



Lecture Notes in Mechanical Engineering

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Past and Present: Teaching and Research in Vehicle Engines at the University of Miskolc

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Abstract The Department of Fluid and Heat Engineering, established as the Department of Machine Operation in 1952, hosts research and teaching in engines for vehicles. In the first two decades after the foundation of the department, besides engines in vehicles, steam engines still played an important role as they were used in locomotives. At that time the department owned several dynamometers and besides teaching about engines, the department carried out research and development for the national production of engines. After a decade of transition, in the second half of the 1990s the production of internal combustion engines started to flourish again. This was manifested first in teaching, but from 2010 in research as well. The replacement of the old laboratory equipment with modern measuring instruments and engines and the construction of a full departmental laboratory for engine diagnostics contributed to this. All of these factors explain why the Department of Fluid and Heat Engineering is in charge of teaching internal combustion engines in the new (starting from 2016) Vehicle Engineering B.Sc programme.

1 Introduction

The Department of Machine Operation was established in the Faculty of Mechanical Engineering at the Technical University of Heavy Industry by Decree 25 of 1951. The first head of department was Professor Alajos Lancsarics (1903–1963) (Fig. 1).

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Fig. 1 Alajos Lancsarics, founding professor of the department



Since its foundation, the department has hosted research and teaching in engines for vehicles. After its educational and research profile became established, the name of the department was changed to the Department of Fluid and Heat Engineering by Decree 52341/1965, MM on 15 March 1965.

The organisational structure of the Faculty of Mechanical Engineering and Informatics was modified by the formation of institutes in the autumn of 2013, leading to the establishment of the Institute of Energy Engineering and Chemical Machinery. Two previously existing departments joined to form the institute, and our activities go on within the Institute.

2 In the Beginning

Alajos Lancsarics was legendary for his enthusiasm for teaching machinery, and especially heat engines. As the vice rector for financial affairs, it was his task to set up and expand the equipment available for workshops and laboratories, which were quite rudimentary in the beginning. He managed to provide the necessary background needed for teaching about internal combustion engines, despite the numerous difficulties faced in the 1950s.

Heat engines were a major part of the content taught at that time, with a focus on internal combustion engines and also steam engines (see Fig. 2), as their role in locomotives was still important at that time.

It was mainly the tireless work and wide professional knowledge of Alajos Lancsarics that contributed to the development of teaching materials for the newly formed department (Fig. 3). He was enthralled by motorization, and in his opinion a degree in mechanical engineering could not be granted to someone lacking a thorough knowledge of these machines. In the laboratory classes for engines, he arranged trips for pairs of students between Miskolc and Hatvan in a steam locomotive, or organised a special train to take all of the mechanical engineering students on a visit to a power plant, using the Campus-Tiszapalkonya line. As early as the 1950s, students were learning how to drive motorcycles (Fig. 4), automobiles, tractors and combines.



Fig. 4 Students learning how to drive a motorcycle on campus

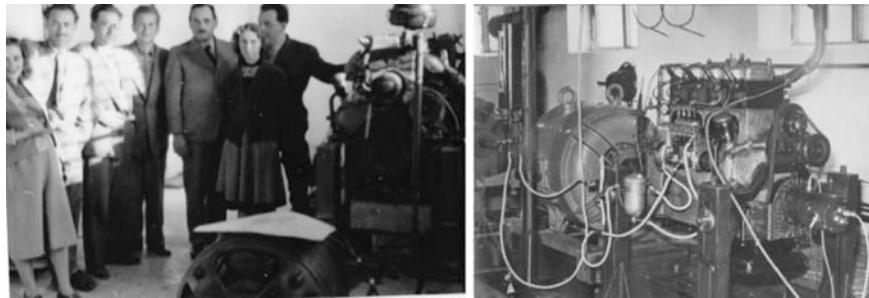


Fig. 5 Motor testbeds in the 1950s

In the first two decades, the department laboratories were located in the makeshift premises earlier inhabited by the prisoners who built the first buildings of the university. In addition to housing various types of vehicles, there was also an engine test lab with a testbed. That the members of the department had their photograph taken with this equipment (Fig. 5) testifies to their strategic importance.

During those first two decades, the department was involved not only in teaching but also in R&D on behalf of Hungarian motor manufacturers. These activities also supported the research progress made by lecturers. An example is the 1966 thesis for the university doctor's degree written by György Vida on the factors determining heat transfer in the cylinders of a diesel engine.

From the mid-1960s the teaching and research profile of the department altered somewhat, under the leadership of Tibor Czibere, with hydraulic machines gaining more emphasis among the turbomachines. Naturally internal combustion engines remained a focus of interest, as shown by the fact that half of the space in the

modern laboratory (established in 1969) was given over to the engine testbeds, while the other half was used for the teaching of and research on hydraulic machines (Figs. 6 and 7).

In the 1990s, most of the motor manufacturing in Hungary took place on a licensing contract basis, and the amount of R&D was quite limited. During this period the main focus for engines was in teaching, while hydraulic turbines were a topic not only in the classroom but also for research.

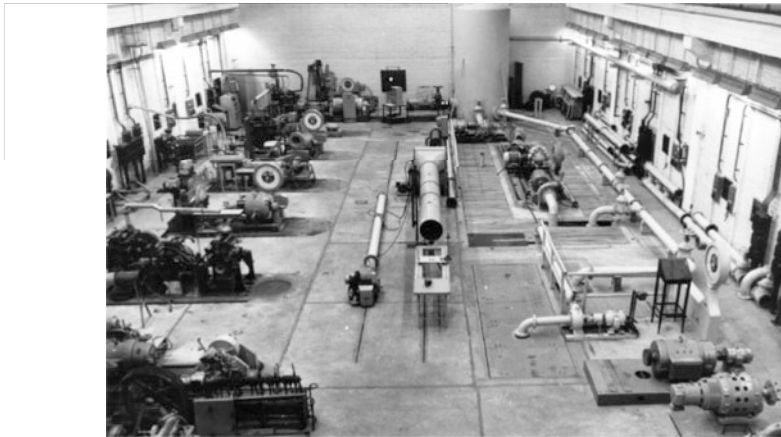


Fig. 6 The new department laboratory (1969), with testbeds on the *left* and underground water reservoirs and hydraulic machines on the *right*

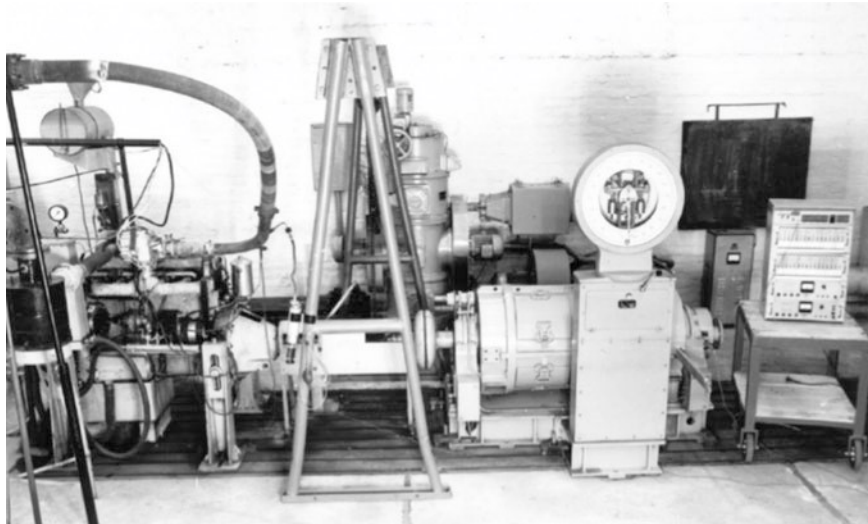


Fig. 7 A modern testbed with dynamometer (1969)

With the settlement of multinational companies in Hungary in the new millennium, the production of internal combustion engines started to flourish in Hungary. At the same time gas engines and gas turbines came to the front in energy production. That is why the demand for engineers specialising in these fields has increased again. Awareness of these trends motivated the department to revise the curriculum and update the equipment needed for teaching and research. Within the subjects of Turbomachines, Power Stations and Systems of Power Engineering within the B.Sc programme in Energy Engineering special attention was given to heat engines, steam turbines, gas turbines and gas engines. In the area of internal combustion engines educational equipment was first procured: a 90 hp 1.4 Opel Astra G petrol engine of 1997, a 2.0 HDI (High Pressure Direct Injection) Peugeot diesel engine of 2002, vibration diagnostic equipment called EASY-VIBER, a Testo type exhaust gas analyser and Würth type automotive diagnostic equipment. Using this equipment, new courses were launched such as Internal Combustion Engines and Engine Diagnostics.

As the next step, in 2010 an engine test stand for the engine braking of single cylinder petrol and diesel engines produced by GUNT was purchased (see Fig. 8). The test stand was produced as equipment for engineering education but can also be used for doing some simple research. For example, using this equipment it became possible to investigate fuel consumption [1] or the use of additives for reducing fuel consumption. Using the apparatus, students investigated the effect of auxiliary devices within complex assignment and final thesis projects.



Fig. 8 An engine test lab system with a drive motor and dynamometer produced by GUNT (2010)

3 Nowadays

The largest development took place in 2012. The research and teaching laboratory was established in two rooms of the departmental laboratory for engine diagnostics. The establishment of the laboratory was mainly supported by a grant for infrastructural development. The engineering and technological design and the implementation of the project were carried out by Energotest Ltd. [2]. The name of the laboratory became the Lancsarics Engine Test Lab after the founder of the department.

The engine test room was established using existing machines. The 2.0 TD Common-rail diesel engine used for the first experiments was awarded to the University of Miskolc by Audi Hungaria Motor Ltd. The tested engine (Fig. 9) was placed in a soundproofed room separated from a control and teaching cabin. Soundproof fire doors between the two rooms ensure visibility and accessibility.

The fixing of the engine to the base of the machine and positioning it to the dynamometer is ensured by specially developed engine holder palettes. The



Fig. 9 Interior of the engine test laboratory

connection between the engine and dynamometer for the transfer of torque and speed (of revolution) is ensured by a Cardan shaft with a very flexible rubber element for absorbing torsional vibrations and equipped with fitting disks. The 8000 rpm dynamometer (maximum power 250 kW, maximum torque 1200 Nm) is water-cooled eddy current dynamometer with impulse modulation control electronics. A 44 kW induction motor with frequency converter speed control is attached to the engine brake side of the powertrain system, constituting a compound braking unit developed by Energotest. The controllable induction motor enhances the dynamics of the system substantially and also the effectiveness of the dynamic tests. Also, the induction motor is capable of driving the test engine, hence the engine operation can be avoided and tests can be carried out using an electric motor to rotate the engine, ensuring the investigation of engine friction.

The environmental and technological boundary conditions are provided by a preparatory and serving measuring system developed and built by Energotest with the following elements:

- A preparatory system for liquid coolant that provides cooling of the test motor using a water–water heat exchanger, built-in pipe system, a pump whose parameters match those of the system, and control elements.
- A preparatory system for diesel fuel provides the fuel needed to drive the test motor. The cooling of the fuel is carried out with a fuel–water heat exchanger.
- A preparatory system for the air intake of the motor provides the proper filtering of the air needed for motor operation, with adjustable de-pressurization and temperature control in the temperature range of 15–40 °C.
- An exhaust system removes the emitted fumes with corrosion-free piping and a compensator. A test section allows emission measurements.
- A ventilation system for the room provides continuous ventilation of the lab, with ventilators removing and introducing air, air ducts, fume hood, filtering system and rain proofing elements.
- An accelerator unit ensures the control of modern E-gas systems as well as conventional bowden cable systems.
- A CAN bus data acquisition system can be configured flexibly and the potentially extendable version allows the measurement of motor and environmental parameters up to 20 signals. It can also control the preparatory system and that of the test engine. The whole system is computer controlled with Hungarian language Energopower engine test bed software installed in an industrial computer built into the rack-type control desk.

The up-to-date engine test laboratory is suitable for investigating energy processes taking place in internal combustion engines and for carrying out diagnostic and emissions tests on diesel engines for passenger cars and light commercial vehicles, in use today or for future development, as well as for educational activities related to the practical operation of motors.

With a dynamometer, during motor operation, it is possible to determine charge characteristics, investigate part loads and test cycles defined by the user, measure

fuel consumption, determine specific fuel consumption curves, and investigate the effect of changes in environmental parameters on performance. In addition, with the environmental system the effects of various types of motor oil and fuel can be investigated, and harmful emissions can be analysed using an AVL emission meter of “0” accuracy class.

Being able to rotate the engine by an electrical motor enables us to investigate the friction at different speeds, and to carry out tests as used by manufacturers for engine development. This is a fundamental measuring technique for the downsizing experiments expected these days.

Since being put into operation the engine test bed has been engaged in three large research projects when long tests for different purposes have been carried out on diesel engines:

- 100-h test to check the laboratory operation at different engine operating conditions
- 800-h test of deposition and soot deposition
- 500-h test of motor wear and oil consumption.

All of these factors explain why the Department of Fluid and Heat Engineering is in charge of teaching about internal combustion engines in the Vehicle Engineering B.Sc programme being launched in 2016. This includes subjects such as Internal Combustion Engines and Motor Vehicle Engine Diagnostics.

Research within the department on two doctoral-level research topics is currently underway: one deals with experimental and numerical investigation of the exhaust system and the other with the development of an alternative valve.

In addition to measuring devices and apparatus, the software package ANSYS Fluent and AVL motor diagnostics software are available for numerical simulation.

Further development of the engine test laboratory is planned in order to accommodate the latest models of engines, and we would like to expand the research topics by purchasing equipment for vibration diagnostics in order to investigate mechanical effects of vibration.

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References

1. Tollár S, Mátrai Z (2012) Investigation of the effect of different diesel fuels on operating parameters of an engine. *GÉP* 62(9):57–60
2. Szilágyi G (2012) New dual-function dynamic engine test lab at the University of Miskolc. *GÉP* 62(9):5–6