

# INFORMATION TECHNOLOGIES EMPLOYED IN ARMAMENT DESIGN FOR EDUCATION

Delchev L.\*; Beevski A.\*\*; M.Sc. Ing. Antonov S.\*\*\*; Prof. Lilov I.\*\*\*\*

National Military University "Vasil Levski", Artillery, AAD and CIS Faculty,

\*lubodelchev@mail.bg; \*\*beevski@abv.bg; \*\*\*stamantonov@abv.bg;\*\*\*\* inl@abv.bg

**Abstract:** In the report is explored employment of armament design information technologies for education purposes and usage of automation, calculation, design and engineering methods for analysis and testing of armament models in virtual environment.

**Key words:** CAD-CAM-CAE SYSTEMS, MATHCAD, INFORMATIONAL TECHNOLOGIES.

## 1. Introduction

The calculation, design and engineering analysis are complicated processes which is easily processed by the engineering software products "Mathcad" and "SolidWorks"

Mathcad has several mathematical packages available on the software products market, where complex, mathematical tasks are solved quickly, simply and effectively, even in symbolic (analytical) form. Such are Maple, Matlab and others. Mathcad is a class of applications called PSE - a Task Scheduling Environment. This means that its work is not uniquely determined by user actions, such as in text editors, but is largely the result of the operation of in-package algorithms that are inaccessible to the user. The script of the various commands from Mathcad follows the popular command description of "Windows" applications in a way, with the sequence of choosing commands and subcommands being separated by a slash. (fig.1.)

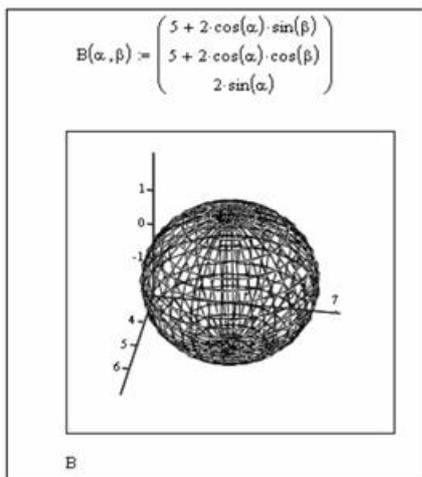


Fig.1. A Mathcad's capabilities

SolidWorks is a 3D CAD-CAM self-contained program for creating three-dimensional details and assembled constructions, allowing direct building and visualization of objects.

The software creates solid-state models. But it can also insert, create and manipulate surface patterns, view patterns in contour shape, and generate 2D-3D drawings.

It also offers an interface for a wide range of simulations and analyzes as well as the possibility of adding additional package extensions for fill simulations, shapes and shaping tools, fluid and kinematic analyzes, electronic components and more (Fig. 2.)

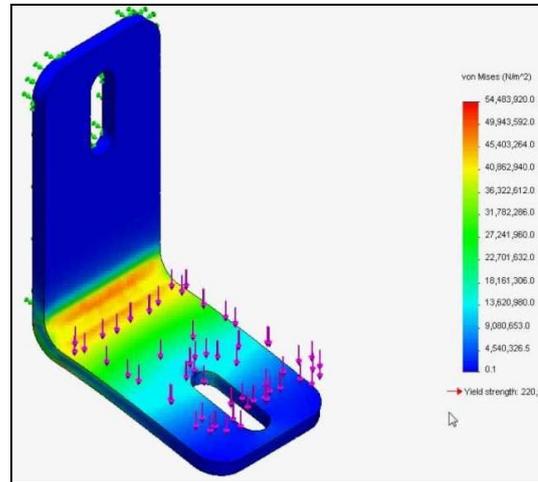


Fig.2. SolidWorks analysis

## 2. Research

The research contains the method of designing which includes calculation, design and 3D modeling of a hydraulic recoil brake and gun elevation mechanism for artillery system 2S1 "Gvozdika" (Self-propelled howitzer) and their analysis.

### 2.1. Calculation

Initially, the program product is prepared to work, fix some basic settings and introduce the main (constant) data in the algorithm. After all of the mathematical calculation about hydraulic recoil brake and gun elevation mechanism, are made. The result of the calculation is the basic data (dimensions, material and structure) necessary for the upcoming processes of design and analysis. (Fig.3)

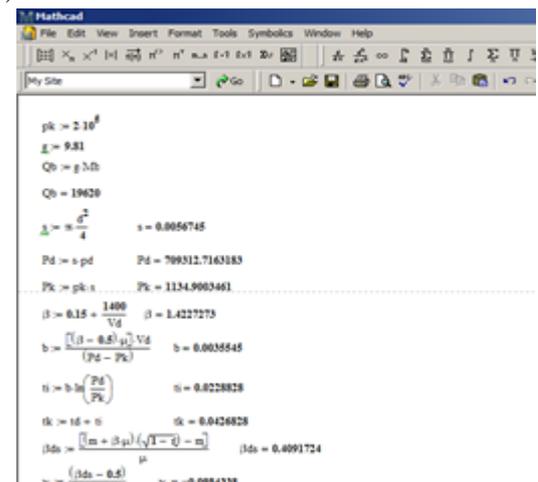


Fig. 3. Example of the basic calculations

### 2.2. Design and 3D modeling

After solving the mathematical algorithm and reaching the values necessary for the modeling of the product, the process continues with making a three-dimensional model. For this purpose, SolidWorks engineering product are used.

The creation of a three-dimensional physical model will help defense engineers to clear up their visualization, defining all types of dimensions.

Due to the fact that a hydraulic recoil brake and gun elevation mechanism consists of many kinds of different parts and elements, it is necessary that each part be created separately and then assembled. The created parts are:

- Hydraulic recoil brake (Fig.4.) – Cylinder; Cylinder cover; internal compensator cylinder; Moderator; Seal; Teflon sleeve; Ram; Brake compensator. (Fig. 5.)

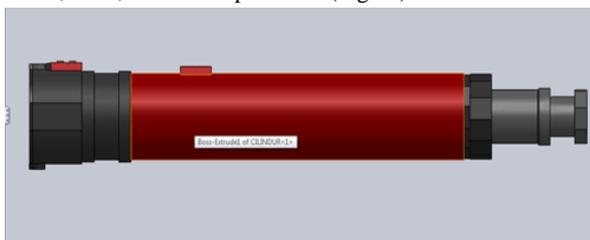


Fig.4. Assembly of the Hydraulic recoil brake

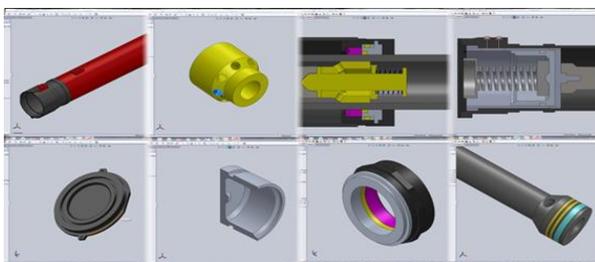


Fig. 5. Separated parts of the recoil brake

- Gun elevation mechanism

Body; Cover; Worm gear; Worm shaft; Shaft; Splines; Spur-wheel; Bearings; Bearing caps; Plugs. (Fig. 6.)

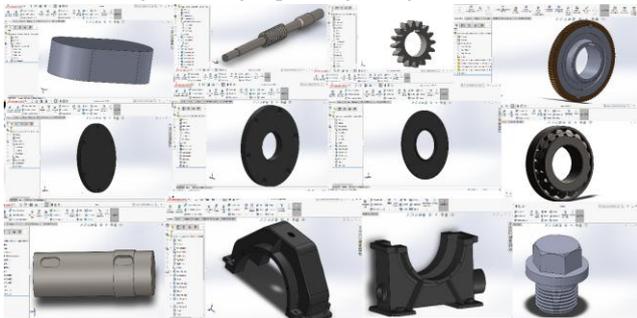


Fig.6. Separated parts of the Gun elevation

### 3. Analysis

The main idea of the analysis is to check the purpose and the work of you future designed details. It replaces the old fashion way of calculating the stress on the details on a sheet with a pen, and improves the quality of the calculated features. The main idea of the simulation is to save time and be an economy factor when it comes to designing parts. In this project the simulation part is concentrated mostly on stress test, pressure test and a motion flow test inside the Cylinder of the Hydraulic recoil brake. The results of the tests in the motion study are concise in the deformation after the force of

the pressure when different constants of pressure are added. Secondly, the gun elevation mechanism is also tested with the SolidWorks features “Simulation analysis expert”. The test there are different than the ones on the Hydraulic recoil brake, because the forces which put pressure on the details are highly concentrated on twisting, bending and applied pressure on the surface of the details. The objects that are tested in the Hydraulic recoil brake analysis are:

- The cylinder with added pressure 200 N/m<sup>2</sup> (Fig.7.)
- The cylinder with added pressure 2000 N/mm<sup>2</sup> (Pa) (Fig.8.)
- The Stem with added pressure 200 N/m<sup>2</sup> (Fig.9.)
- The Stem with added pressure 2000 N/mm<sup>2</sup> (Pa) (Fig.10.)

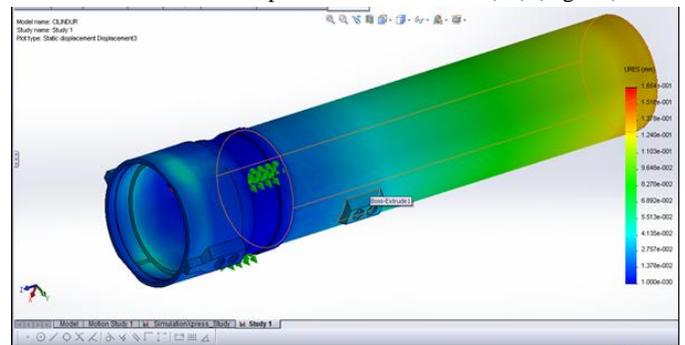


Fig.7 -The cylinder with added pressure 200 N/m<sup>2</sup>

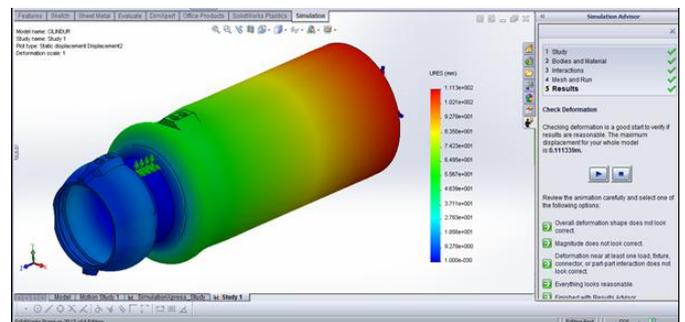


Fig.8 -The cylinder with added pressure 2000 N/mm<sup>2</sup> (Pa)

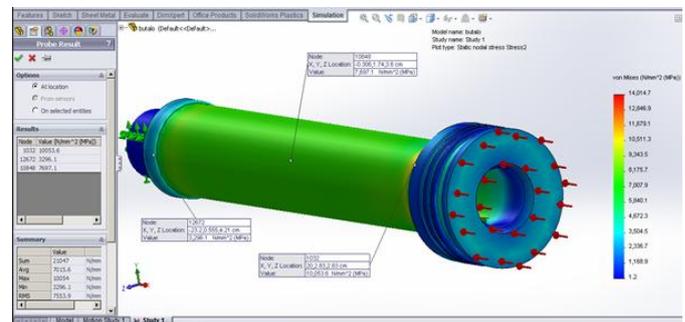


Fig.9.The Stem with added pressure 200 N

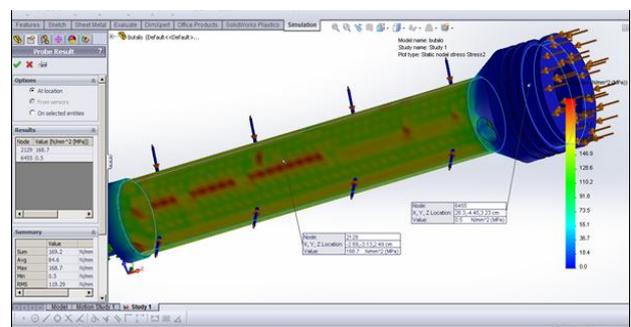


Fig.10. The stem with added pressure 2000 N/mm<sup>2</sup> (Pa)

After the test with pressure, flow simulation test were conducted. The results show the speed of the fluid, the direction of the fluids and the places where friction is expected.

Furthermore, a motion study was conducted to see how the fluids move inside the Hydraulic recoil absorber and to observe the effectiveness of it by animation study. By using the same methods the parts of the Gun elevation mechanism were also tested by applying forces with their direction and size on the different objects of the mechanism. The parts which were tested are:

- The Worm shaft by applying the forces  
 $P_{t1} = 322,2681\text{N}$ ;  $P_{a1} = 606,8356\text{N}$ ;  
 $P_{r1} = 220,8701\text{N}$ . (Fig. 13)

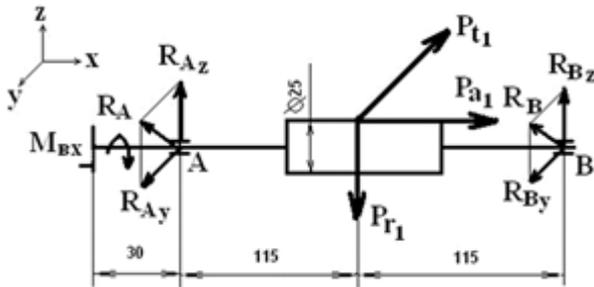


Fig.11. The forces acting on the worm shaft and their directions.

- The Shaft with worm gear and spur-wheel  
 $P_{t2} = 606,8356\text{N}$ ;  $P_{r2} = 202,8701\text{N}$ ;  $P_{a2} = 322,2681\text{N}$ ;  
 $P_{t3} = 98100\text{ N}$ ;  $P_{r3} = 35705,48\text{N}$ . (Fig. 14.)

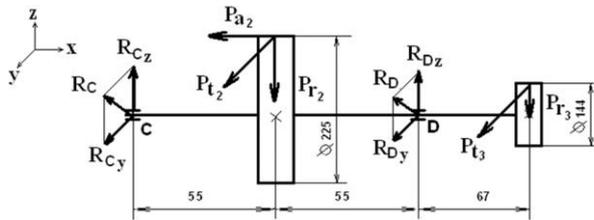


Fig.12 The forces acting on the shaft and their directions.

In figure 15 are shown the tests on the part of the Gun elevation mechanism. The tests show the deformation of the bodies when the forces, explained above, are added also, the weakest spots in the body of the object with constants.

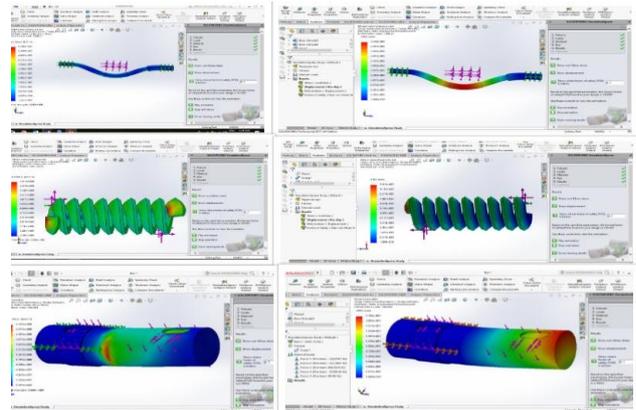


Fig.13. Analysis on the parts of the Gun elevation mechanism

### 4. Conclusion

The programs for mathematical calculations, design and analysis are making the education method more effective, faster and easier. Furthermore, for the armament specialists working process those programs are a great economy of deadlines, money and efforts. By using those programs the mistakes are less and the analysis are more accurate. They are also very helpful when it comes to educate cadets in armament design.