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Technical mechanics within Technology Teachers Training System

Drohobych Ivan Franko State Pedagogical University, Ukraine
V. Luzhetsky, Yu. Pavlovsky

Based on the theoretical analysis and practical experience grounded circuit integration course Technical Mechanics, which eliminated duplication of technical disciplines in the system of training the teachers of technology.

Key words: *technical mechanics, technical knowledge, technology teachers training system*

V. Luzhetsky

Yu. Pavlovsky

The Introduction

The knowledge of mechanics within technology teachers training system is important not only for learning the basics of statics, dynamics, various deformations and rating machine elements, but also for creating a basis for further knowledge acquisition in the sphere of vocational training.

The first knowledge of mechanics was acquired by the future technology teachers at the lessons of Technical Mechanics, introduced as a package of several disciplines though abridged to some extent in comparison with those studied in technical colledges. A systematic training of technology teachers started in late 1960ies, though attempts to combine this profession with other specialities had been made earlier [1]. Particularly, there were such qualifications as a teacher of physics and technical mechanics, a teacher of physics and fundamentals of production. Besides, some engineering specialities were combined with education in order to train teachers for the schools of vocational training. As an independent speciality, its name varied together with the changes of qualifications, until the final decision was made to make the name of the teacher's qualification sound exactly as the subject taught at school.

Over ten years research has been conducted aimed at optimization of integrated knowledge of the technical mechanics for the future teachers of manual labor and technology. Despite the variations of the name the essence of the speciality, the structure of the technical mechanics has remained unchanged though it was not a separate learning subject before. More than ten years ago in the desire to create integrated courses, such separate disciplines as Theoretical Mechanics, Strength of Materials and Theory of Mechanisms and Machines were artificially combined into one [2]. This was the approximate scheme under which the technical mechanics was taught in technical colleges. Moreover, research is being made aimed at improving the methods of teaching several parts of mechanics within such an integrated course. Therefore it was necessary to approximate the structure and the content of this course to that of the Technology subject taught in comprehensive schools.

The main material

Previously the syllabus of the learning subjects related to the technical mechanics varied according to the

scope, having been modified in 1970, 1981, 1987, 1998 and 2001; whereby in the first two the course of the Technical Mechanics was refered to sciences – just like General Physics – rather than to professional traing. The first attempt to devise a really integrated course of technical mechanics was made by V. Kurok [3], whose course includes the following components: Statics, Kinematics, Dynamics, Basics of Machine Elements Rating. Here the emphasis is placed on the theoretical mechanics, even the names of the chapters have been retained, Statics, Kinematics and Dynamics being the parts of the Theoretical Mechanics course. But the practical experience made it necessary to be improved by introducing certain corrections and additions without changing the integration principle. This scheme avoided the repetition of studying the same technical disciplines while training engineers and the content of the integral course was more adequate to the scope of technical tasks faced by the teacher. Thus, the scientific foundation of the new approach towards integration of the technical mechanics course raises no doubts. The role of integral knowledge of technology for the teachers of manual labor has been studied by many scholars who came to the conclusion that the knowledge integration leads to fundamentalism of education which, applied to the teacher of technology, is realized by comprehensive and technical training.

When changing from the classical model to the 4-tier system of manual labour teachers training the technical mechanics syllabus was significantly reduced in hours which adversely affected the professional qualifiacation of the teacher. When the 2-tier system of teachers training was introduced together with the involvement of the Ukrainian higher education in the Bologna process the technical mechanics is taught to 2nd and 3rd-year students as is required by the bachelor's degree qualifications. The previous syllabus the reduction of hours dedicated to the technical mechanics let to a reasonable abridgement of the course content, and namely, not by excluding certain topics but by compressng the information according to the principle of expediency defined by the effective syllabus.

Analyzing the fundamental definitions of the technology and mechanics an integral harmonious system of modern technologis is observed. No technics and mechanics is possible without technologies, therefore the name of the integral course of technical mechanics reflects its content. The technical mechanics as a discipline has existed traditionally in the system of professional training of technicians and from 1991 to 1998 was included in the system of training manual labor teachers both in colleges of education and universities.

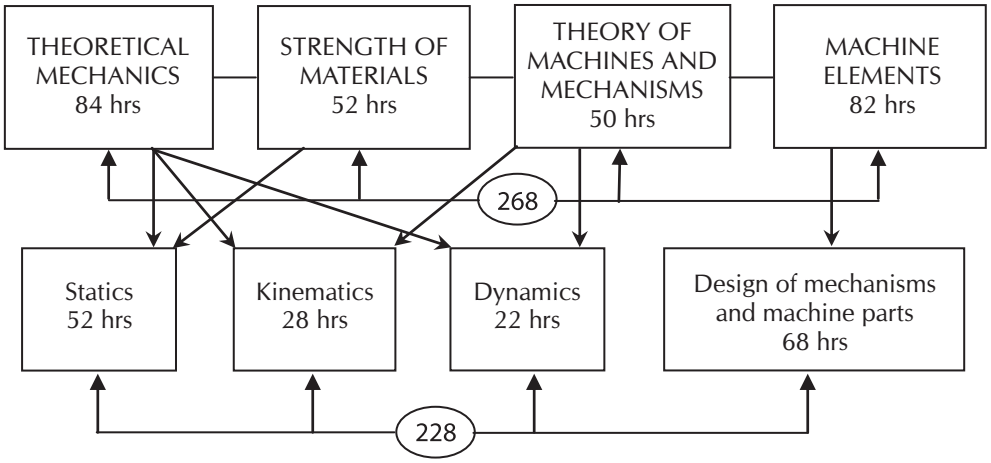
The majority of the production processes nowadays are performed by machines and mechanical devices. Their efficient application is possible only with the understanding of the processes within them. Herefore, it may be concluded that the understanding of the structure and the function of the machine is a social requirement in the modern society. The teacher of technology must bring this knowledge to the students which in its turn requires a sufficient level of the teacher's competence. A plenty of scientific courses study the functioning of machines and mechanism and it is impossible to embrace the whole spectre of the knowledge of machines.

At the first stages of the integration of the Technical Mechanics course the materials of the previous syllabus in theoretical engineering were used in accordance with the following model (Fig. 1).

This scheme removed the repetition of the same technical disciplines in the system of professional training of engineers and the content of the integral course reflected more the total technical knowledge required by the future teacher of technology. Due to the integral knowledge of technology the education is fundamentalized, and for teachers of technology this is performed by technical training.

However, even now some universities training the teachers of technology teach the technical mechanics accord-

Fig. 1. Scheme of the integration process of the Technical Mechanics course



ing to the outdated scheme. Research is being conducted aimed at improving the methods of teaching some parts of mechanics according to such structure. Therefore the scientific substantiation of the new approach to the integration of the technical mechanics course is beyond doubt.

The intermediary stage of improving the syllabus of technical mechanics provided for structural modifications by introducing such courses as the statics of perfectly rigid bodies, the statics of complex systems, kinematics and dynamics, basics of machine elements design.

If we analyze the dynamic change of the hours dedicated to the study of technical mechanics we observe the tendency to their significant reduction, which may demonstrate the fact that the role of this discipline decreases or, worse, it has not found its place in the system of the professional training of technology teachers. The reduction of hours in the syllabus of the technical mechanics has lead to superficial study of widely used mechanical gears and auxiliary elements and some parts are excluded from the syllabus to be studied by the students independently. Therefore, a sysem analysis has been carried out which singled out the topics advisable to be included in the syllabus and the reseach activities which are sure to extend the knowledge and form and consolidate the skills.

An analysis of the manual labor syllabus in 5th to 9th grades of the secondary school demonstrates the fact that the topics of this discipline are extensively taught at the school lessons. The following topics should be pointed out:

- A general characteristics of machine elements used in technology. The notion of an element and mechanism. Types of mechanisms. Crank-and-rod mechanism.
- Kinematic diagrams, legend therein.
- Types of machine element joints. Threaded joint. Thread elements. Riveted joints. Types of riveted joints. Forces acting on rivets and their strength.
- Mechanical transmissions (belt drives, screw gears, rack gears).

The modern theory of education gave rise to numerous methods of teaching, however, from the viewpoint of information process only such methods can be called systemic, which provides for independent learning with the advisory aid of the teacher. Unfortunately, the syllabi rarely provide incentives for a creative learning by the students. At the same time, a yearly project is one of scarce creative works requiring an independent approach to application of

a wide range of knowledge of technical disciplines. The designing process requires a systematization of the acquired knowledge, which activates the cognitive and creative activity of the student. Creative work is the evidence of almost completely trained professional. However, the classical methods of teaching have become rather outdated in the age of information technologies. Computers can and must be used while studying the integral course of the technical mechanics.

The integral components of the technical mechanics have been: the statics of perfectly rigid bodies, the statics of complex systems (strength of materials), kinematics and dynamics, basics of machine elements design.

They were studied in the above sequence, starting in the third through seventh terms. The 8th term was dedicated to applied mechanics. Having analyzed the syllabus based on the 10-year experience of teaching the subject we have come to the following conclusion. The discipline Statics of Perfectly Rigid Bodies shall be renamed Statics without changing its content and shall have the scope of 1.5 credits. Thereafter, Kinematics and Dynamics shall be taught (1.5 credits). The Statics of Complex Systems (Strength of Materials) shall be combined with the Basics of Machine Elements Design and renamed as Strength of Materials with Machine Elements Design retaing the total amount of hours (4.5 credits). The course shall be completed with selected problems of the applied mechanics with a yearly project. The syllabus for a 2-tier system of training for the bachelor's degree provides 432 hours for technical mechanics, including 168 hours lessons in class (70 lectures, 88 laboratory lessons). The study of technical mechanics begins in the 3rd term and ends in the 7th term, 2 hours weekly, while in the 7th term – 1 hour per week. The teaching of the integral parts shall be arranged as follows: in the 3rd term 2 hours for statics, 1 hour lecture, 1 hour laboratory lesson, final check – examination. In the 4th term 3.5 hours, including 2 hours kinematics and dynamics, 1 hour lecture, 1 hour laboratory lesson. In the 5th term just 1 hour including 1 hour lecture in. In the 6th term 3 hours to continue Strength of Materials with Machine Elements Design, including 1 lecture and 2 laboratory lessons, final check – examination. In the 7th term 2 hours for selected problems of the applied mechanics, including 1 lecture and 1 laboratory lesson, finalized with a yearly project. As it can be seen, the total amount of class hours is reduced from 180 to 168.

In accordance with the school syllabus and the interdisciplinary relations with other integral courses the content of each part of the syllabus includes the following. Statics, Kinematics and Dynamics shall include the issue of the statics of a material point and of a solid body as a whole. Here the main notions and tasks of statics shall be considered, including the connections and their reactions, composition of forces, system of convergent forces, momentum elative to the centre and axis, force couple, conditions of equilibrium, reduction of force system to the centre, coplanar force system. It is very important to study the statically definite and indefinite problems, spatial force system. Friction and its laws is one of the most important issues of mechanics. The ways to define the center of gravity coordinates, solving the problems in statics will be included as applied problems. Thereafter students shal be acquainted with the basic notions of kinematics, types of motion and ways of seting (linear and rotary motion of a point and solid, compound motion of a solid), plane-parallel motion of a body, kinematic couples and chains, the structure of planar and spatial mechanisms, kinematic study of lever mechanisms, kinematic study of cam mechanisms, dynamic study of planar mechanisms, types of friction in mechanisms being accounted for in designs, kinetostatic analysis of planar lever mechanisms, nonuniformity of motion of mechanisms and machines, fundamentals of motion control – this is a list of crucial issues to be studied after mechanics and basics of dynamics.

The Strength of Materials with Machine Elements Design are combined

into a unity since all the theoretical problems of the strength of materials find their practical application in the machine elements design. Such integration avoids repetition of some issues of the strength of materials when designing machine elements. The theoretical information provided to the students includes the main hypotheses and assumptions, types of loads and major deformations, tensile and compressive deformation, strain energy, the notion of the strength hypothesis, theory of strength, statically indefinite problems, geometrical specifications of plane section, shearing, torsional and bending deformation, and with compound strain. The load dynamic action, requirements to machines, their elements, types of transmission, axes, shafts, bearings. Couples, mechanical connections, study of wave and planetary gears and drive units.

Conclusion

Based on the theoretical analysis and practical experience grounded circuit integration course Technical Mechanics, which eliminated duplication of technical disciplines in the system of training the teachers of technology. Thus, the scientific substantiation of the integral course of the Technical Mechanics and the proposed structure of the discipline Technical Mechanics is aimed at activation of the student's cognitive activity by involving them into independent work.

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