STUDIA UNIVERSITATIS BABEŞ-BOLYAI
Engineering 67(1) 2022 DOI: 10.24193/subbeng.2022.1.25

# Electromechanical engineering education and science in Republic of Moldova

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***Abstract.*** *The work is a summary of the history of the industry and education development of electrotechnics in the Republic of Moldova during the independence period. With the national renaissance, the process of professional training in the electrotechnical field began to take on a natural national face - training in the Romanian language. Scientific research is determined by the subject of special submersible and permanent magnet electric machines, renewable energy sources, but also by new directions such as the development of adjustable electromechanical systems for the automation and efficiency of technological processes and traction systems of electric passenger vehicles.*

***Keywords****: electromechanical engineering, education, science*

## 1. Introduction

Electrotechnics is an important branch in any country's economy. In a previously published paper [1], a series of problems was related to the appearance of the electrotechnical field in the Republic of Moldova industry, the formation of the electrotechnical school in education and research were elucidated. The electrotechnical industry in Moldova (within the former USSR) had a considerable weight during a long period in the national economy. In the period after 1990, the role of this industry, was significantly reduced, but at the same time other branches of electrical engineering appeared, such as electric transport, the automotive industry and others. Thus, for a correct planning of the next steps, regarding the development of the field in its entirety, but also of the Technical University, including the Department of Electrical Engineering, as an indispensable part of it, a deep and multilateral analysis of both the previous period and the situation in the current period is necessary [1].

## 2. The history of the industry development during the period of independence of the Republic of Moldova

With the dissolution of the Soviet Union (USSR), or more precisely since 1990 (1989 was recognized as a pre-crisis year), the annual volume of production began to decrease, which led to the degradation of the industry. The economic situation in the country was aggravated by the 1992-armed conflict in Transnistria, the consequences of which are still felt today. Structurally, the economy of the republic gradually began to lose its industrial character: the share of industry in GDP fell to 31,8% (in 1995), and the number of people employed in industry decreased by 50%. At the same time, another structural change occurred – the reduction of the share of the machine-building industry (mainly electrotechnical), both in production and in exports. In the year (1995), in which the real reform of the republic's industry began, the volume of industrial production, compared to the level of 1990, was 44,2% [2].

What were the causes of the electrical industry catastrophe in the period immediately following the collapse of the USSR? Most of the companies in this branch were part of the group of those with Union subordination. The economic value of these enterprises for the Republic of Moldova, of course, was enormous. In 1990, the share of the Union subordinate industry in the whole sector of the republic, in terms of production was 29%, in terms of the number of staff – 36%, and after the cost of basic production funds – 48%. These largely determined the scientific and technical potential of the Republic of Moldova. However, for these enterprises the ministries and party structures of the USSR in Moscow adopted all decisions. There, the nomenclature and volume of production, the sources of raw materials, the way of production, and the financing were planned. The Republic of Moldova was responsible for the social part and waste. Persons brought from Russia exclusively supplemented the leading and scientific staff. It should be noted that the share of military-industrial complex enterprises in these five years has decreased from 11,4% to 0,77% in 1995 [2].

Towards the year 2000, the decline of industrial production stopped and the gradual increase in the production of electrical and electronic equipment began (figure 1).

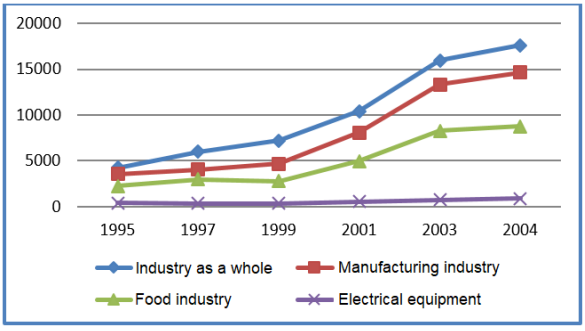


**Figure 1.** Volume of industrial production-by-production sectors in million MDL [3] (processed by authors).

### 3. The dynamics of the current electrotechnical industry transformations

After the years 2003-2005, there was a slow increase in industrial production overall, and some structural changes took place: the share of manufacturing industry production increases (83,3%) [4-6]. After a long period of slow growth, on the background of stagnation of traditional electrotechnical productions (figure 2) there is an explosive development of a specific sector related to the automotive industry - the manufacture of wires, cables and other equipment for assembling cars. Small and medium enterprises in the electrotechnical field have developed in recent years

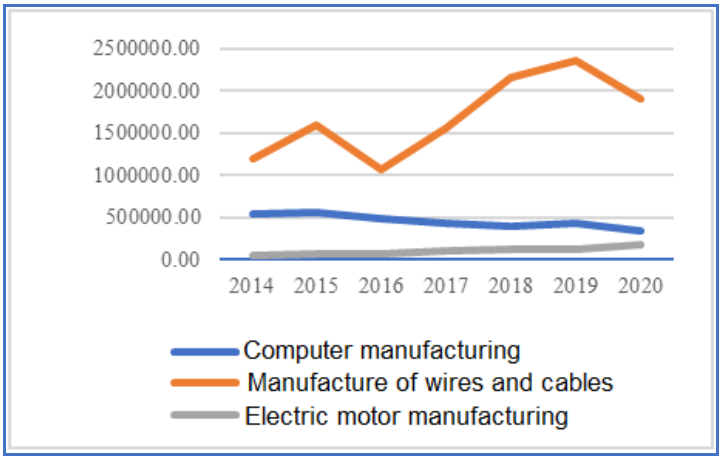


**Figure 2.** Dynamics of the manufacture of electrical and electronic equipment, 2014-2020 [7, 8] (processed by authors).

There are also other characteristic moments of the current economic development of the country. If in 1990 the GDP of the services chapter accounted for 20%, for 2020 their rate is 60%. The complexity of services, for example, urban electric transport, vertical transport in multi-storey buildings, automatic water supply systems and others has changed a lot, which requires a higher degree of qualification of specialists.

### 4. Modification of the process of specealists preparation

The changes in the economy of the Republic of Moldova imposed essencial reorientations in the policy of training the specealists - the transition to wider specializations for a wide range of enterprises. What does our faculty, our department, do in these circumstances?

After several attempts, in 1988, the establishment of a new study program „Electric drive and automation of technological processes" was accepted. This was a real test for the department. In addition to the traditional courses of Electrical Engineering, Electric cars, Electrical appliances, in a short time, we had to learn many new disciplines specific to the specialty mentioned.

In parallel, groups with teaching in Romanian had to be formed, the library filled with literature in Romanian. Here we could mention the special contribution of some teachers who were directly involved in the teaching process: Professors Lorin Cantemir, Alexandru Simion (UTIs), Aurel Câmpeanu and Gheorghe Manolea (UCr); Carmen Golovanov, Mihai Covrig, Valentin Năvrapescu (UPB), Elena Helrea and Mihai Cernat (UTBr), Adrian Graur (USV). This collaboration is continued by the next generation (Dorin Lucache, Iulian Birou, Sergiu Ivanov, Vasile Horga, and Calin Munteanu). We will also mention, on this occasion, the special contribution of the people coming from the research: dr. conf. Tudor Ciuru - specialist in the field of electric drives, Valeriu Blaja dr. conf. – electronist, Vladimir Gutic – former chief engineer.

In 2015, the „Electromechanical" bachelor program was accredited by the AQAS quality assurance Agency in Germany.

In 2017, was approved the current specialty nomenclature, according to which the program was renamed into „Electromechanical systems Engineering" (ISEM). At the current stage the ISEM program has the mission to train specialists – integrators of programmable electromechanical systems (starting-protection equipment, electromechanical converters, static converters, sensors-transducers, PLC, SCADA) for the automation and efficiency of working machines or technological processes.

Due to the reduction in the number of high school graduates in 2019 was proposed joint trunk for two years of studies in full, and at the years three and four they have a common trunk that constitutes 30-40%.

For over 55 years, within the department over 1800 highly qualified electromechanical engineers have been trained for the national economy. Former electromechanical students represent the core of the production/repair of equipment and electrical machines (Hidromaș, Electromeaș, Energorotor, Electromotor-Service), electrotechnical enterprises (Volta, TehElectro-SV, EltroTehnoImport, Salonix) or provides the installation and exlocation of auatomatize technological lines from the most diverse fields (glass container Company, Franzeluța, Vitanta, Orhei-Vit etc.). It is gratifying that several electro-emcanic graduates have founded their own national and multinational enterprises, which successfully deal with the development and production of modern technological lines based on automated electromechanical systems with PLC and SCADA control (Alex Dragomir, Alexandru Jalba, Artiom Moldovan, Nicolae Prisacaru, Vladimir Ivanov, etc.).

## 5. Organizing scientific research under new conditions

The topic of scientific research within the department has also undergone essential changes, dictated by those changes that took place in the economy, on the labor market (the needs of our partners), but also in the study process.

A significant orientation toward the issues of sustainable development occurred both in the study programs and in the topic of scientific research at the department. Thus, in the bachelor programs the fundamental course of „renewable energy sources" is studied, at cycle II – Master studies was introduced the module „project Management" which was supplemented with a course „Environmental impact assessment of development projects". The doctoral school proposes to all doctoral students to study the „methodological foundations of sustainable development" and to argue the topic of its research on its principles.

Currently, the scientific research of the department is focused on the following priority directions *„Renewable Energy Sources", „Special Electric and Electromechanical Converters", „Traction systems for urban passenger electric transport", „Adjustable electromechanical systems for the automation and energy efficiency of technological processes"*.

***Research direction „Renewable Energy Sources".*** As early as 80 years of the last century, the team of researchers Petru Todos, Iurii Mindru, Iurii Soloviov and the student Ion Moldovanu developed an autonomous system for supplying electricity to a hail protection equipment, using wind energy. Next, the department had several researches and elaborations related to the valorization of renewable energy sources through research projects within state programs, European projects and cooperation Moldova Romania.

The results of the research carried out within the projects Tempus („Creation of a Center for Higher Education in the Area of Renewable Energies" in collaboration with the French Agency for Energy and Environment, leader Ion Sobor, 1996-1998; „MSC programme in Environment and Clean technologies", grant holder: Royal technological Institute in Stockholm, coordinator Petru Todos, 2004-2006), two projects funded under the United Nations Framework Convention on Climate change, were developed courses and textbooks for students [9-10] related to the conversion and efficient use of the most widely used renewable energy sources in the Republic of Moldova (wind, sun, biomass, flowing water).

Another research project was carried out between 2001-2003 „Elaboration of the wind energy cadastre of the Republic of Moldova", financed by the national Council for Science and technological Development (research team: Petru Todos, Ion Sobor, Andrei Chiciuc and the student Mihai Grosu). These team laid the methodological foundations for studying the wind energy potential, elaborated the data instrumentation and processing system, the calculation algorithm, the methodology for interpreting and graphical presentation of the results. A first map of the

wind energy potential at height was drawn up (figure 3). The most important success of this project was the breaking of the dogma, promoted by the traditional energy lobbyists, that Moldova does not have wind energy potential.

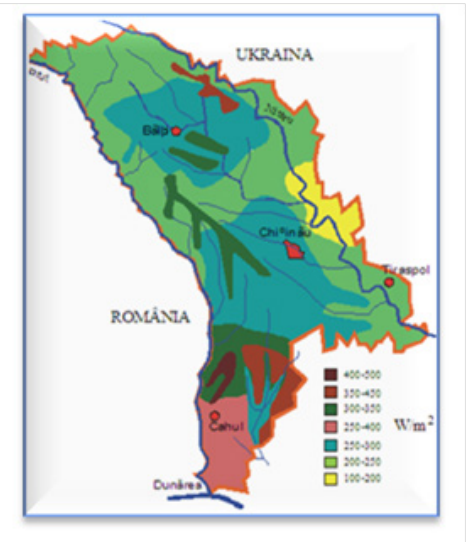


**Figure 3.** Map of wind energy potential of RM (height 70 m from ground)

Another research project was carried out between 2014-2017, (coordinator Ion Sobor), financed from the energy efficiency fund of the Republic of Moldova, was completed with the elaboration and editing of „Atlas of wind energy resources of the Republic of Moldova", authors Ion Sobor, Andrei Chiciuc and Vasile Rachier.

***Research direction „Special Electrical and Electromechanical converters".*** Projects carried out under this theme relate to the development of methodologies, devices and systems aimed at enhancing energy efficiency and energy conservation, which is included in the sustainable development goals declared in the United Nations Development Strategy 2030, which is also reflected in the development strategy of the Republic of Moldova.

The project *„Elaboration and production in series of small and special transformers from reconditioned materials (2002-2015)"* had as research objective the development of the technology for the reuse of the electrotechnical materials obtained when the power transformers are dismantled at the end of their term of use. Research team: prof. dr. Ion Stratan, prof. dr. Tudor Ambros, Alexandr Gorceac, Vladimir Olhovschii, Marcel Burduniuc, Valeriu Bordian, Natalia Chirița. Based on the technical documentation and the developed technology, the company S.A. "RED-Nord" manufactures a wide range of single-phase and three-phase power transformers from 10 kVA to 250 kVA (figure 4).


**Figure 4.** Transformers produced from reconditioned materials

The project “Submersible pumps with electromagnetic action”, realized in the period 1997-2004, the research team: Ion Sobor, Nicolae Kobîleaţkii, Abdel Wahhab, Corneliu Gherțescu, Iaroslav Kobîleaţchii, the objective of the research was to modernize the electromagnetic action of household submersible pumps in order to reduce the costs of electrotechnical steel, copper and increase the efficiency. An electromagnetic pumping system for irrigation of small areas, powered by photovoltaic panels, was developed and implemented.

Between 2004 and 2008, the team of professors, engineers and students from the department (I. Sobor, T. Ambros, N. Kobîleaţkii, conf., dr. ing. A. Chiciuc, conf., L. Iazloveţchii, M. Burduniuc, V. Bordian, A. Dragomir) have done more research on synchronous machines with permanent magnets. Industrial prototypes of the synchronous motor with permanent magnets of 7,5 kW were made for the operation of submersible pumps, of the permanent magnet generator for the wind turbine of 10 kW, 136 rpm and direct coupling with the wind turbine rotor, a series of permanent magnet generators for micro-hydropower plants (figure 5) with rated power 3 kW, rotational speed 375 rpm.

**Figure 5.** Generators with permanent magnets of 3 kW

***Research direction „Traction systems for urban electric passenger transport".*** An indisputable way to solve environmental pollution problems and reduce fossil consumption is to use electric motor transport units [11, 13, 14]. Public electric transport, electric cars, vertical transport are today elements, which without urban life cannot be imagined [12].

The research teams of the department and the Informbusiness enterprise studied the traction systems of urban electric vehicles [15, 16]. In the period 2005-2008, the structure and control algorithms were developed and the company INFORMBUSINESS produced/produces in series DC/DC static converters for equipping or upgrading trolleybuses and trams from Ukraine, Romania, Russia and the Republic of Moldova. In 2008-2010, the structure and vector control algorithms of traction inverters for trolleybuses with asynchronous engines were developed [15, 16]. At the exhibition „Made in Moldova-2010", the INFORMBUSINESS campaign presented the first Moldovan trolleybus with asynchronous engine and vector control. Over the past 5-7 years, the focus has been on the development of traction and power systems of batteries for electrolip batteries (figure 6). As a result, in Chișinău the electric buses provide eight connecting routes with the suburbs over 150 km long.

**Figure 6.** The traction and battery supply system for electric buses

Within the cooperation project between the Polytechnic University of Timisoara (prof. Sorin Deaconu-director) in association with the Technical University Gh. Asachi of Iaşi (dr.conf. Vasile Horga) and Technical University of Moldova (dr. conf. Ilie Nuca-director, Vadim Cazac, Marcel Burduniuc, Petru Virlan, Iurie Nuca, Adrian Turcan) „Performance systems of hybrid and electric vehicles with a dual-rotor axial synchronous machine, a single stator and inverter HELSAX (2016-2018) were developed and researched electric propulsion systems based on a single-stator and two rotors axial electric car and a single static converter with two independent output frequencies [16].

In the period of 2020-2022, the Technical University of Moldova of Chisinau in partnership with the Technical University „Gheorghe Asachi" of Iasi had realized the project of cross-border cooperation RO-MD EMS-ENI 2SOFT/3.1/54 „Improving the cross-border public transportation using electric buses supplied with renewable energy". In the project were carried out extensive studies of the traction systems of electric motor electrobuses, electronic power converter and battery accumulators, of vector control methods, intelligent and energy efficient, a mixed automated system was developed to supply battery accumulators of electric mains batteries and solar panel farm [17, 18].

Since 2020, within the State Program, the team of the Department of Electrical Engineering (dr. conf. Ilie Nuca-director, prof. Petru Todos, prof. Tudor Ambros, dr. conf. Vadim Cazac, dr. conf. Alexandru Tarlajanu, Marcel Burduniuc, Cornel Gherțescu, Ghendie Tertea, Iurie Nuca, and Alexandru Motroi) carries out the research project no. 20.80009.5007.29PS „Integrated autochthonous electric traction systems for urban passenger vehicles". The aim of the project is to develop integrated domestic electric traction systems with increased energy efficiency and reliability for urban passenger vehicles, based on the associated use of the electronic static converter and the asynchronous motor, both with six phases. At the current stage, models of static converter and hexafazate asynchronous motor (figure 7)

have been developed and manufactured, in-depth experimental research is carried out to test the topological structures of the motor and inverter, as well as the optimal control methods.

**Figure 7.** Models of the hexafazate asynchronous motor and inverter

***Research direction „Electromechanical adjustable systems for Automation and Energy efficiency of technological processes”*** It is fully in line with the national Program for Energy efficiency. Within the national research project „Toward an Energy autonomy of the Republic of Moldova (AUTOEN)” the team of the department (prof. Tudor Ambros, dr. conf. Ilie Nuca, dr. conf. Leonid Iazlovețchi, Marcel Burduniuc, Iurie Nuca, Adrian Țurcan) have developed and researched various electromechanical converters with low power loss, adjustable electromechanical systems to increase the energy efficiency of pumping/ventilation technological processes, industrial technological processes and common technological installations [19].

## 6. Conclusions.

During the period of independence of the Republic of Moldova, the industry underwent many transformations. In accordance with the requirements of the idustria, the study programs at the Electrical Engineering department were, also, modified. Science, in the field of electromechanical, is developing in step with the development of technologies used in the industry.

**Acknowledgment.** This work was supported by a grant of the National Agency of Research and Innovation (ANCD), project number 20.80009.5007.29.

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