Virtual Prototyping of a Car System Used for Impact Simulations

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Abstract: This paper presents issues concerning the use of CAD systems in modern technology virtual prototyping, in this case a complex virtual model for a car system used for impact simulations. Virtual prototyping is a process that uses a virtual prototype instead of the physical prototype for testing and evaluating specific elements of the designed product. Virtual prototype is created on the computer closer to the actual characteristics and operating conditions so as to allow the simulation to perform the role for which it was designed. The three-dimensional model has been exported into simulation software able to perform kinematics simulations and finite element analysis, at the same time. With that virtual model were analysed different situations similar with car crash. Results of simulations have been analysed and compared with measurements made on the real models.

Keywords: Virtual prototyping, car system, crash simulation, testing.

1. INTRODUCTION

According to the Traffic Police statistics, the majority of road accidents in Romania in 29% are caused by irregular and unadapted speed to the road conditions.

What a great extent defines the main cause of road accidents in the our country is the improper conduct adopted by a number of traffic participants.

Among the victims (dead and wounded) of road traffic accidents, the first place are car drivers (64%), the second pedestrians (26%), followed by cycling (4%) and carters (1%), McC Mathias (2007); (CEEX nr. X2C36 , 2007).

A crash simulation is a virtual recreation of a destructive crash test of a car using a computer simulation in order to examine the level of safety of the car. Crash simulation are used by researchers during Computer-Aided Engineering (CAE) analysis for crashworthiness in the CAD process of modelling cars. During a crash simulation, the kinetic energy, energy of motion, that a car has before the impact is transformed into deformation energy, mostly by plastic deformation of the car body material, at the end of the impact.

Data obtained from a crash simulation indicate the capability of the car body structure to protect the occupants during a collision against injury. Important results are the deformations of the occupant space and the decelerations felt by them, which must fall below threshold values fixed in legal car safety regulations. To model real crash tests, today's crash simulations include virtual models of crash test dummies and of passive safety devices (www.wikipedia.org.)

2. CRASH SIMULATION

2.1 CAD model of the car system

SolidWorks is a CAD parametrical software specialized for mechanical engineering. The main module was designed for 3D solid part and assembly definition. Also, the parts and the assemblies could be automatically imported into drawing module where the entire drawn documentation can be organized for a mechanical project. In Figure 1 was presented the start window for modules definition.

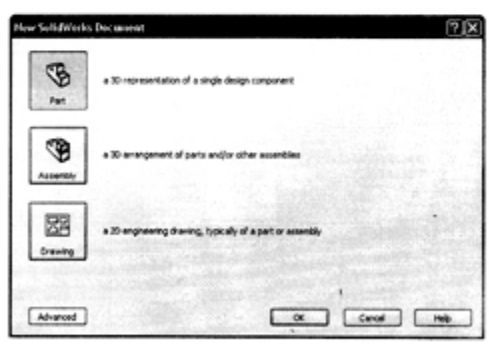


Fig. 1. The start window for modules definition.

First, in the part module can be defined every kind of parts using the primary definition commands (Insert/Base/Extrude) starting with a planar sketches.

At the base model can be attached two kinds of shapes:
- additional shapes (all types of bosses);
- other features like chamfers, fillets and domes.

Also, the same features can be cutting shapes extracted from the body of the part. After several operations was obtained the part models of the components of a car system which were presented in the Figure 2.

Fig. 2. The virtual models for car system parts.

Using the same method can be defined any kind of part. The parts already defined can be united in groups of parts, named assemblies. The assembly module use windows for that operations and the parts are dragged into the assembly window like in the Figure 3.

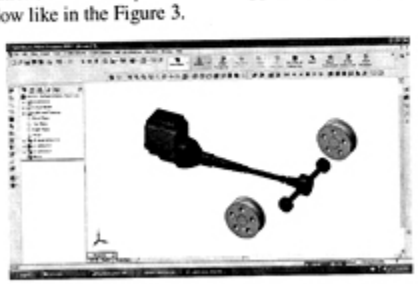


Fig. 3. The assembly window.

After several steps was defined the final model of the car system presented in the Figure 4.

Fig. 4. The final model car system.

2.2 *Crash simulation*

To prepare a crash simulation to the car model was attached a ground part and a virtual tree part (Fig. 5).

Fig. 5. The final model crashes system.

The entire model of the car crash system was exported in analysis software in ACIS format (.sat type). In that software were defined the kinematical joints, material and kinematics parameters. The presented simulation was made for a car velocity of 50km/h, Abedrabbo (2009); Maltese et al (2007).

In the same way were defined all the motor (active) joints of the final assembly. After that operations was started the simulation. First simulation result was the simulation movie. In the Figure 6 were presented some important frames of that movie.

Table 1. Masses of the Dummy components

Dummy part	Mass [kg]
Head	4.54
Neck	1.54
Torso	40.23
Lower arm	1.77
Palm	0.5
Upper leg	5
Lower leg	4.67
Foot	1
Upper arm	2.98

Also, were defined the other initial parameters as the materials of the components, collide and non-collide elements, other mechanical joints, the initial velocity of the car system, the limits of the movement for some parts, the conditions for the friction for the components a.s.o. First result was the movie simulation. In Figure 14 were presented some important frames obtained after the running of the simulation, Fildes et al (1994).

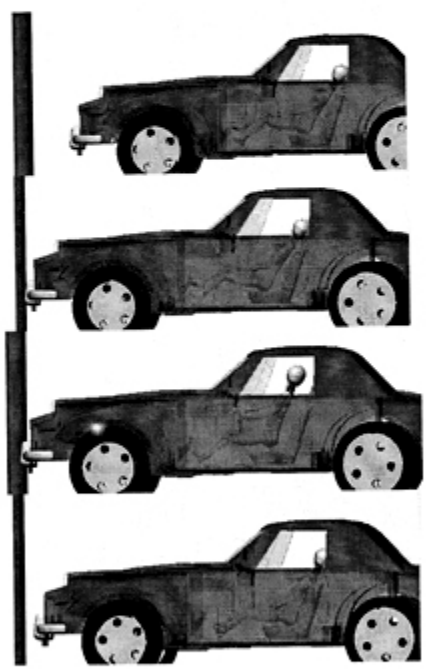
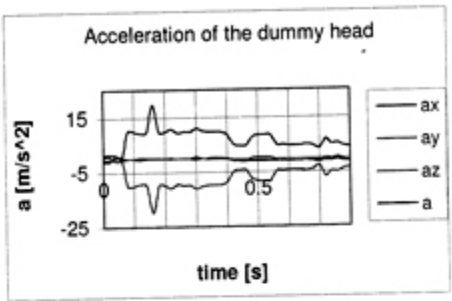
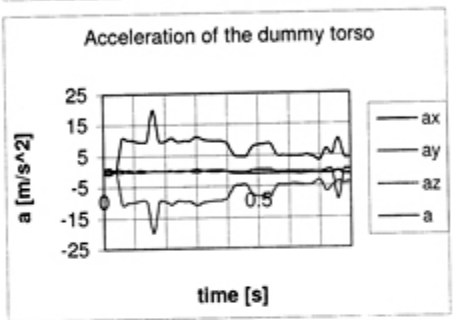
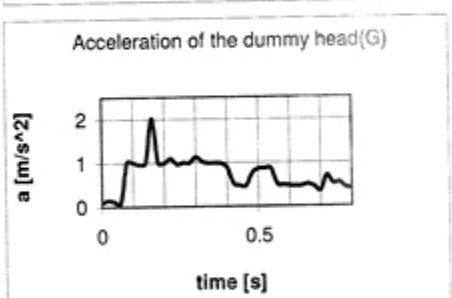


Fig.14. The main frames of the simulation.

Also, can be determined automatically the time variations for any component included in the dummy model for the kinematical or FEA parameters. In Figure 15 were presented four graphical representations for acceleration (Visual Nastran).







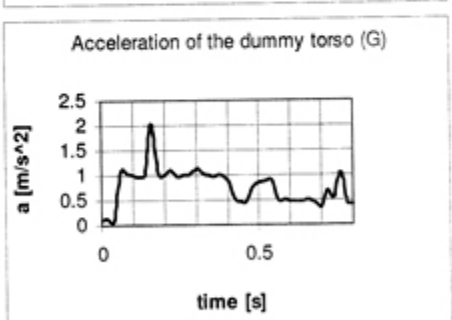


Fig.15. Acceleration of the head and dummy torso.

3. CONCLUSIONS

The paper presents the usable mode based on Solidworks software for complex assemblies representations.