Animated Physical Principles of Mechanical Engineering

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Abstract

Mechanical engineering is based on principles of physics and material science. When designing, manufacturing and operating machines, there are many processes of energy transformation, action of different forces, occurrence of various forms of movement, shape and dimension changes and material properties or state of matter. These phenomenons, often very complicated, can be explained and illustrated by means of video recordings. Authors of this paper use these multimedia products when teaching in the course **Fundamentals of Mechanical Engineering.**

Key words: *mechanical engineering, physics, animation, didactics*

Introduction

At faculties of mechanical engineering, not only classical physics but also a number of related subjects are presented, e.g. technical mechanics, mechanics, statics, kinematics, dynamics, strength-elasticity, hydromechanics, thermomechanics etc. The inclusion of these subjects into syllabi demonstrates that the mechanical engineering is based on physics. At the Mendel university in Brno, the course Principles of mechanical engineering is presented to students of bachelor degree, specialisation Waste Management. This specialisation is of biological and chemical character and for that reason the authors decided to develop a multimedia teaching programme.

Material and methods

The multimedia teaching programme Fundamentals of Mechanical Engineering was developed on the base of the Adobe Flash software, which was supplemented with sound, 3D animation and video records.

Results and Discussion

The multimedia teaching programme Fundamentals of Mechanical Engineering contains tens of animations enabling to explain physical principles of this discipline. The following several examples can give you an idea about the conception of this product.

In waste management, heating and cooling engines are rather important. The animation of a heat engine with the maximum efficiency is presented in Fig. 1. In the Carnot engine, the piston moves forwards and backwards and this movement is transformed to rotation by means of a crank mechanism. The crank shaft is coupled with a flywheel, which enables the course of compression *(in reality, the status changes take place very slowly – the flywheel would not rev up).* The engine drives the working machine *(in this case the centrifugal pump)* and this assures the output consumption.

In Fig. 2 the biker drives up a slight slope with the constant speed. Students should determine the gear ratio, angle and peripheral velocity of the chain ring and rear wheel, moment of forces on the crank arm and the rear wheel, motive power of the chain, driving force on the wheel perimeter and the biker's output. Calculated values are entered into corresponding boxes and the correctness of results is checked with a movable magnifier.

Each machine consists of parts that perform linear, rotary and/or general types of movement.. In the task presented in Fig. 3 students should determine mass, model of inertia, angular velocity and kinetic energy of rotating cylinders. Calculated values are again entered into the table and checked with a movable magnifier.

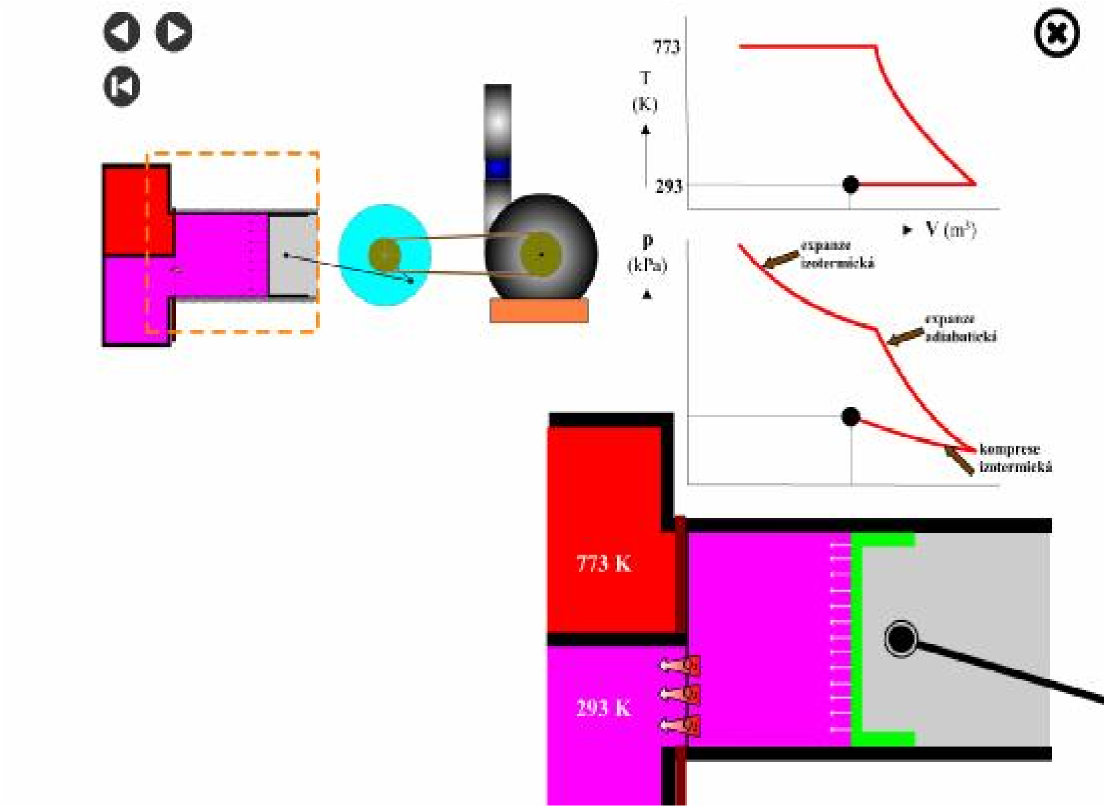

Figure 1 Direct Carnot cycle

Figure 2 Bicycle

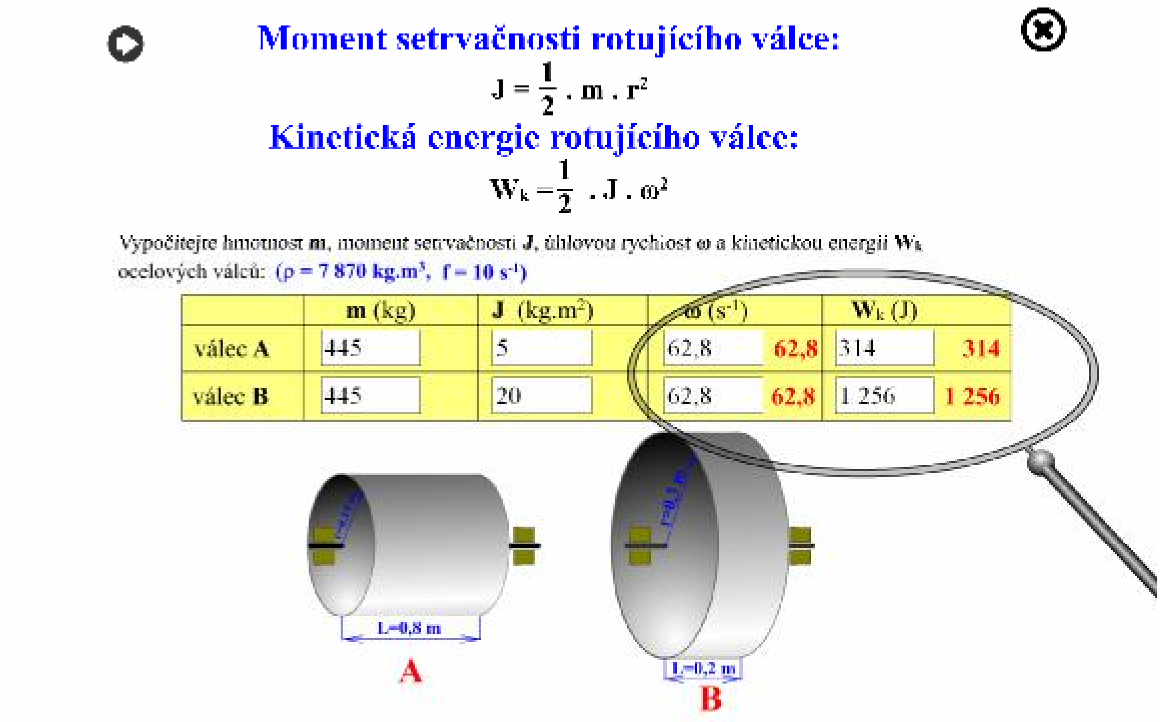

Figure 3 Flywheels

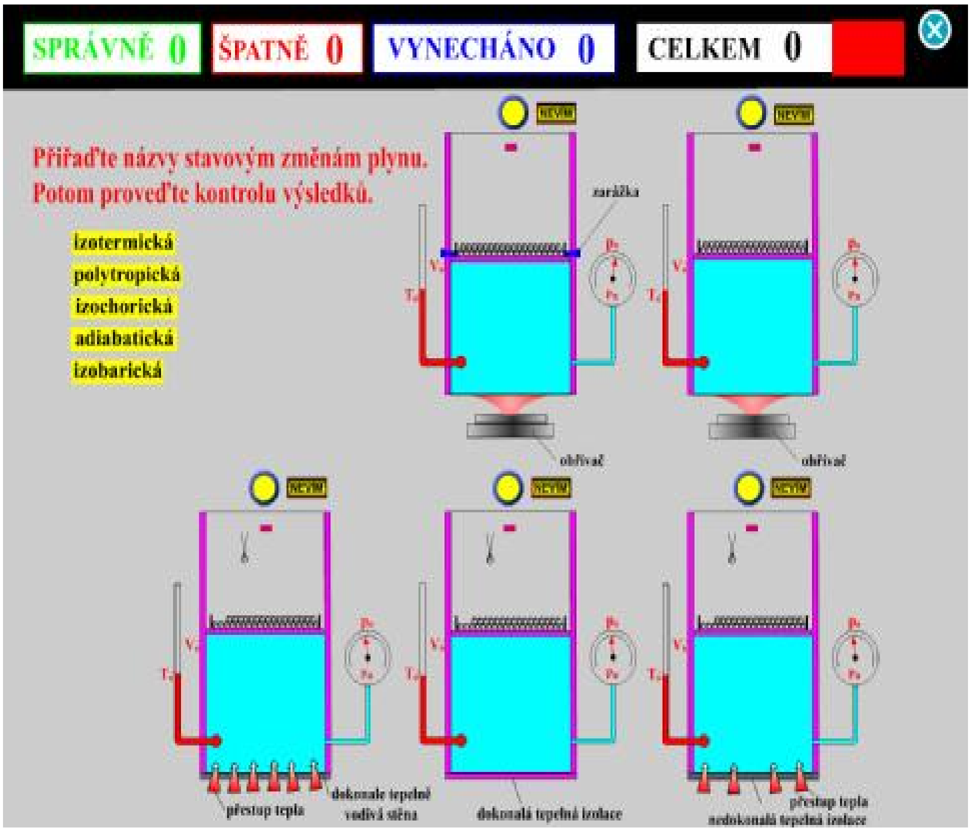

Figure 4 Basic status changes of an ideal gas

The teaching programme Fundamentals of mechanical engineering involves also sine didactic tests that can be used not only for examination of students but also for their direct teaching. Basic status changes of an ideal gas that are illustrated in Fig. 4 run simultaneously and for that reason it is possible to highlight their common and different features. It is also suitable to select a concrete status change and to magnify it (*using the function Zoom In*). Using this detail, it is possible to illustrate clearly and comprehensibly changes taking place in temperature, pressure, volume, latent (internal) energy,volume work, and/or heat input and output.

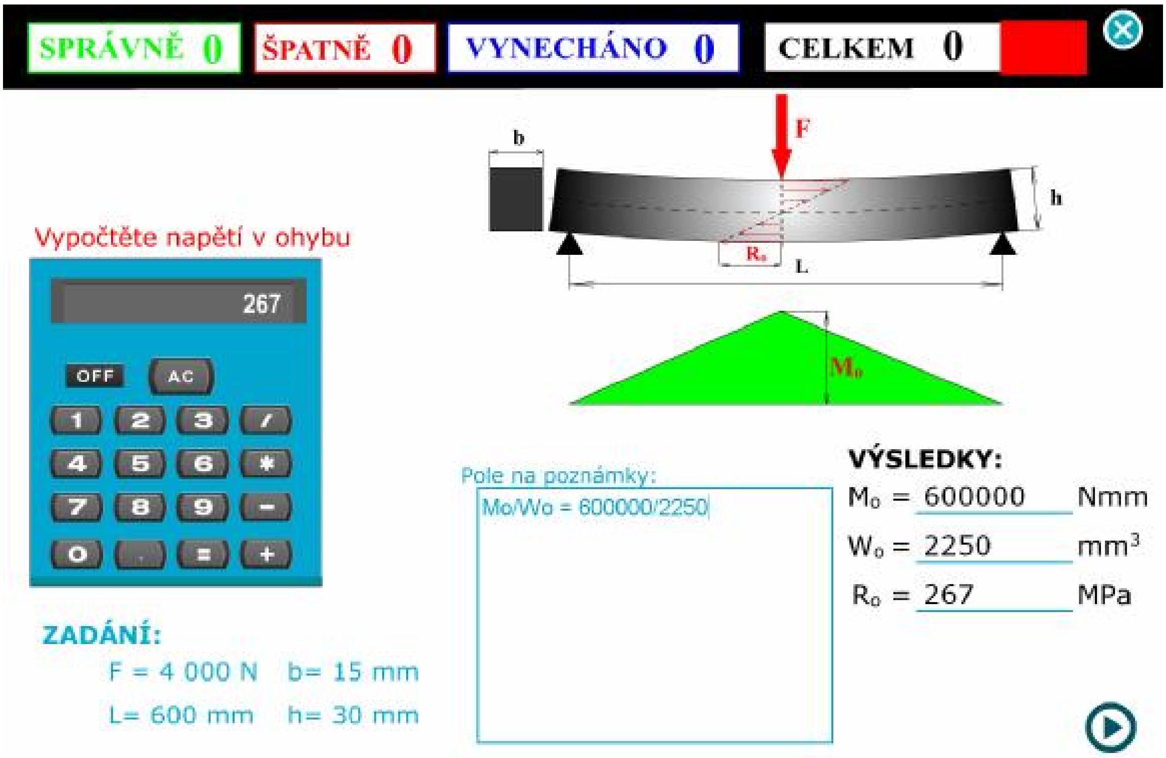

Figure 5 Single bend test

In a single bend test (Fig. 5) the load strength, tensile stress, compressive stress and the bending moment in the beam cross-section normally increase. Using ordered values, students should use the in build calculator and determine the final bending moment, module of bend cross section and tension in the utmost filament.

Conclusions

Basing on several years of experiences with the development and application of interactive animations we came to the conclusion that it is possible to explain the physical principles also to students of other specialisations than of mechanical engineering. however, the development of these didactic tools is demanding and time-consuming. The authors of such programmes must be well educated not only professionally but also pedagogically and they must be also able to apply the animation software.

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