiCAD significantly differs from the one applied in AutoCAD (no ESC button, windows and doors are automatically inserted into existing walls, no surface modeling).

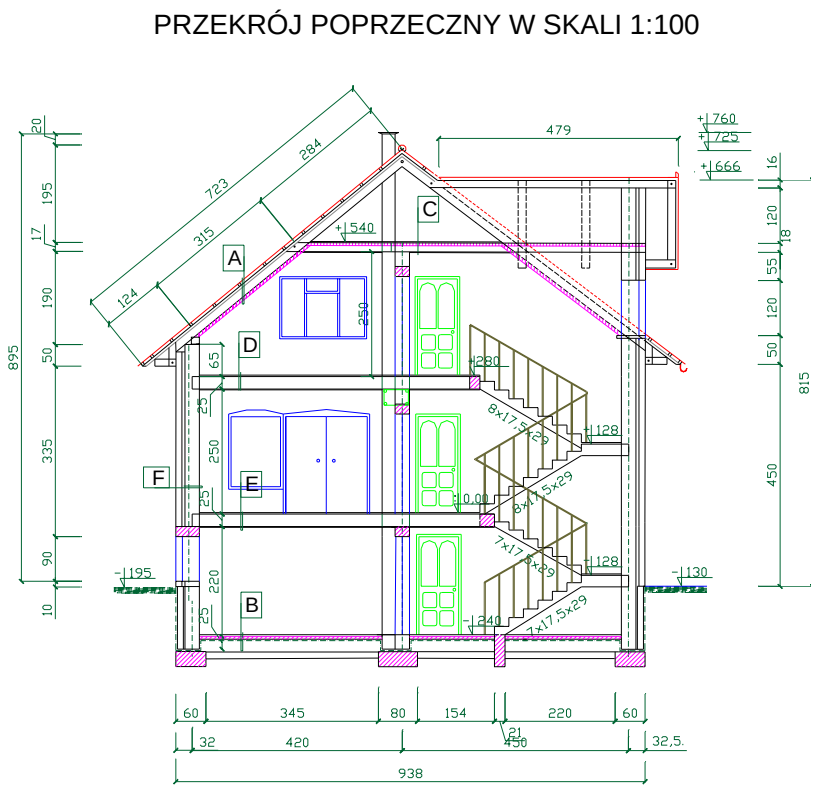

Fig. 2. Cross-Section of a Single-family House

Differences in using design tools and customs between the two programs are very often difficult to handle with. In ArchiCAD we need to remember that a 3D model is being designed using certain libraries and that the model may be securely transformed from one platform to another only in an archive type file (*.pla file) together with the objects' library. In consequence the files are large and require saving on a CD.

The advantage of using ArchiCAD package for a design project is that it can be displayed using various projection methods (axonometry or perspective projection). It has a built-in rendering tool and photo presentation tool. In Fig.3 we see a rendered view of another

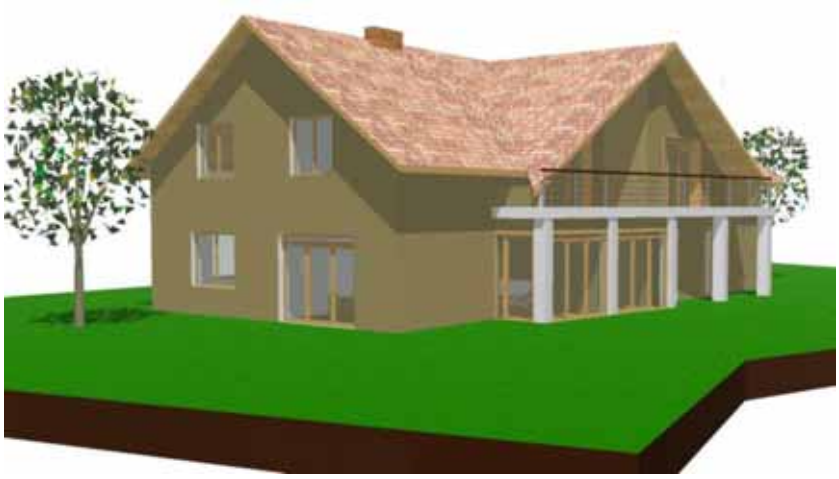

Fig. 3. 3D Model of a Single Family House Provided with ArchiCAD.

house. In the project not only the layout of the external and internal walls and slabs, the layout of a roof and foundation can be designed. The interior furnishing and the exterior equipment are also available in the package. The tool of a cross-section is used as a checkpoint of the designed elements and their placement on certain stories.

3. CONCLUSIONS

New tools application into engineering curricula becomes a challenge for educators in the field of graphics and visualization [2]. University faculties recognize the importance of the use of new technologies in solving engineering problems and for the purpose of visualization. In the new, technological world it is critical to meet the challenges of modern world and to provide a future engineer with modern tools of CAD. The choice of the type of a tool is so much crucial. The point is to provide a good level of education, to have sufficient experience to teach adequate methods and to be flexible and responding to contemporary world.

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MODELOWANIE WSPOMAGANE KOMPUTEROWO JAKO ŚRODEK DO ROZWIĄZYWANIA PEWNYCH PROBLEMÓW PROJEKTOWYCH

Idea współbieżnego projektowania inżynierskiego zakłada, że wszyscy uczestnicy procesu projektowego są uniwersalni i zamiennie wykonują zadania. Trzy obszary procesu projektowego, to jest idealizacja, doskonalenie wytworu oraz wdrażanie nie są rozłączne. Z drugiej strony w praktyce projektowania używa się rozmaitych, bardzo wydajnych programów komputerowych. Jednak dostępne oprogramowanie CAD/CAM nie jest jeszcze w pełni kompatybilne i to znacznie ogranicza możliwości nowoczesnego projektowania. Najbardziej popularnymi w Polsce pakietami CAD są AutoCAD oraz ArchiCAD. W artykule omawia się niektóre własności tych programów w oparciu o doświadczenia Autorki.

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