



THE HISTORY OF THE INTRODUCTION OF CAD SYSTEMS INTO PRACTICE AND TEACHING IN ENGINEERING

Michal Fabian¹, Jan Strohmandl², Róbert Boslai³, Jana Fabianová⁴

¹ Department of machine design, transport and logistics, Technical University of Košice,
Letná 9, 042 00 Košice, Slovakia, e-mail: michal.fabian@tuke.sk

² Faculty of logistics and crisis management, Tomas Bata University in Zlín, Studentské
nám. 1532, 686 01 Uherské Hradiště, Czech Republic, e-mail: strohmandl@flkr.utb.cz

³ Department of machine design, transport and logistics, Technical University of Košice,
Letná 9, 042 00 Košice, Slovakia, e-mail: robert.boslai@tuke.sk

⁴ University of Security Management in Kosice, Kostova 1, 040 01 Košice, Slovakia,
e-mail: jana.fabianova@vsbm.sk

Abstract: *The introduction of CAD systems has an impact on the functionality of products, product design flexibility, the possibility of implementing rapid change of order and also to shorten the time of innovation cycle. Electronic data play a role of "functional" pieces with the virtual image which is used for market research, testing the finite element of stiffness as well as to generate data for material functional samples, whether for rapid prototyping methods or to generate data for CNC machines when tangible model is produced by classical machining. This development has the effect of shortening the time of innovation cycle of the product. In the automotive industry this limit was reduced from 8 - 12 years to 4 - 6 years. Leaders in the automotive market come with new models approximately in this interval.*

Key words: *Cad systems, Skoda, solid modeling, designing*

1 INTRODUCTION

The model Skoda 1000 MB was manufactured in 1964, i.e. exactly 50 years ago. The "new" Skoda 100 came to market in the late of 1969 and remained in the market until 1976. Thus a model range of Škoda 105/120/130 reached our domestic automotive world in the late of 1976 and persisted in the market as a fixed star in 1990 (Fig. 1). It had been produced the longest and had has undergone a great deal of major design changes . In 1984, engineers widened the front and rear axles and sat it on 13 inches wheels, which significantly improved

the handling characteristics. It also got the rack management and power of braking action already set in a serial format. Extending the axles had an impact on the shape of the wings. A new front and rear mask with new headlamps were added to this. At the end of production a five-speed gearbox was assembled in these cars, which affected not only the driving dynamics but also the economy of operation. Last Škoda 136 L got a modified engine from the Favorit and an angular shuttle trailing rear axle and it was basically the peak era of Škoda concept „everything in the rear part“. Despite all these facts, the current young generation can say that Skoda 1000 MB was produced from 1964 to 1990, and was three times facelifted. (Figure 1)



Fig.1 Comparison Škoda years of production from 1964 to 1990

During the production, there occurred many useful changes but we must admit that the innovation cycle in the automotive industry has been considerably shortened nowadays and some automakers create new types in the range of four to six years, which is supported by the help of the computer aided design and manufacturing. It can be said that the car arises largely in a virtual environment of CAD systems now.

2 THE BEGINNINGS OF THE INTRODUCTION OF CAD SYSTEMS INTO PRACTICE

It had been 25 years since the beginning of the introduction of AutoCAD from Autodesk to design process within the framework of Action 2000 AIP workplaces. Under this pilot project there had been established 2000 offices with the support of the automation engineering pieces of work (AIP). Basically there were about 2000 workstations with AutoCAD graphics system implemented in practice, science and research throughout the territory of the former Czechoslovakia. This created Computer Aided Design was to bring mainly simple changes of management in the drawings, to help save the time of the design engineers, to improve the efficiency and effectiveness and ultimately improve competitiveness of our products in the world markets.

The Teaching of CAD systems in the Mechanical Engineering Faculty of the Technical University in Košice began in 1990, when the first licenses of AutoCAD Release 11 were

purchased. AutoCAD was excellent means to penetrate into the problems and terminology of the CAD world. Teaching started on the PC - 286 Hercules with the graphics card but soon first VGA graphics card came. (Fig. 2)

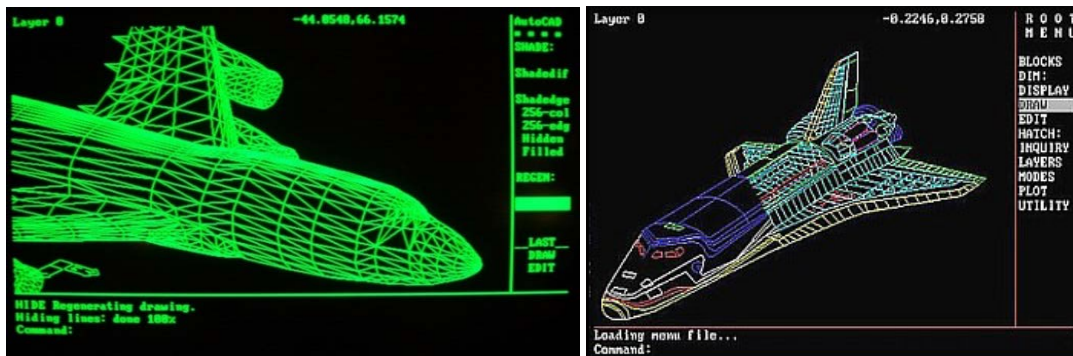


Fig.2 Samples of view CAD model on two different graphics cards: Hercules and VGA [1]

First 3D models were at first network and then wire. Full-featured 3D modeling came up through the major CAD systems, which at that time was presented by CATIA, Pro / Engineer, CADD5, IDEAS, ICEM Surf, Euclid. As suggested above, with lectures 2D graphics they started at PC 286 later 386, 486 and Pentium in AutoCAD. The role of the first CAD systems was to replace the drawing board with the electronic sheet of paper and to deal with the change of management by editing commands for drawing in electronic form. In 1991 we were lucky enough to get to the two workstations with IBM RISC/6000 CATIA V3. Due to this fact that this version came to market in 1988, we can confidently say that we made a great progress at that time. And now we got to the full 3D CAD system. Work in this configuration is shown in Fig. 3.



Fig.3 Design shapes of cars in the 90s of last century

3 SOLID MODELING

The first experience was gained in solid modeling. Approach was based essentially on pulling in other words rotating of the contours modeled in 2D. Holes in other words removals were done with the assistance of readings bodies, essentially based on the laws of Boolean operations. Commands like Hole and Pocket at the time of this release did not exist in this product there. This environment did not have the history of the product tree, so that the sequence of the steps of the formation was known only to the creator of the model. Also

parameterization was an unknown concept. A widely great handicap was committed to CATIA processor RISC/6000 IBM and AIX operating system. Teaching took place in two workstations. The examples had been designed to be managed within 90minutes. It was a simple prismatic set of bodies such as a rod, flange, etc. We later simulate the machining process on them and generating the NC program (Fig. 4).

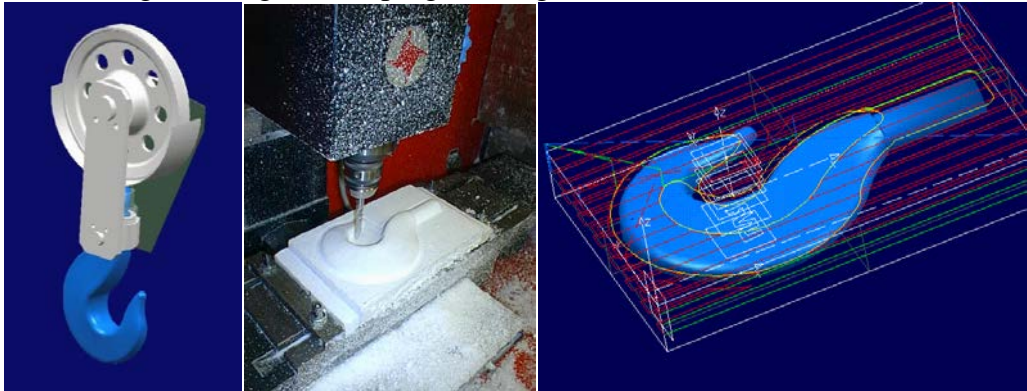


Fig.4 Line up blocks, visualization tool path for machining the hook and rough milling [2]

Completely new situation occurred in the transition to CATIA V5 , for us it was in 2004. This version was running on Windows personal computers which made it more accessible. There were purchased 10 licenses and we started a "mass teaching" of major CADs. The beginnings were difficult. A brand new operating philosophy of CATIA V5, features, tree history of product formation, it was all needed to get used to. Parameterization and tree history enabled faster change of management and consistency with the drawings in real time. The demanding requirements of models grew gradually and the results were reaching higher quality. Students began to use 3D CAD as a tool to assist in constructing other objects (Fig. 5, 6, 13, 14).

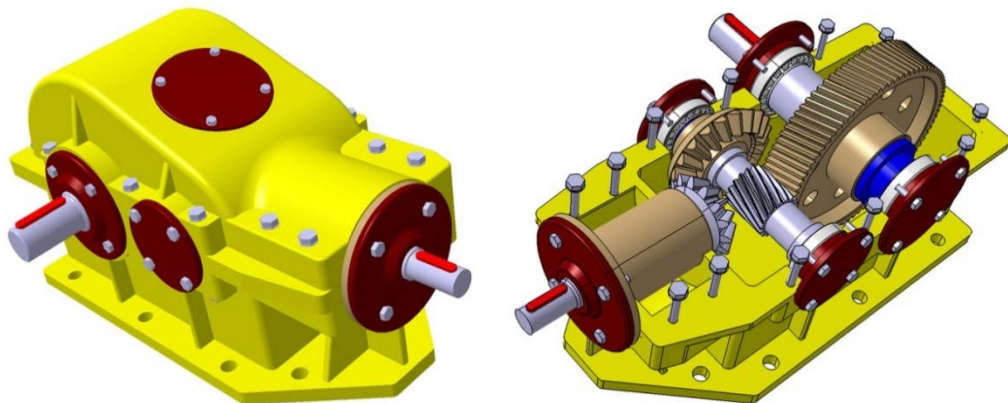


Fig.5 Speed gears [2]

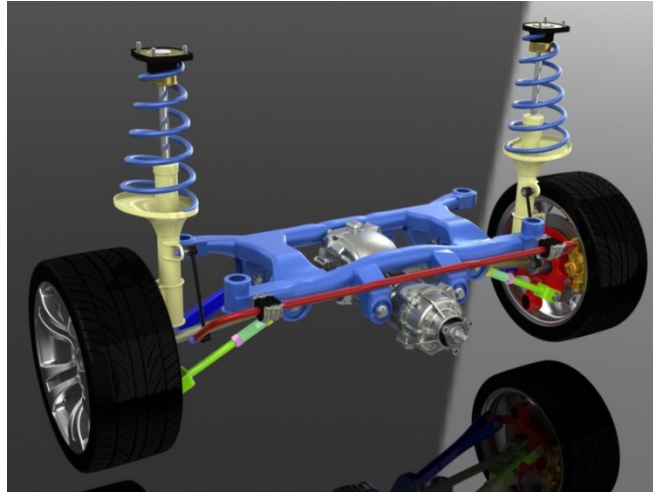


Fig.6 Rear axle assembly model car

Designing practically any shape in CAD system, generate numerical data describing the modeled shape and its subsequent production help of NC technology had opened the door naked shaped surface in the aerospace, automotive and consumer goods industries. Cars had become "rounder", has not only circular lights, but as we see today, each model range of any brand has a shaped reflector. With the development of injection molding technology reflector optics was transferred from the cover glass to the reflecting surface of the reflector and the lens are clear, revealing interesting points inside the reflector. Such connection also had an impact on the design of new cars (Fig. 7, 8).



Fig.7 The difference between the reflector optics on the cover glass with clear cover glass optics with the dish

This was reflected very much on the overall design of the Car. Turn signals are integrated into the reflectors, light continuously follows the fender, hood and front mask. Cars started to be individualized (Fig. 8).



Fig.8 Solutions cross section shape of the front part of the Car

Construction had become very important in this regard, namely „a rounded corner“, which addresses a smooth filling in the space of defined boundaries for areas 3-6 (Fig. 9). One of the fundamental solution is „sharp and blunt rounded corner“. These and other solutions allow to create a surface modeler existing CAD systems (Fig. 9, 10).

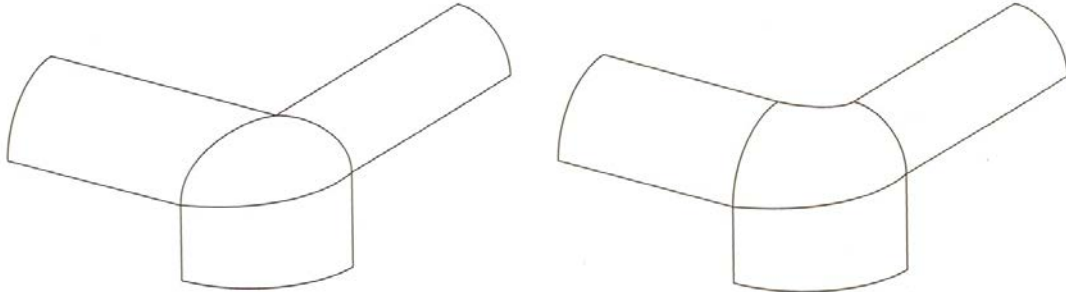


Fig.9 Example 9 "round the corner" [2]

In the contemporary manual of CATIA V4, many structures were described in detail. Example of creating such a surface is vividly documented in the manual of 1997 in Fig. 10

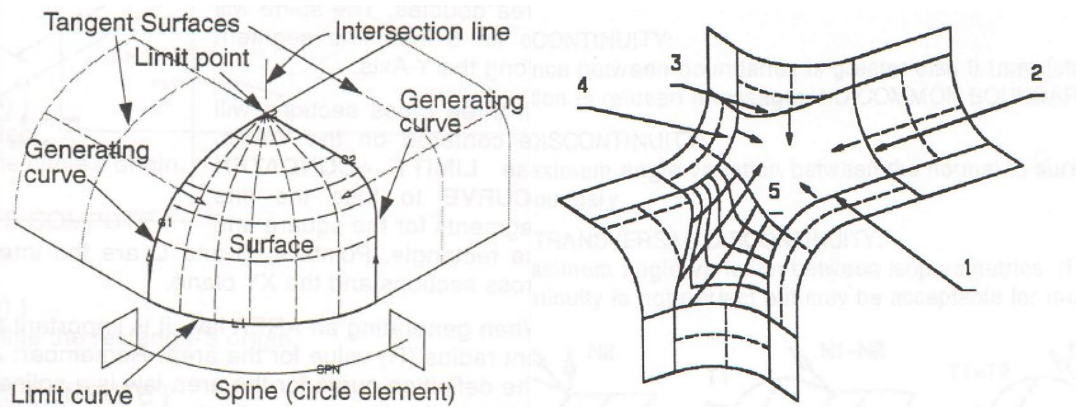


Fig.10 Describes the creation of a round corner in the manual CATIA V4 [2] and fill the surface Fill function [3, 4]

Surface modeler became the prerogative of the Major CAD systems. One of the pioneers of the CATIA and ICEM Surf. CATIA V3 and V4 was at that time an excellent surface modeler definition of areas was difficult and took place in two phases. In the first phase, the general surface of the substrate was established. "Surface" was created by functions Surf 1, respectively Surf 2 and it was then called the final surface. "Face" for assistance functions Limit 2. This philosophy was the creation in detail in manuals, which was very difficult to achieve. The reason was simple. CATIA V3 and V4 could not have been bought by anybody and software was also tied with special training. It should be noted, however, that training had a great level and was documented by the excellent supporting literature. Philosophy formation surfaces - making the underlying "surface" and their final "face" was in training documents processed in image detail. (Fig. 10, 11)

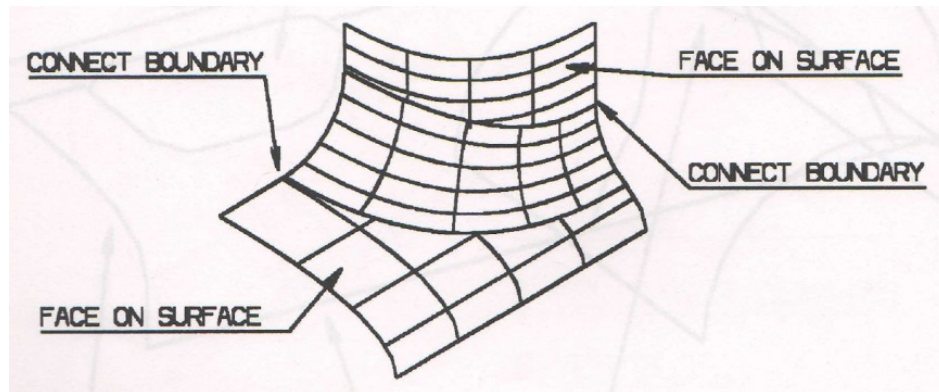


Fig.11 Explanation of the concept of borders, the underlying surfaces and final shape [4]

The work was demanding for precision and attention in establishing boundaries and defining the final layers formed on the substrates. Process of defining surfaces for example the shape of the plastic rudder of the 80's is shown in Fig. 12

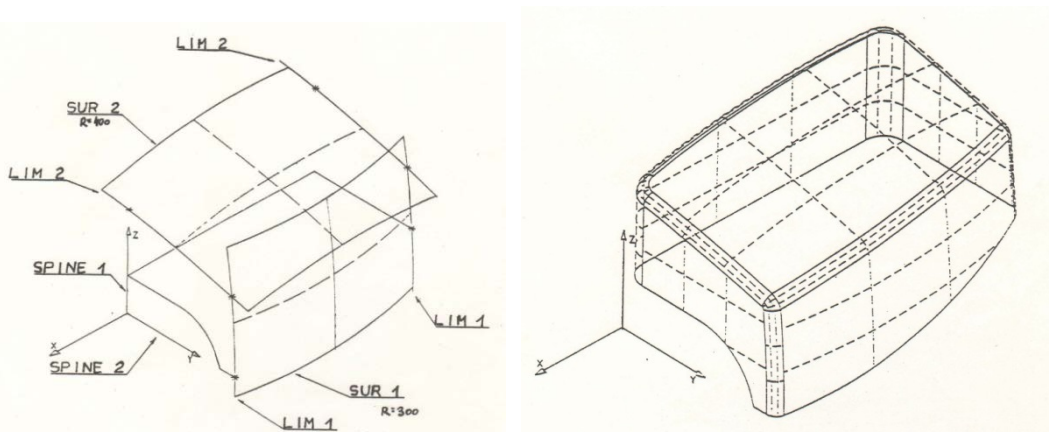


Fig.12 Creating underlying surfaces - surface and final boundary areas - face [5]

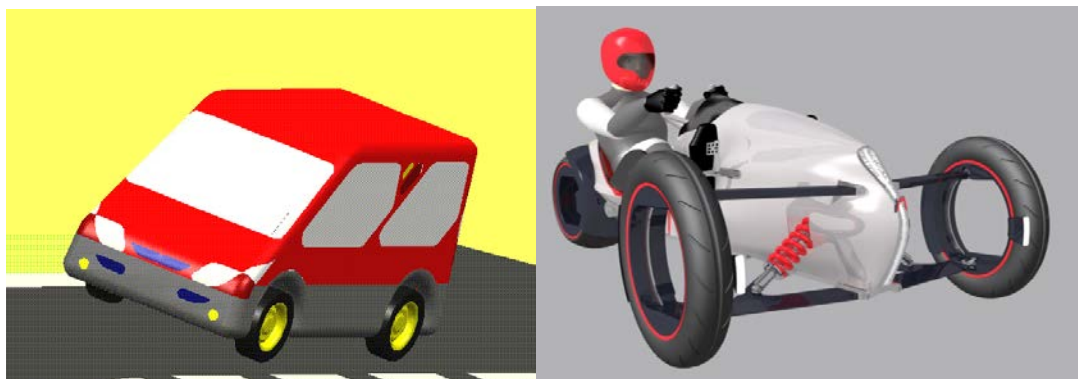


Fig.13 Examples of students' work in surface modelers CATIA V4 and V5 [2]

The onset of modern CAD systems at the turn of the millennium, based on the parametric model definition with tree history-making model (CATIA V5, Pro/E, Autodesk Inventor) brought a new philosophy of modeling. These new capabilities shortened the period of modeling not to mention the ease of incorporation into the change management model. There was no need in creating the underlying surfaces of clipping and laborious final "face" to the underlying "surface". The program is "intuitive" in most cases resolves itself. Teaching the intuitive modeling based on forming "virtual mass" began with growing experience in the

module Imagine & Shape as well as in creating a model based on the template "point cloud" module in Free Style. FIG. 14 shows the process of model building car body on the basis of four 2D views in Imagine & Shape module.

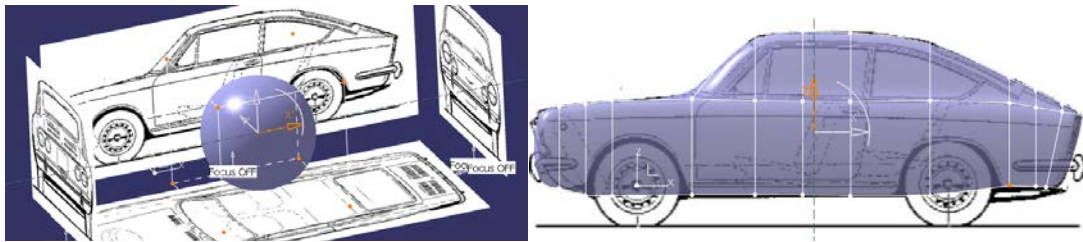


Fig.14 Shaping the virtual mass in the module Imagine & Shape CATIA V5 [2]

4 CONCLUSIONS

The aim of the article was to show the history of the introduction of 3D CAD systems in the engineering sector and automotive industry. There were described modeling tools used in the design process of shapes of automobiles. In early nineties, partially ICEM Surf was used in the development of some parts of Skoda Felicia. Skoda Octavia I. is considered comprehensively to be designed in CAD. Models Fabia I., Octavia II , Superb and Roomster have already been designed in CATIA V4 and ICEM Surf. The final shapes of body and interior parts of Superb II and Yeti have been designed in CATIA V5 and ICEM Surf. Of Course the units were constructed in Pro / ENGINEER (now Creo).

The article was prepared with the support of grant project VEGA 1/0085/12

References

- [1] History of Computer Graphics and 3D Visualization, [cit. 2014-01-08], URL: <<http://www.jrrio.com/en-hist.html>>
- [2] Sjf TU vKošiciach, PaEC, Ukážky prác v systéme CATIA, [cit. 2014-01-08], URL: <<http://sjf.tuke.sk/ci/catia/>>
- [3] One on One with CATIA, Advanced Surface Design (4.1.8), Book 13, Think CAD Bleu 1997.
- [4] CATIA Training Surface Design, Version 4 Release 1, Dassault Systemes, 92150 Suresnes, France, March 1994.
- [5] CATIA V3 – Školení, Ing. P. Kotauczek, spol. s r.o., Technická kancelář Liberec, 1991.
- [6] Stanová, E., Olejníková, T.: Zobrazovacie metódy v deskriptívnej geometrii, Košice: TU, SvF, 2009, 213 s., ISBN 978-80-553-0186-0.
- [7] Fedorko, G., Molnár, V.: Catia základy projektovania,1. Vyd., Košice.: TU, 2006. 105 s., ISBN 80-8073-648-0.
- [8] Daneshjo, N., Olejník, F., Korba, P., Iľaščiková, L.: CAx systémy v leteckom priemysle, Košice: TU, 2011. 253 s. ISBN 978-80-553-0692-6.
- [9] Spišák, E., Slota, J., Tomáš, M., Evin, E., Majerníková, J.:Optical measuring of 3D deformation in sheet metal forming, In: Acta Mechanica Slovaca. Roč. 15, č. 4 (2011), s. 74-80. ISSN 1335-2393.
- [10]Šeminský, J.: Present trends in designing of technical systems, 2014. In: Applied Mechanics and Materials. Vol. 460 (2014), p. 73-80. ISSN 1660-9336.