# APPLICATION OF EXPERT SYSTEMS ANSYS AND ADAMS IN OPTIMISATION OF MECHANISMS WITH ELASTIC MEMBERS

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***Summary:*** *The aim of this paper is to present possibilities in optimisation of mechanisms by means of expert computation systems ANSYS and ADAMS, considering flexibility of its members. The paper also includes some of the outputs of simulation analyses realised on the models of distribution systems of combustion engines, in balancing of combustion engines and in the range of frequency optimisation during development and design of high-speed machines.*

## 1. INTRODUCTION

The intention to work with more realistic and sophisticated ideas concerning behaviour of existing constructions or constructions being designed at service loadings (usually dynamical) resulted in the decision of the company LENAM, s.r.o. to enlarge its existing SW equipment (FEM – ANSYS, MARC, PATRAN) by another multi-disciplinary computation SW system - ADAMS. The combination of SW tools ANSYS-ADAMS has been used in several projects for an analysis and optimisation of construction arrangement of system of bodies – mechanisms. The aim of the paper is to indicate and discuss present possibilities offered by the above stated combination of SW tools in the field of mechanical engineering.

## 2. OUTLINE OF METHODOLOGY OF APPLICATION OF SW TOOLS ANSYS AND ADAMS

ANSYS is a SW product for solving physical problems through the Finite Element Method (FEM). ADAMS is a SW product, applied among others for static, kinematic and dynamic analysis of mechanisms, usually with solid members, but it also enables to calculate generally with non-solid links between the members or between a mechanism and its surroundings. However, with a recently implemented modulus ADAMS/FLEX, the system ADAMS makes possible to find solutions of mechanisms with flexible members by means of a method of modal synthesis. The condition is, though, that flexibility of such bodies in the data files communicating with the ADAMS environment was presented in a previously prepared form. „Modal neutral file“ („MNF“) has been chosen as such a form, which results from several previously realised analyses in FEM and contains information about geometry, weight characteristics and modal shapes of a flexible body. When using ANSYS, „MNF“ is generated directly, after the analyses in the following order: modal analysis, reduction of FEM object to a super-element and spectral analysis. However, flexibility of the corresponding object/member of the mechanism has to be considered in the frequency range, i.e. the user has to be aware of what frequency range the system/mechanism should respect.

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## 3. CHARACTERISTICS OF SOLVED PROBLEMS

### Distribution mechanisms of combustion engines

To study behaviour of distribution systems OHV and OHC, and thus to reveal parts limiting the function of the distribution system, FEM models and models in the system ADAMS/FLEX have been created. By means of these models it is possible to

- predict kinematic quantities, for example, these of a valve,
- identify loading and stresses of individual parts of the distribution systems,
- optimise their weight, dimensional, and consequently strength characteristics
- use the models for quicker and cheaper testing of various cam curves as early as in the stage of prototype creation.

A comparison with later realised experiments, focused on identifying valve kinematics (lift, speed, acceleration), proved a satisfactory agreement both in the range of absolute maxims of measured quantities, and in the range of relevant frequencies, see fig. 1- 4.

### Simulation of the combustion engine set

The parameters, influencing equipoise of the engine-set of a combustion engines, suspended in the vehicle body, are verified by means of simulation analyses in the system ADAMS/FLEX environment. The evaluations of the observed physical quantities at various service regimes (particularly in the frequency range), including relevant flexibility of members of a crank mechanism and combustion pressures, contribute preciously to the knowledge of mechanical response of this complicated 3-D mechanism.

### Optimisation of construction arrangement of high-speed machines

Designers often encounter problems of unexpected vibrations in service ranges of machines, whose parts rotate at speeds of order of several thousands rpm. The above-mentioned methodology of simulation analyses allows not only to predict these problems, but also to minimise them through a suitable construction arrangement of the system, or to reveal their causes and thus to avoid them. Combination of SW ANSYS and ADAMS helped to optimise arrangement of bearing links of a drum winder, which is an important part of technological fibre processing, see fig. 5-6.

## 4. CONCLUSION

Potential, offered by multi-discipline expert SW tools such as ANSYS and ADAMS for studying and understanding dynamical responses of mechanical systems, offers to users new qualities and efficiency, especially in cases when it is time-spending, costly or impossible to study complicated dynamical responses through physical experiments. Nevertheless, authors' experience shows that the results of simulation analyses should be confronted step-by-step with a sane engineering conception and verified by a suitable physical experiment, when necessary.

## 5. LITERATURE

[1] Archive of technical reports of the company LENAM, s.r.o.
[2] Dokumentation of SW products ADAMS, Mechanical Dynamics, Inc.

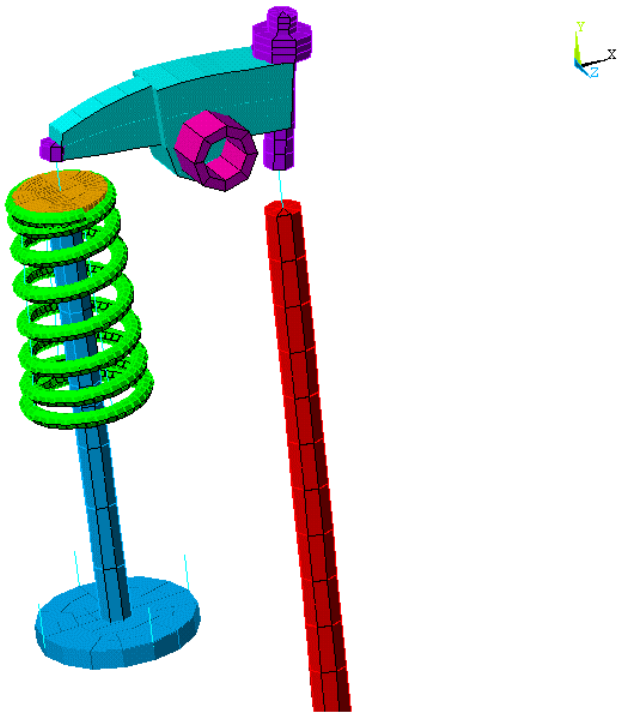

Fig. 1  FEM model of the OHV distribution system

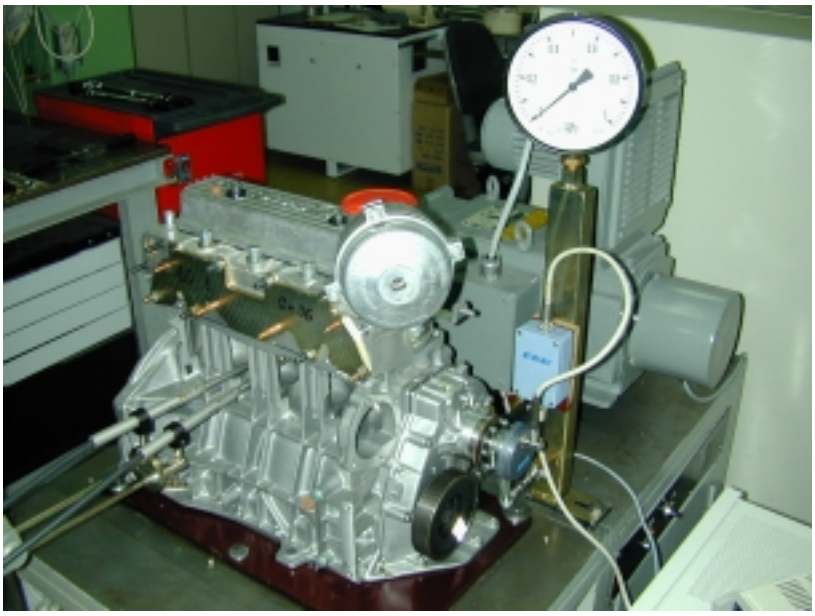

Fig. 2  Arrangement of experimental measurement of valve kinematics

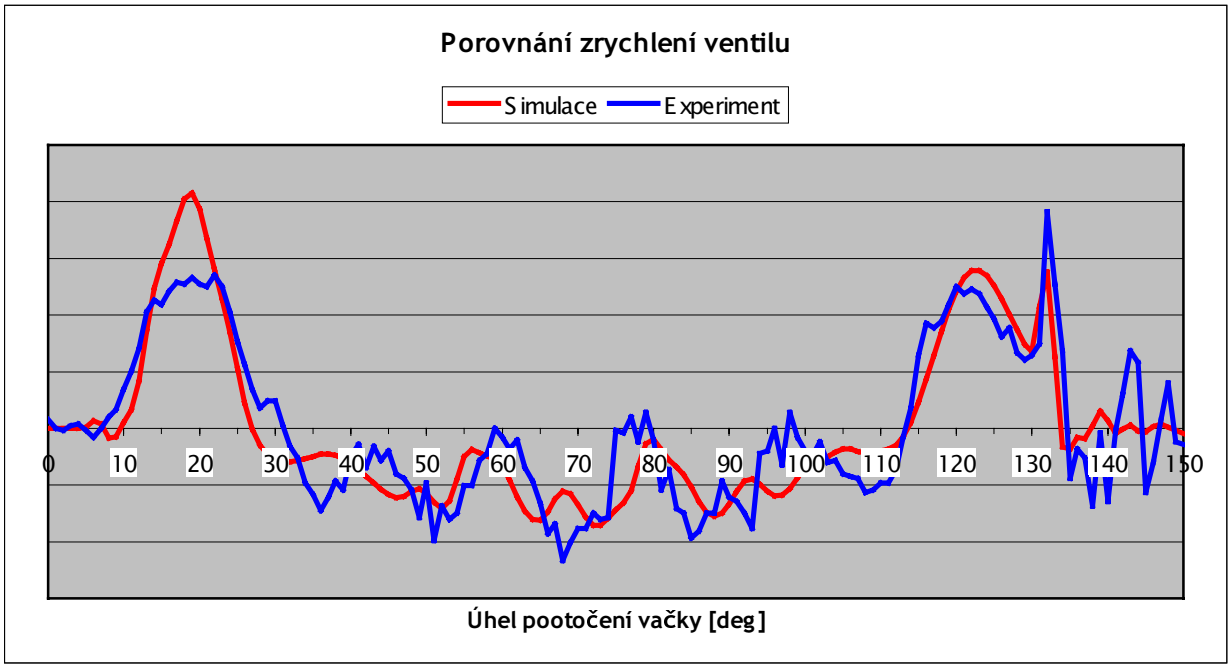


Fig. 3 Valve acceleration – comparison of physical experiment and simulation

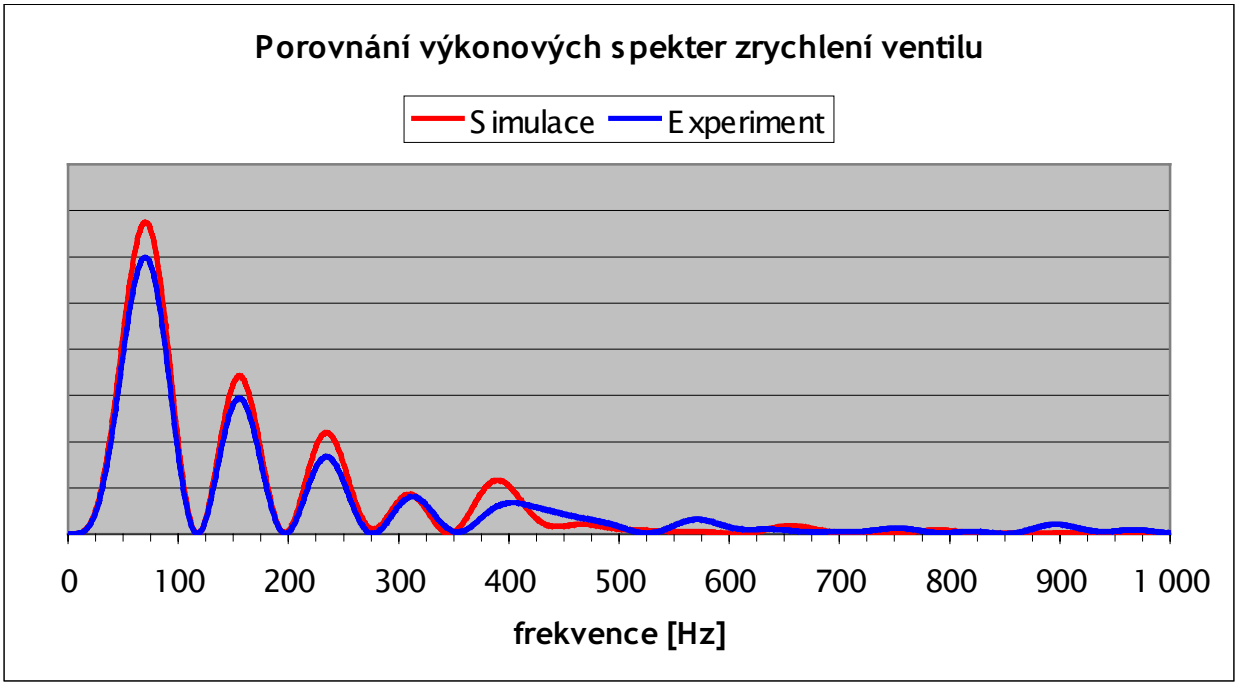


Fig. 4 Axial force in a pushrod – comparison of physical experiment and simulation

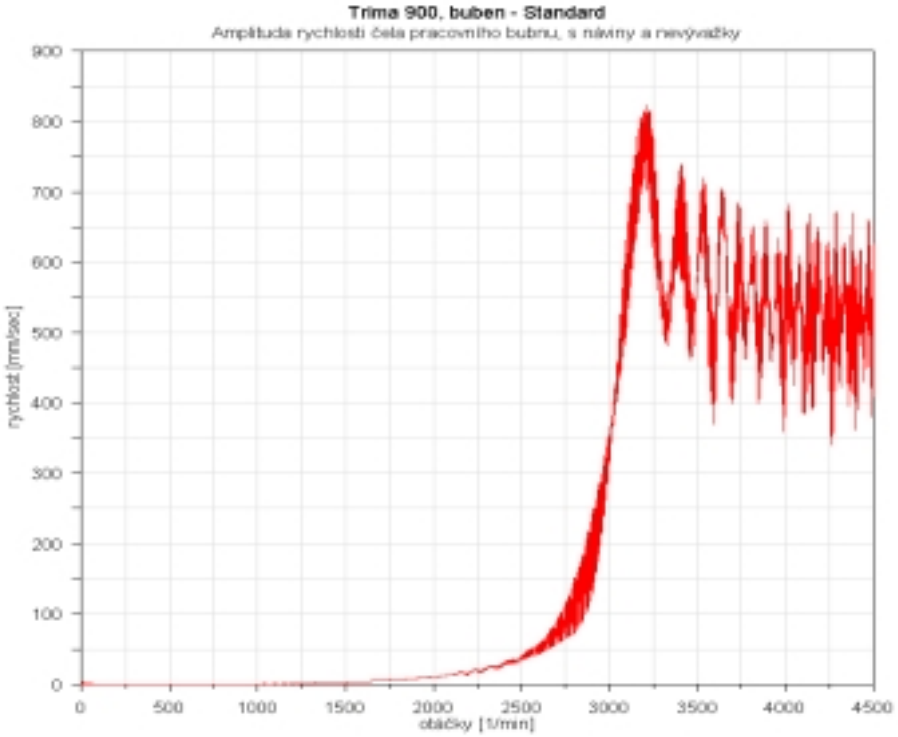


Fig. 5 Original situation – working speed range 2500-4000 1/min

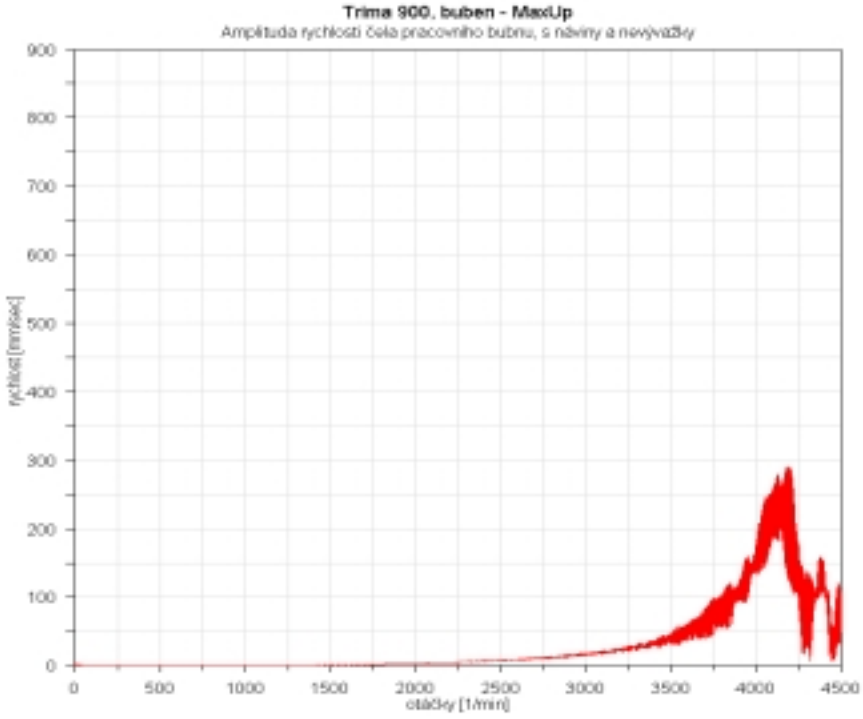


Fig. 6 State of vibrations after optimisation of bearing arrangement