Training Tool: Workshops on Basics of Constructing

Ivan Kolarov

Department of Machine Elements, Material Science and Chemistry, Higher School of Transport, Geo Milev Str. N 158,1574 Sofia, Bulgaria, e-mail: ikolarov@vtu.bg

Keywords: Computer registration, mechanical parameters

ABSTRACT

The main aim of this training tool (WORKSHOPS ON BASIC OF CONSTRUCTING) is to present an innovative approach in terms of quality assurance in technology education on workshop by ICT according to the general objectives of MODULARTE pilot project. The training tool is developed in machine investigation fields by integrating variety ICT in didactics used at the Higher School of Transport. For this aim a tool for workshops on Basic of Machine Constructing has been made.
Computer registration of physical and mechanical quantities gives a lot of opportunities of machine elements and mechanisms research. The advantages of well-organized computer laboratory both technical and methodological, namely: Registration and on-line observation of a number of processes with random speed; replacement of high-cost specialized laboratory equipment; mathematical data processing; solving educational problems by modern technologies; dealing both with machine objects and ICT by oneself.
The approach presented can be applied in other field of technology teaching.

1. INTRODUCTION

The main aim of this training tool (WORKSHOPS ON BASIC OF CONSTRUCTING) is to present an innovative approach in terms of quality assurance in technology education on workshop by ICT according to the general objectives of MODULARTE pilot project. Nowadays ICT is an innovative approach for developing technology training by relevant using the most applicable didactics technologies like text, graphics, photos, videos and as well as by flexible opportunities for information spreading, updating and joining variety of software. Internet technologies and computer measurements are integrated in this training tool. The main accent of every workshop is opportunities students to be able to observe the nature experiments, and here this is based on computer measurements.

The physical and mechanical parameters such as force (moment), linear and angular deformation and speed are typical parameters to be examined in the laboratory of Machine Elements. Their experimental determination gives important information about the serviceability, technical state and properties of machine elements and mechanisms.

The classic examination on machine elements and mechanisms is done on stands, specially designed for that purpose and creating conditions of object operation that are close to the real ones. One, two or more parameters are examined at one and the same time. The registration of results is done most often by mechanical, electromechanical, electro-pneumatic devices, etc. To

obtain complete information about the processes studied, electronic devices for registering rapid processes and mathematical data-processing have been produced in industry. The latter are with high prices and are specialized for a limited number of operations.

Teaching in a contemporary laboratory has to combine classic models of general engineering subjects with fast-developing measuring equipment including the application of computers. The usage of universal computer equipment and software for registering and mathematical processing of electrical quantities obtained from the stands for different topics is quite appropriate under the conditions of a school laboratory.

The purpose of the paper is to present the experience of the Higher School of Transport in implementation of universal computer system for registration of physical and mechanical quantities. For this aim a tool for workshops on Basic of Machine Constructing has been made. It consists of 11 workshops and supplied with additional information.

2. METHODS

All methods for the workshops on Basic of Constructing are based on combining real stands with computer measurements and virtual presentation of real experiment. The virtual presentation is based on real experiments, video clips and photo and students can use them for self-independent learning for the workshops purpose.

A wide range of topics including almost the whole set of machine elements and mechanisms in practice are studied at that laboratory. The base of each examination is measuring characteristic parameters for determining the functional fitness. The parameters searched often changed their values dynamically. Where the natural processes can be described by theoretical models, the models are presented, so students should calculate the results and to compare to experiments. For this aim a mathematical modules are applied (in Excel format) and students can determine deviation. It helps students to understand that the theoretical models existing in mechanics reflect the reality which has a great impact on their whole engineering education. But to realize these activities it is necessary to have precise measuring equipment allowing true registering of rapid processes.

To carry out laboratory workshops in Basic of Constructing a computer system is used. It consists of a universal interface with software and a computer. The system is integrated within the school equipment by implementing a diagram shown in Fig. 1.

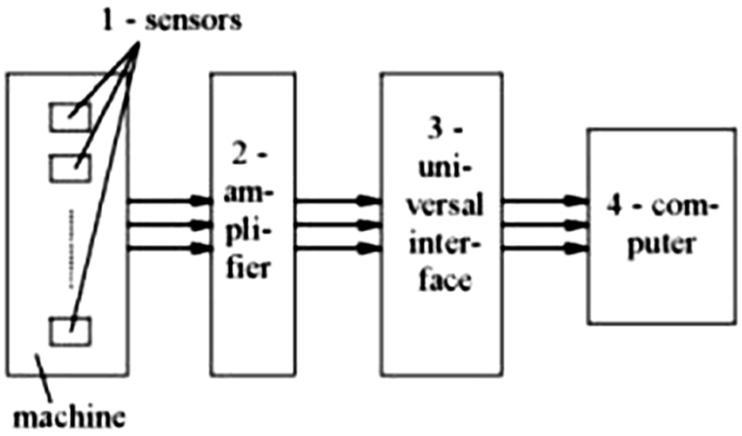
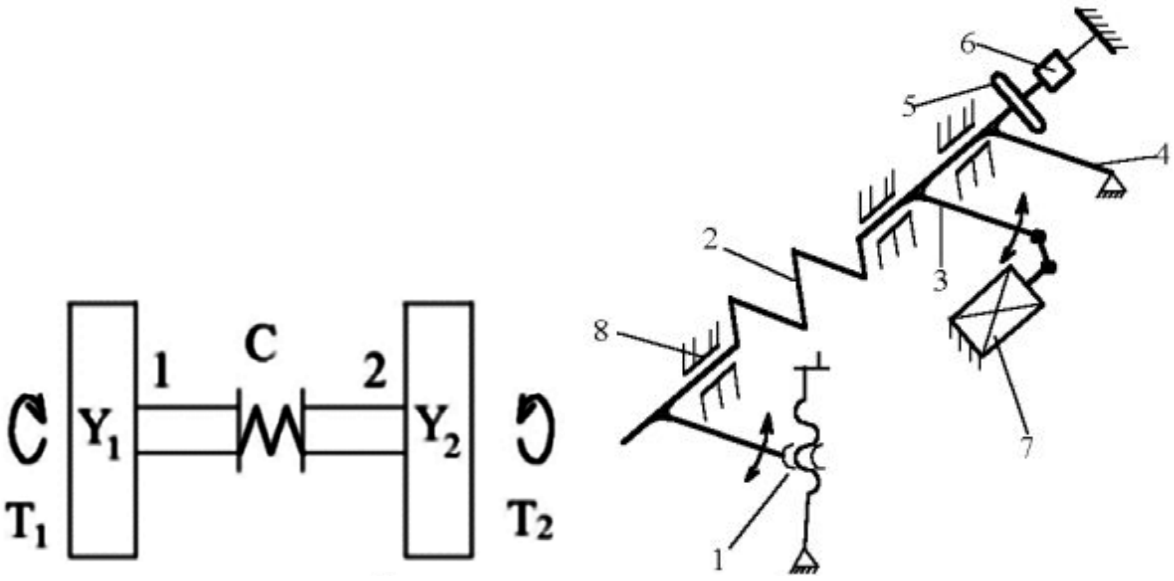


Figure 1. Diagram of measuring physical and mechanical parameters: 1 – sensor, 2 – amplifier, 3 – universal interface, 4 – computer.

Sensors and amplifiers are used depending on the physical nature of parameters measured and are electrically matched. A 12-bit interface and software for registering and mathematical processing operating are used to test the process of measuring. This technology is applied for 11 workshops: Surface's Roughness (Micro deviations), Linear Flat Surface profile investigation, Ultrasonic investigation of press-fit joints, Critical revolution of a straight shaft, Coefficient of friction in a sliding support, Efficiency of screw and nut gear, Characteristic of an elastic element (spring), Features of an elastic conjunction, Press fit joints - coefficient of friction, Efficiency in worm gear, Belt drive investigation. These methods are presented in a book and in a CD together with pictures, diagrams, video clips and experiments. Share ware software and computer registered data are recorded in the CD in order the applied experiments to be readable. Here is given an example by the workshops on Elastic Coupling.

The main function of the elastic coupling is to reduce (dampen) the dynamic loads between the joined shafts. Representation of a dynamic model is shown in Fig.2 a, where T_1, T_2 and Y_1 and Y_2 are torques and momentum of input and output shafts. During the laboratory workshops a coupling with an elastic element made of rubber is examined. Rubber is a material with internal friction with elastic deformation. That is the reason for dampening the dynamic loads between the joined shafts.

The elastic coupling is loaded statically and dynamically on a special stand. The diagram and picture of the stand are shown in fig. 2 b and 3. Two video clips are applied in the workshop method presented in the CD – for static and dynamic experimental investigation. The operation of the stand is as follows: The coupling (5) is loaded statically for torsion by a screw-and-nut gear (1) and a spring (2). The coupling is loaded dynamically by an electric engine and crank mechanism (7). The torsion moment in the coupling is measured by the strain-measuring shaft (6), and its angular deformation - by a strain-measuring bar (4). The signals from the strain-measuring shaft (6) and bar (4) are transmitted to a specialized amplifier and a registered by a computer system (Fig.1).



a *b*

Figure 2. Representation of a dynamic model (a) and of a diagram of a stand for static and dynamic study (b); 1 – screw-and-nut gear, 2 – cylindrical spring, 3 – flat spring, 4 – strain measuring of the angle of torsion, 5 – elastic coupling, 6 – strain measuring shaft for measuring the torsion moment, 7 – electric engine with a crank mechanism, 8 – supports.

.

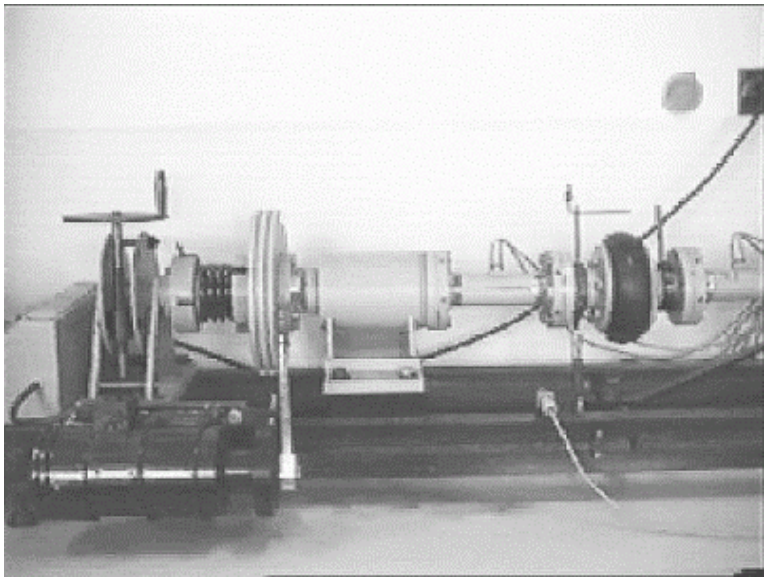


Figure 3. Picture of the stand "Elastic Coupling"

Coefficient of dampening ψ of an elastic coupling is determined from [1]:

$$\psi = \frac{A_{damp}}{A_{poten}},$$

where A_{damp} is the work of the forces of the internal friction in a coupling with deformation, A_{poten} - the mechanical work for coupling deformation. Damping in the coupling is the reason when the torque T_1 dynamically changes the torque T_2 decrease due to deformation

3. RESULTS

Typical results registered with dynamics loading of an elastic coupling are shown in Fig. 4 a, b and c. The input T_1 and output T_2 torques and the angular deformation φ have been measured. The dampening ability with dynamic loading has been obtained on the basis of registered values.

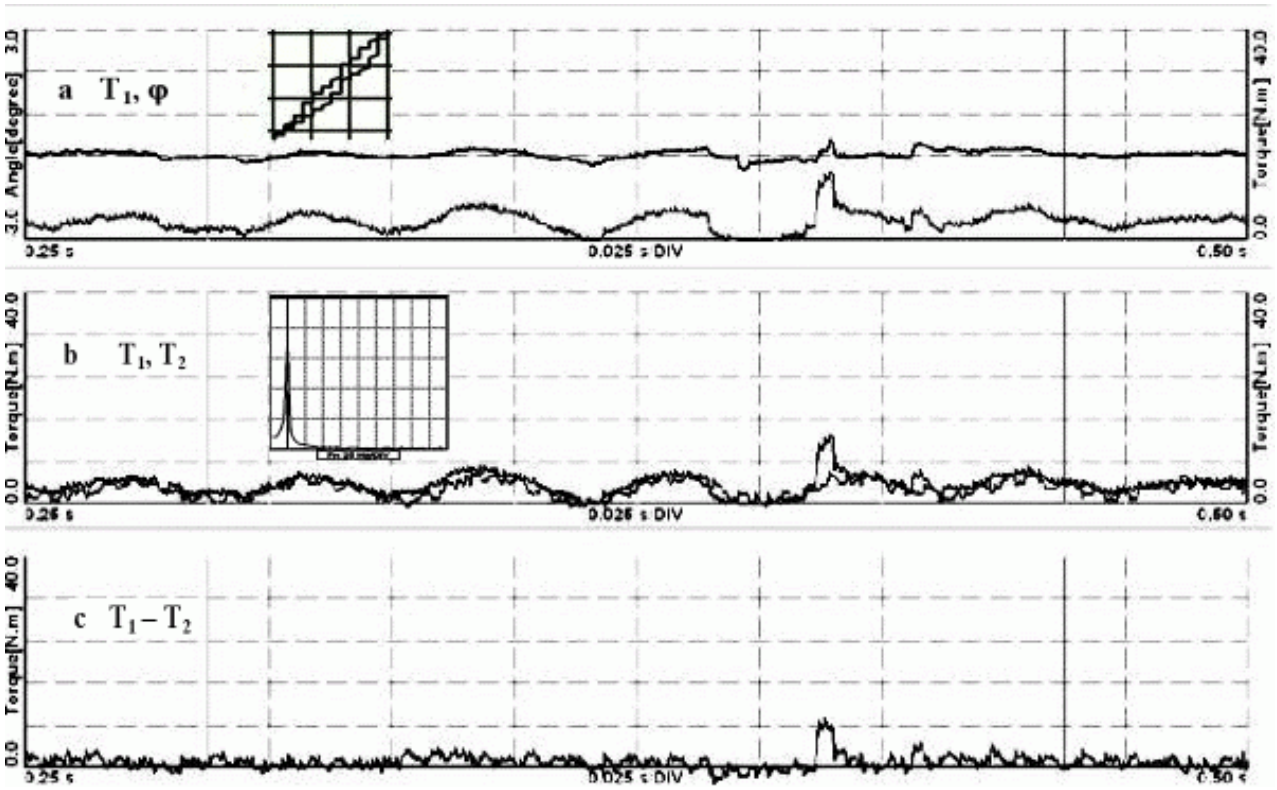


Figure 4. Results obtained with dynamic loadings of a coupling; a presents results for T_1 and angular deformation φ, in the rectangle is presented 2D drawing based on a cycle of loading for coefficient of damping calculation; b – for T_1 and T_2, in the rectangle is presented 2D drawing of frequency analyze; c – for the difference T_1 - T_2 for damping effect visualization.

The dynamic study is carried out with a value of the static moment of 0.6 Nm and amplitude of the dynamic moment of 8 Nm. The additional diagram images in Fig. 4 “a” and “b” have been obtained after data registering in a digital kind and their introducing into specialized software for mathematical processing. Values of 0.12 and 0.08 have been obtained for coefficient of dampening with static and dynamic study on a coupling. The frequency of changing of T_1 has been determined by using the built-in function for Fourier analyzing. In Fig. 4 c the effect of coupling dampening could be seen. A dynamically increasing of T_1 estimated on about 9 Nm has been dumped.

4. DISCUSSION

The results obtained on the base of testing the computer system sensor – amplifier – universal interface – computer are valuable for teaching the subject Basic of Constructing. The computer system is used as an oscilloscope with wide opportunities to regulate the time interval of registering the results for online registering physical and mechanical parameters. All machine elements have been investigated by using special stand. Two dimension drawings, frequency analysis have been made where is reasonable for mechanical process presentation. Photos, video clips, theoretical explanations and real experiments are in help of students for better understanding and learning the nature of experiments. The approach presented can be applied in other fields of technology training.

REFERENCES

1. Arnaudov K. and co-authors. Machine Elements, Tehnika, Sofia, 1980 (in Bulgarian).
2. Minchev N., V.Grigorov. Vibration Diagnostics of Rotation and Piston Machines, Tehnika, Sofia, 1980 (in Bulgarian).

Dr. Ivan Atanasov Kolarov

Dr. Ivan Kolarov was born in 1959. He has earned his M.Sc. degree in engineering from Technical University of Sofia in 1984. Afterwards, he worked in car manufacturing company “Sredec” in Sofia as machine constructor between 1984 and 1986. From 1986 to 1987, he worked in Central Machine Institute, Sofia as a scientific employer and subsequently started his work in Todor Kableshkov Higher School of Transport, Sofia as a lecturer and researcher. He has earned his Ph.D. at the same institute in January 2000.

Since 2002, he has been working in Todor Kableshkov Higher School of Transport as an associate professor on machine elements and mechanisms. He has been involved in MODULARTE as the team leader of Bulgarian partner and took active part throughout the project particularly in the design and preparation of modules and the training tool regarding the course “Basics of Constructing”.