# THE USE OF COMPUTERS IN SCIENTIFIC RESEARCH

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The use of computers in research is a prerequisite for the study of complex systems. The traditional methodology of the theory-experiment relationship must be complemented by the principles of computer simulation. This new effective procedure enables a holistic study of the behavior of the most complex systems, both natural and designed to test theoretical hypotheses.

The use of computer models transforms the computer into a universal experimental setup. In a computer experiment, complete control over all system parameters is ensured. A computer experiment is cheap and safe. With the help of a computer it is possible to perform "fundamentally impossible" experiments.

The essence of computer modelling is to obtain quantitative and qualitative results on an existing model. The qualitative conclusions obtained from the results of the analysis allow us to identify previously unknown properties of a complex system: its structure, dynamics of development, stability, integrity, etc. quantitative conclusions are mainly of the nature of forecasting some future or explaining the past values of the variables that characterize the system.

The physical processes that characterize the stress-strain state of solids, motion and heat transfer of a fluid are modelled by the SolidWorks (SW) Solid State Parametric Modelling System [1], or more precisely, by its applications: SW Simulation, SW Floxpress, SW Motion [2]. These applications use a geometric part model or SW assembly to form a design model.

Integration with SW makes it possible to minimize operations related to the specific features of finite element approximation. The boundary conditions are assigned in conjunction with the geometric model. Procedures for presenting the

results have the same peculiarities.

SW applications do the following:

- applied uniform or non-uniform pressures in any direction, forces with variable distribution, gravitational and centrifugal loads, support and distance forces;

- not only isotropic but also orthotropic and anisotropic materials are assigned;

- the effect of temperatures on different parts of the part is applied (conditions of heat exchange: temperature, convection, radiation, thermal power and heat flow; the temperature profile available in the calculation of temperatures is automatically read and thermal stress analysis is carried out);

- there is an optimal solution that meets the constraints of geometry and behavior; if the assumptions of linear static analysis are not applicable, apply a nonlinear analysis;

- fatigue analysis evaluates the effect of cyclic loads in the model, determines fatigue events with constant and variable amplitude;

- in the analysis of the impact test the dynamic problem is solved (a plot is created and a graph of the model response in the form of time dependence is constructed);

- results of frequency and longitudinal bending, thermal and nonlinear loads, impact tests and fatigue analysis are processed;

- plots of longitudinal forces, deformations, displacements, results for reaction forces, forms of loss of stability, resonant forms of oscillations, results of temperature distribution, temperature gradients and heat flux are constructed;

- analyses of contacts in friction assemblies, tension or hot landings, thermal contact resistance analyses are carried out.

By changing some of the input parameters in numerical modelling, you can track the changes that occur with the model. The main advantage of the method is that it allows not only to observe, but also to predict the result of the experiment under some special conditions.

The method of numerical modelling of car parts (investigated camshafts and crankshafts, pistons, axles and rockers of engines; shaft gears and gear wheels of

transmission, oil pumps, differentials; bipod steering; forks and crossings of cardan gears; trunnions of rotary joints; etc.) has the following advantages over other traditional methods:

- gives the opportunity to simulate the effects, the study of which in real conditions is impossible or very difficult for technological reasons;

- allows you to simulate and study the phenomena predicted by any theories;

- is environmentally friendly and does not pose a danger to nature and man;

- provides clarity and is easy to use.

But to make technically competent decisions, it is necessary to be able to correctly perceive and understand the results of calculations. Purposeful search through a series of tests of the optimal or rational solution in the design tasks is much more interesting and instructive for the future engineer than obtaining only one optimal project that cannot be improved and nothing to compare with.

With a large number of project variants, the analysis of machine calculations using the SW Utilities application reveals the basic patterns of change of project characteristics from varied design variables (the difference between the original detail and the corrected version of the same detail) and contributes to the quick and deep study of the properties of design objects.

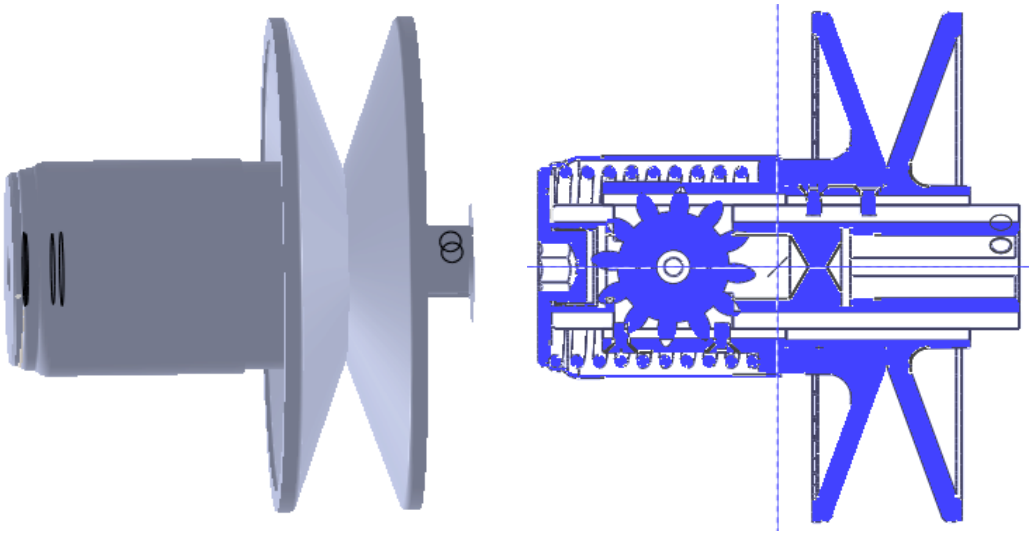
When designing and using computer simulation systems, a modern engineer must have the skills to work with computer systems, be able to develop mathematical models of forming the parameters of strength estimation of parts. The introduction of numerical calculation methods not only improves the level of computerization of engineering work, but also allows you to make optimal decisions.

Consider the method of static study of the details of the V-belt variator at an early stage of design:

- SolidWorks created a solid-state model of the V-belt variator (fig. 1);

- in SW Simulation a gear is selected for static calculation; Attachments and external loads were applied to the model, a grid of finite elements was constructed, and components of the stress-strain state were determined (fig. 2). The results obtained confirm the relevance of the study in determining the limiting capabilities of

the gear (minimum strength factor n = 18,46).



a b

**Fig. 1. Solid-state model of the V-belt variator: appearance (a) and section (b)**

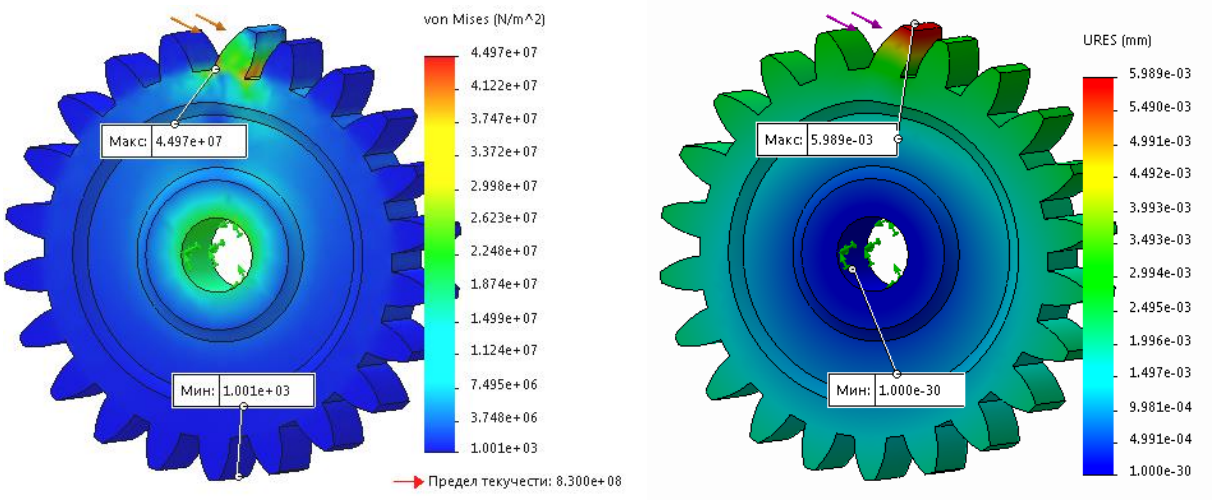



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**Fig. 2. Equivalent stress distribution for the 4th hypothesis (a), total displacement field for 3D model (b)**

For the purpose of detailed analysis of the possibility of modelling the design of the variator for the given technical conditions of its operation, it is necessary to further check the operability of all its details.

## References

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