

An overview of the didactic and scientific activity at the faculty of mechanical and electrical engineering of the Polish Naval Academy

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ABSTRACT



The article characterises the didactic and scientific activity at the Faculty of Mechanical and Electrical Engineering of the Polish Naval Academy. The current didactic offer and the areas of current research work are presented, along with main characteristics expected from the naval specialisation graduate majoring in mechanics and machinery construction, in the context of the Polish Navy technical staff education system. Discussed are the subjects of research activities initiated in particular Faculty units, and leading scientific problems which have been studied for years within the field of widely understood utilisation of naval technology.

Keywords: Polish Naval Academy, Faculty of Mechanical Engineering, Faculty of Electrical Engineering, Didactic, Scientific

INTRODUCTION – HISTORICAL BACKGROUND

The Polish Naval Academy, bearing the name of Westerplatte heroes, is the only military naval academy in Poland, which since 1922 has permanently trained officers wanting to serve on Navy ships and offshore units.

The beginning of activity of the PNA Faculty of Mechanical and Electrical Engineering dates to November 1, 1931, when Commander Karol Korytowski, the then Commandant of the Naval Officers School in Toruń, admitted as freshman cadets 12 candidates for naval technical officers [1].

The earliest formulated general mission of the Faculty of Mechanical and Electrical Engineering was training mechanical engineers ready to perform their duties as naval officers responsible for operation and professional service of all machinery and systems situated in the ship's engine room.

During 75 years of Faculty's existence its organisational structure was changed several times, always to follow the development of naval sailing techniques. In the most difficult years of the Second World War, when the Academy was moved to the United Kingdom (Plymouth, Davenport, Okehampton), the organisational structure of the Faculty reflected the requirements resulting from war activity conducted in alliance with the Royal Navy. In those days the then Faculty of Technology graduated 23 mechanical officers ready to command, during war operations, power plants on both Polish Navy's ships and those obtained from the United Kingdom [2,3].

After the Second World War the activity of the Faculty was continued in a new situation of geopolitical reality. On January 18, 1946, in Gdynia-Okęsywie the Naval Officers School, the predecessor of the present Polish Naval Academy, started its activity, with the Faculty of Technology as part of it. Since then to now the headquarters of the Academy have

been situated in the block of buildings designed in 1924 by Professor Marian Lalewicz - a lecturer of architecture at the Lvov and Warsaw Universities of Technology (Photo 1a). Until 1939, the Centre of Experts Training of the Polish Navy had had its headquarters in there, and during Hitler's occupation - the Kriegsmarine. The present sight of the Academy is given in Photo. 1b.



Photo. 1. Campus of the Polish Naval Academy in Gdynia
a) Academy under construction - 1925, b) present sight of Academy.

The most recent change in the organisational structure of the Academy was made in 2003. It resulted in restructuring the Faculty of Mechanical and Electrical Engineering which, preserving its previous name transformed its structure formerly consisting of four faculty institutes and two separate Departments of Mathematics and Physics into that consisting of two faculty institutes and one Mathematics and Physics Department. The present structure of the Faculty is given in Fig. 1.

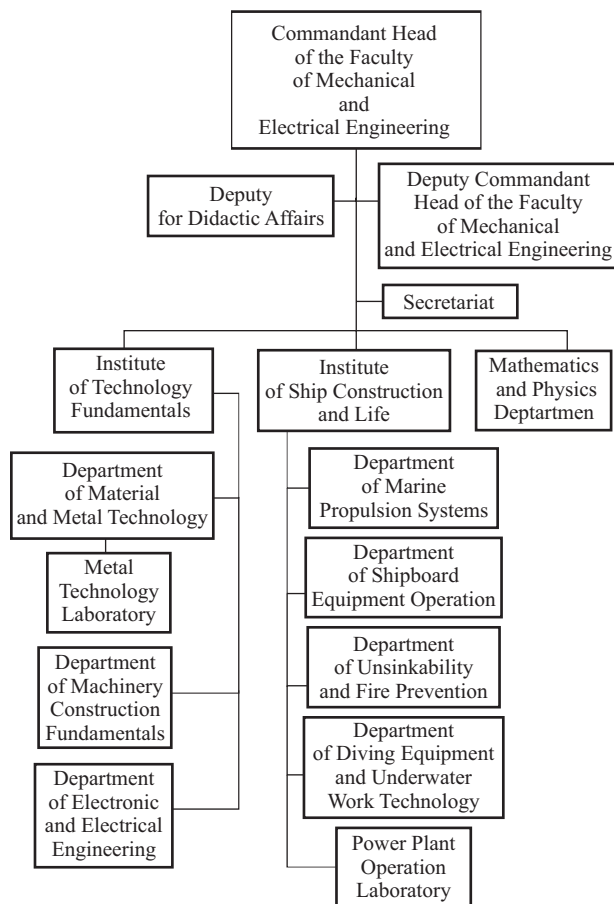


Fig. 1. Organisational structure of the PNA Faculty of Mechanical and Electrical Engineering

At present the Faculty employs 53 academic lecturers, including 12 independent research workers (6 full professors and 6 associate professors) and 41 assistant research workers (28 assistant professors and 13 masters of science). To conduct BS studies, MS studies, and unified intramural studies of mechanics and machine construction, the Faculty has the relevant minimum staff for the home unit (5 independent research workers representing the discipline identical or very close to the education major, i.e. machine design and operation, and 3 independent research workers representing similar, or basic disciplines being in some relation with the education major) and for running an outside didactic centre. In the latter case the requirements for the home unit include: 8 independent research workers and 7 assistant professors, including 5 independent research workers and 6 assistant professors representing the discipline of concern, with the remaining academic lecturers representing related disciplines. A complementary requirement which is met by the Faculty is to have 9 assistant professors with professional practice. At present the Faculty has 184 students in total, including: 60 intramural military students, 31 intramural civilian students, and 93 extramural civilian students. All this gives an extremely high ratio of education quality, as compared to other higher-

education institutions in Poland. This ratio, understood as the proportion of independent academic lecturers to students, is equals to 1:15 in PNA.

Admission limits for military studies are decided, year by year, by the Minister of National Defence, and the Academy cannot change them. This year the admission limit for the major of mechanics and machinery construction was equal to 18 persons. Such a small number of military students allows these studies to be treated as privileged, individual in practice, and completely adequate to professional requirements expected from the graduates – future Navy officers and operators of marine power plants.

Until the academic year 2004/2005 the admission limit for civilian studies had been decided by the Ministry of Science and Higher Education, and was equal to 20 candidates for intramural studies for the entire Academy. In the recent year, i.e. for the academic year 2005/2006 this limit was increased to 100 persons (out of which 30 persons for the Faculty of Mechanical and Electrical Engineering). At present, the admission limit for civilian studies is decided by the Academy Senate, depending on the scale of the financial support obtained from the Ministry of Science and Higher Education. The number of young people starting civilian intramural studies, initiated for the first time in the Faculty in academic year 2005/2006, have been doubled to 60 people in the present year.

Since 1987 the Faculty is authorised to confer scientific degrees in the field of technical sciences and the discipline: machine building and operation. Since the authorisation to confer doctors degree was obtained, 44 doctor's theses were successfully defended at the Faculty. Eight Faculty graduates were conferred the degree of associate professor and four - of full professor.

TRAINING TECHNICAL STAFF FOR WORK AT SEA

The Faculty of Mechanical and Electrical Engineering conducts studies preparing for work at sea. It trains candidates for Navy officers at five-year uniform graduate studies, with the major in mechanics and machinery construction, and major specialisations in marine power plant operation and electrical equipment operation, as well as (since 2005) civilian students for candidates for merchant marine officers, with the same major and the specialisation in marine power plant operation. The future officers are taught general-education subjects, including English, psychology, sociology, mathematics, physics, physical education, and job-oriented subjects, such as, for instance, thermodynamics, mechanics, electrotechnics, turbine engines, piston engines, marine power plants, marine power plant control systems, theory of operation, and ship equipment repair technology. The graduates are conferred the title of an engineer - ship mechanic and (candidates for Navy officers) the degree of Navy Ensign. Civilian graduates receive the diploma of the merchant marine watch officer.

As well as that, since 1998 the Faculty has conducted extramural BS studies in the major of mechanics and machinery construction, and the major specialisations in marine power plant operation and electrical equipment operation. After these studies the graduates are conferred the title of an engineer - mechanic with relevant specialisation.

As a consequence of including naval academies to the Act on Higher Education, extensive work is conducted in the Naval Academy towards its fast adaptation to the requirements of this Act. Following the Bologna Convention, starting from the academic year 2006/2007 a system of two-level education of civilian students has been introduced, which will also apply

to military students since the academic year 2007/2008. New programmes of two-level studies conducted in the intramural and extramural modes take into account all programme and time requirements defined in relevant teaching standards for the course of mechanics and machinery construction, as well as standard requirements concerning marine staff education, defined in the STCW Convention. With respect to military students – relevant directives of the Ministry of National Defence are also taken into account. The studying programmes take into account ranking by the ECTS evaluation system, concerning transfer and accumulation of ranks, and include detailed check of ability to communicate in English. According to NATO standards in force in the Academy, our military graduates have to meet language requirements defined in STANAG 6001 - level 3, which corresponds to standard C1 requirements according to the criteria of the European Council.

Characteristics of the military graduate

The military graduate of the PNA Faculty of Mechanical and Electrical Engineering has to possess knowledge, skills and professional attitude which will allow them to take duties of Navy officer commanding the electromechanical section of the ship. Professional dispositions for doing this duty by the graduate are warranted by the possession of Quality Certificate ISO 9001:2000 by the Faculty, and conducting the studies in accordance with Education Quality Standards defined by the Ministry of Science and Higher Education, and the International Convention Concerning Requirements in Training Sea Vessel Crews, STCW 78/95. In recognition of high quality of education in the two abovementioned areas, the Faculty was granted the following accreditations:

- Quality Certificate ISO 9001:2000 confirmed for three years, i.e. until 21.09.2008. The range of the certification covers:
 - o teaching students in intramural and extramural modes at the first and second level, and at postgraduate studies
 - o conducting scientific research in the field of military, technical, and human sciences
 - o conducting specialist courses, including those concerning activities named in the resolutions of the STCW Convention, and professional improvement courses.
- Certificate of the Commission of Accreditation of Technical Academies for the major of mechanics and machinery construction, for academic years 2002/2003 to 2007/2008
- Certificate of the National Accreditation Commission for the major of mechanics and machinery construction, for academic years 2005/2006 to 20011/2012
- Certificate of Acknowledgement of the Minister of Marine Economy for training marine staff at the operating level in the engineering department, within the range covered by STCW resolutions - in force until July 1, 2011.

An essential property of the process of education is ability to form appropriate professional attitude by direct contact of Academy graduates with the didactic personnel, members of which, along with university titles and degrees, also reveal vast sea-war practice confirmed by relevant professional degrees.

As far as military studies are concerned, the Faculty conducts training in two major specialisations: marine power plant operation, and marine equipment operation.

The graduate in the major specialisation of marine power plant operation possesses basic general and job-oriented education obtained following the studying programme relevant

for the major of mechanics and machinery construction and necessary for understanding scientific fundamentals of engineering knowledge within the area of the construction and technology of ship machine production. Moreover, they possess versatile specialist knowledge required for independent running of marine power plants, including the use of weapons, and meeting at the same time ship sailing safety and sea environment protection requirements. This, in turn, allows them, just after the graduation, to take independent officer's posts on Navy vessels and merchant marine ships. They also have thorough knowledge on how to solve technical problems in mechanics, and design ship machinery and equipment with the use of modern computer-aided methods invented to support engineering work.

The graduate in the major speciality of electrical equipment operation possesses versatile knowledge and skills concerning the construction and operation of mechanical and electrical systems on the ship. They acquire ability to work in engineering teams consisting of specialists in mechanics, machine building, electrotechnics and electronics. High attention is paid to syntonico cooperation of the future engineer-mechanic with the computer environment, both within the range of its operation, and the integration of ship machines with elements providing opportunities for computer control, digital recording and processing of operating data. Programme essentials included in particular lectured subjects are a warranty that the graduate in this specialisation is well prepared to solve technical problems connected with the operation of ship machines and systems containing electronic, electrical and mechanical components. The studying programme includes interdisciplinary problems within the fields of modern machinery industry and advanced electrical and electronic technologies, studying of which requires linking basic knowledge of mechanics, and machine construction and operation, with widely understood experience in informatics, automatics, electrotechnics and electronics.

The graduate of military studies is prepared to :

- ◆ command the crew of the ship department
- ◆ make rational operational decisions in difficult situations taking place in marine power plant operation at sea and in extreme battle conditions
- ◆ manage material resources on the ship according to the regulations in force
- ◆ run research projects and scientific investigations in scientific and research institutions
- ◆ continue education at third-level studies.

In particular, specialist qualifications of the graduate include:

- ability to operate and design marine power plants and general vessel systems
- familiarity with the construction and principles of operation of ship propulsion systems, and electrical and electronic equipment
- ability to use computer systems to support design of ship machines and equipment
- familiarity with marine power plant control systems and electric power generation systems on the ship
- theoretical and practical knowledge of problems of diagnostics and control of marine power plant machines and systems.

The graduate is ready to work:

- ⇒ on Polish Navy ships – as the commander of the electromechanical department
- ⇒ on sea merchant ships – as the watch officer

- ⇒ at technical universities, in scientific research institutes, or research and development centres with ship oriented specialisation, respectively, as academic lecturer, or research worker
- ⇒ in institutions involved in industrial consultancy and promotion of knowledge on mechanics and machinery construction.

Characteristics of the civilian graduate

Within the framework of civilian studies, the Faculty conducts teaching in two major specialisations: marine power plant operation (marine specialisation) and technical applications of computers (polytechnic specialisation without marine rights).

The major specialisation of marine power plant operation is oriented on training marine experts able to do a duty of an engineer-mechanic – watch officer on merchant vessels, while the specialisation of technical applications of computers – specialist in naval computer systems.

Among the subjects lectured in the naval specialisation, special attention is paid to the construction and practical use of general ship systems and power plant systems on civilian watercraft. The studying programme covers the area of interdisciplinary problems concerning modern machine industry and advanced electric technologies, studying of which requires basic knowledge of mechanics, and machine construction and operation linked with wide experience in electrotechnics. During their education the students get familiar with the structure and operation of marine power plants and general ship's systems, as well as mechanical and electrical systems. They gain ability to work in engineering teams consisting of specialists in mechanics, machine building and electrotechnics. The essentials of particular lectured subjects are the warranty that the graduate with this major specialisation is well prepared to solve technical problems connected with the operation of marine power plants, and ship's machines and systems having pneumatic, hydraulic and mechanical components.

Specialist qualifications of the graduate with the civilian marine specialisation are identical to those obtained after military studies. Beside already mentioned sea-going ships, employment prospects for these graduates also include shipyards and design-and-production plants having connections with the shipbuilding industry.

Studies in the major specialisation of technical applications of computers focus on problems of widely understood applications of computer systems for solving present-day problems on naval engineering. The studying programme includes all standard subjects in the major of mechanics and machinery construction, extended by problems of computer engineering systems in operation in naval applications. During their studies the students get familiar with basic problems of mechanics and naval machinery construction, with selected problems concerning principles of operation of naval mechanisms and equipment, as well as with the structure and control of computer systems. The studying programme includes computer aided design, realisation of engineering computations with the aid of specialist software, graphical data presentation and their processing using multimedia techniques, as well as the use of internet resources.

The thematic structure of the subjects offered in the studying programme pays attention to theoretical and practical preparation of the graduate to easy implementation and practical use of new achievements of computer technique in numerous applications of naval engineering. We expect that

these abilities may turn out very useful on the present-day and future work market.

Specific qualifications of the graduate include:

- ☛ ability to use computer software as the aid in designing elements of naval machinery and equipment
- ☛ knowledge of the structure and basic principles of operation of naval machinery and equipment
- ☛ practical ability to use available computer software for engineering analyses
- ☛ practical knowledge of present-day ship propulsion control systems and electric power generation systems
- ☛ theoretical and practical knowledge of problems of steering and control of ship's engines.

The graduate in this speciality has the following employment opportunities:

- ☆ shipyards, design offices and production plants having connections with the shipbuilding industry
- ☆ technical and marketing departments in companies offering measuring instrumentation for naval machinery and equipment, among other destinations
- ☆ companies offering industrial control and measuring equipment
- ☆ companies developing marine power plant computer control systems.

Professional training

Professional training is integral part of the education process. Depending on the type and year of studies, it is conducted on Navy ships, in Navy training centres, on sea-going vessels, and in shipyards and repair or production plants working for shipbuilding industry. Ship training courses, lasting 6 months, aim at familiarising the trainees with the conditions of work at sea, ceremonials and customs cultivated by the sailors, and principles of operation of a marine power plant with the power output above 750 kW.

At the same time technological training courses, conducted in the production plants and shipyards, are oriented on gaining by the trainees more knowledge on the ship repair technology used in shipyards and the naval equipment production technology.

Didactic offer

Within the framework of the course of mechanics and machinery construction, the didactic offer of the Faculty includes vast variety of specialisations. While the specialisations of the military studies are strictly defined by MOD regulations, those offered in the civilian studies are the effect of permanent analyses of the work market, performed by the Faculty, and reflect the recognised educational needs. In our attempt to follow these needs, every year we extend our didactic offer by new specialisations, to meet in our projections the expectations of alumni of the secondary schools.

A serious organisational problem is relatively low, so far, popularity of intramural civilian studies offered by the Faculty. The Academy is well known in Poland but rather because of its military studies. In this-year recruitment for military studies there were 6 candidates for 1 place. The problem of recruitment for civilian studies, and the resultant poor mathematical and physical knowledge represented by the admitted young people, make it necessary to organise additional compensating courses oriented on minimisation of disproportions between the requirements of the studying

programmes to be realised by the Faculty and intellectual abilities of the young people starting their studies. The problem is becoming even more important in the light of the fact that the thematic range of didactic lessons conducted in English is more and more extended from year to year.

At present the Faculty offers the following specialisations:

- * marine power plant operation (military and civilian studies)
- * electrical equipment operation (military and civilian studies)
- * technical applications of computers (civilian studies)
- * mechatronics of oceanotechnical objects (civilian studies)
- * diagnostics and repair technology of oceanotechnical equipment (civilian studies).

Such a wide variety of specialisations brings, however, some drawbacks. Namely, in case of high differentiation in specialisations in particular years of studies a situation may happen in which a student who failed to account for one year will not have an opportunity to repeat it, or even to finish studies in the specialisation which he or she started studying (the specialisation is selected during the second semester of studies). But we believe that the nearest future will bring long expected revival of shipbuilding industry in Poland, and the work market will stabilise which will allow us to reduce the list of offered specialisations.

SCIENTIFIC RESEARCH

The scientific potential of the Faculty, growing in successive years of the existence and development of the Academy, was the basis for more and more dynamic scientific activity, oriented on both fundamental and applied research, as well as on development activities and innovative initiatives taken to solve key research problems stated by the Polish Navy, MOD, and shipbuilding industry. Some activities focus on interdisciplinary issues connected with technical aspects of human activity at sea. A noteworthy feature of the scientific activity is that the research conducted in individual teams is strictly related with the didactic process, within the framework of mechanics and machinery construction, the major taught by the Faculty. The results of our scientific research make the basis for large part of the contents of the lectured subjects, while the research rigs, constructed as the result of research activities conducted by the Faculty, are used in laboratory work not only by students, but also by shipbuilding experts of various management levels.

At present, the Faculty of Electrical and Mechanical Engineering has the second scientific category granted by the State Committee for Scientific Research. The Institutes and the Department conduct scientific investigations attributed to various SCSR groups. The Faculty accounts in the group T10 for the scientific activity and the financial support gained for the statute activity.

When characterising the range of scientific research conducted at the Faculty, 7 basic research areas can be named, which, with different intensity, were undertaken throughout the history of its existence as part of the institute structure, i.e. since 1978:

1. Construction and operation of naval machines,

in particular the construction and operation of marine propulsion systems and power plants, operation of electrical naval equipment, diagnostics of marine engines, emission of toxic compounds in exhaust gases of marine engines, and statistical methods in operation, reliability and diagnostics of

naval machines and equipment. At present these subjects are the objects of basic research activity at the Institute of Ship Construction and Life. The subject matter of the conducted activities mainly focuses on issues connected with widely understood diagnostics of marine piston and turbine engines. This activity was continuously developed since 1982 in four esteemed research teams, out of which the team headed by Prof. Adam Charchalis, D.Sc., was focused on turbine engines, two teams headed by Prof. Leszek Piaseczny, D.Sc., and Dr. Stanisław Polanowski, Ph.D., were involved in studying internal combustion engines, and that headed by the author of the present article performed diagnostic studies of flow systems of piston and turbine engines. A key role in the conducted investigations was also played by the team of specialists in applied mathematics, headed by Prof. Franciszek Grabski, D.Sc., Head of the Mathematics and Physics Department. Realisation of over 20 research programmes made it possible to develop the Basic Diagnostic System for marine internal combustion (piston and turbine) engines. The system provides opportunities for a comprehensive on-line and off-line diagnosis of the current state of the engines being under the diagnostic control, and makes it possible to work out horizons of the prognosis of their faultless work. The developed measurement and control system was used for analysing toxicity of the exhaust gases emitted by marine engines in the aspect of meeting requirements of the MARPOL 73/78 convention. This made it possible to prepare methods of effective reduction of the level of toxic compounds and solid particles emitted in exhaust gases by marine engines and boilers, which goes towards the announced introduction of international standards and regulations limiting the levels of those emissions with respect to engines installed on navy ships.

Recent introduction of a new type of propulsion engine, with relatively low control flexibility, on Polish Navy ships is the motivation for looking for new, so called alternative diagnostic methods, which would make it possible to perform a comprehensive analysis of the technical state of such an engine independently of very expensive producer's service. The methods of diagnostic actions developed in numerous doctor's and qualifying theses base on the following measurements:

- a. high- and low-frequency gasodynamic parameters of the working medium
- b. lateral and torsional vibrations, along with their spectrum and correlation analyses
- c. metallic impurities in the lubricating oil
- d. emission of toxic compounds in exhaust gases
- e. parameters of the delivered fuel
- f. endoscopic inspections.

At present, the Faculty conducts two grants in this area:

- ⊛ Method of diagnosing engines on military vessels, with limited space for measuring inner cylinder pressure, on the basis of the results of investigations of the gasodynamic processes in the turbocharging system,
- ⊛ Models for identifying the technical state of an engine from the evaluation of its exhaust gas components.

The results of these grants are being introduced on Navy vessels, among other places.

It is noteworthy that part of the diagnostic instrumentation, such as the endoscope set or gas analysers for instance, can be successfully used for assessing the technical state of both piston and turbine engines. At the same time procedures that realise the diagnostic tests are different - more precisely they

are each time adapted to a particular type of engine. The strategic goal of the presented diagnostic methods, which are continuously developed and modernised, is to provide opportunities for running Navy's marine engines based on their actual technical state. The presently conducted research make it possible to perform technical state based operation of over 150 engines, of total output power exceeding 500 MW. The research rigs, data base, and diagnostic programmes are continuously updated and extended taking into account factory repairs and resultant changes of characteristics of the engines introduced to operation. For the time being, over 1000 expertises of ship's propulsion systems with piston and turbine engines have been done.

The presently conducted research activities are oriented on the development and modernisation of the Basic Diagnostic System, to allow diagnostic supervision of marine piston and turbine engines to be used on American frigates Oliver Hazard Perry (Detroit Diesel, type 16V149TI, and General Electric, type LM-2500), introduced to our Navy in recent years.

2. Technology of underwater activities, construction and operation of diving equipment. Working activities in the area of underwater engineering have been carried out at the Faculty since 1976 in research teams headed by successive commanders of the Department of Diving Equipment and Underwater Work Technology, established in that year as part of the Institute of Ship Construction and Life. They were: Captain Medard Przyłipiak, M.Sc., Captain Marian Pleszewski, M.Sc., Captain Stanisław Skrzyński, Ph.D., and recently – Captain Ryszard Kłos, Ph.D. The subject matter of the initiated research activities was connected with the construction and operation of hyperbaric chambers and the construction of life-support systems in real marine diving systems, including submarines. Depending on the type and construction of the underwater object, these systems secure controlled change of parameters of the breathing atmosphere (composition, purity, smell, state parameters such as: temperature, humidity and flow velocity), or intensive exchange of the atmosphere without changing the pressure inside the object. As part of those activities, a hyperbaric unit for saturated diving was modernised to provide opportunities for long-lasting diving experiments, performed using breathing mixtures based on three gases: helium, nitrogen and oxygen, or two gases: nitrogen and oxygen, or helium and oxygen, down to the diving depth of 120 m. Using this unit numerous long-lasting cases of "diving" were executed to prepare and train teams of test-divers for diagnosing modern oceanotechnical objects. Moreover, as part of the studies of oceanotechnical problems, a system examining breathing apparatuses and robots used in the diving equipment was introduced to operation. The basic commissioner of the research activities in the area of underwater engineering is the Polish Navy and the exploratory company PETROBALTIC.

The presently conducted activities are connected with diagnosing underwater objects with the aid of vision systems, and are oriented on working out a method for dimensioning damages of underwater objects. This problem is of high significance when inspecting underwater constructions and Navy vessels, in particular with the aid of the unmanned underwater vehicle ROV SUPER Achilles owned by the Department of Diving Equipment and Underwater Work Technology.

Research activities closely connected with the technology of underwater work are also conducted in other Faculty's organisational units. In particular, the research work conducted by the team headed by Jerzy Garus, Ph.D., in the Institute of Technology Fundamentals refers to, among other topics,

methods of recognising underwater objects based on their visual representations. The work aims at developing systems of three-dimensional visualisation of underwater objects, with their further identification and classification. The results to be obtained are expected to make the basis for working out a system of automatic detection of sea mines based on their visual representation. A simulator for remote control of an unmanned deep-water vehicle is being built to provide opportunities for effective examination of methods selecting a trajectory for the vehicle, and controlling its motion along the assumed trajectory.

3. Ship theory and construction. After years of stagnation caused by unexpected resignation of one of Faculty's professors in 1991, long expected revival in the field of model investigations of ship stability and unsinkability has been observed. Subjects were formulated in the Institute of Ship Construction and Life which integrated together the research team headed by Captain Waldemar Mironiuk, PhD, involved in building the research rig to examine in the model tank the behaviour of the physical model of a ship in various emergency states. The range of experimental investigations and numerical studies covers both static and dynamic stability of the ship.

The collected measuring instruments make it possible to record physical processes observed when a ship grounds, or some compartments are flooded in the model of a selected surface or underwater ship in operation in Polish Navy. Moreover, the rig provides opportunities for analysing the effect imposed on the initial ship stability by the free surface of the liquid transported in compartments or tanks, and/or by weight loading, moving, and unloading. Another planned option is examining the effect of wind on stability parameters of the ship in motion.

The expected results of the investigations will make it possible to work out new procedures of ship protection against failures, thus contributing to the prolongation of life of battleships in operation.

4. Material engineering. The objects of investigations are modern construction materials, including composites, splinter resistant steels, aluminium alloys and modified wood used in ship constructions. Material tests aim at working out the technology for their production in the context of their possible use in shipbuilding. This refers in particular to the activities connected with developing and introducing amagnetic steels and cast steels used for marine constructions, including methods for increasing ballistic strength of external and internal shields protecting most important battle stations and ship's quarters.

In recent few years, a new subject of scientific research has been developed in the Institute of Technology Fundamentals which is oriented on comprehensive examination of possible use of wood in shipbuilding. Within the framework of a broad research programme headed by Prof. Lesław Kyzioł, D.Sc., a research rig was built and put in operation. The rig is used for studying wood saturation and polymerisation, processes which make it possible to shape physical and chemical properties of the designed construction elements (Polish National Patent). After introducing genuine technological processes it was proved that the mechanical properties, fatigue, and abrasion resistance of the wood can be significantly increased by its modification consisting in surface saturation with a synthetic polymer (methyl methacrylate). The investigations also confirmed high impact strength of the composites making use of the modified wood, which allows them to be used in real ballistic protection shields on ships.

In recent years, the Faculty has also conducted material investigations connected with the degradation of mechanical properties of austenitic steels and the degradation of shipbuilding properties of aluminium alloys resulting from corrosive electrochemical action of sea water. A separate group of topics comprises vacuum-plasma based methods of refining steel surfaces of deck gear elements. For years these issues have been the object of investigations of specialists in material engineering involved in search for qualitatively new materials to be used in shipbuilding, i.e. materials tightly resistant to the action of corrosive environment at varying loads. The research team headed by Commander Wojciech Jurczak, Ph.D., has recently been strongly reinforced by employing Professor Witold Precht by the Faculty, a person recognised both in Poland and abroad as a specialist in material engineering.

5. Mechanics, in particular impact strength of ship constructions, and computer aided design of elements of ship machines and equipment. The presently conducted research activities include issues relating to general and local strength of ship's hull, resistance of naval devices and equipment, especially at pulse loads. The research includes both theoretical studies of the action of underwater shock wave on the ship hull, and experimental tests leading towards determining the resistance of ship's equipment to underwater detonations. Experiments are carried out which simulate loads of naval objects by contactless underwater detonations. This problem directly results from the need to know load characteristics of ship hulls and marine objects, generated during contactless underwater detonations. For obvious reasons these characteristics are not published, or they are not relevant to specific constructions of ships used by Polish Navy. The characteristics cannot be examined experimentally using real detonations, which is the reason why simulation models are to be developed and used to provide data which then can be transposed to real objects - after evaluating the range of model adequacy. The team, headed by Professor Stanisław Dobrociński, D.Sc., that studies these problems has methodological experience unique in Poland, and the preliminary test of the already developed models allows us to expect real and positive results of those investigations. Direct application of those investigations will consist in introducing constructional changes and modifications to improve impact strength of real ships in operation, and in formulating general conditions on how to preserve this property in the constructions of newly built ships.

An important position in this area of research is occupied by numerical methods applied to solve problems of ship construction hydro-elasticity. Moreover, graphical assistance systems are worked out to be used in numerical calculations, both for controlling input data preparation, and interpreting the obtained results. The latter task is realised using graphical visualisation of the output functions of displacement, stress, temperature and pressure.

6. Steering and numerical automation, in particular: identification and modelling of multi-dimensional objects, artificial neurone networks in steering, fuzzy steering, processing, transfer and visualisation of information data in naval systems, operation of electric power systems and electric drives of the ship. The developed research directions also include the computer system of ship control and measurements, modelling and identification of coefficients in dynamics equations for multi-dimensional objects, and steering the objects sailing along a given trajectory. An important position in the conducted research is occupied by unmanned underwater vehicles equipped with a camera and sonar to identify objects of danger (like mines, for instance).

7. Ship command assistance, including research activities within the field of computer integration of general ship systems, automatic ship control systems, graphical visualisation systems, marine power plant control systems, and marine stabilisation platforms. The studies under way refer to systems that visualise and store ship position and motion, along with its trajectory and the navigational situation for the purposes of Navy ships, and also make it possible to transmit the recorded data via radio to a land-based control centre or the depot ship.

LABORATORIES AND RECORDING EQUIPMENT

The Faculty owns various laboratories and working rooms to support the didactic process at the studies of mechanics and machinery construction, and the realisation of research activities conducted in particular organisational units of the Faculty. The specialist equipment and instrumentation of the didactic laboratories reflect present scientific achievements in the relevant scientific discipline, i.e. machine construction and operation. Detailed data on the laboratory equipment owned by the Faculty are given in Table 1.

Tab. 1. Recording equipment used in laboratories and working rooms of the Faculty of Mechanical and Electrical Engineering

Name of laboratory/ working room	Purpose and brief characteristic
Laboratory of marine power plant operation	<p>Equipped with 2 turbine engines, 3 marine piston engines, and all machinery and equipment elements used on Polish Navy ships. Opportunities are also provided for installing recording instruments such as vibration analysers, endoscopes, specialised digital recorders recording high- and low-frequency parameters, etc. The following experimental stands are situated in the laboratory:</p> <ul style="list-style-type: none"> • stand for testing operating parameters of the engine, equipped with the marine engine SULZER, type 6AL20/24, and the Froude water brake, type DPY6D • didactic stand equipped with the marine engine WOLA, type 57 H6A • marine, single-piston, high-speed internal combustion engine • piston engine S312C • turbine engine GTD-350 • current generating set with the turbine engine TG-16 • stand with an auxiliary marine boiler, type VX506A-10 • oil centrifuge stand equipped with the self-cleaning centrifuge ALFA-LAVAL, type MAPX 207 -24S and the centrifuge ALFA-LAVAL, type MB 1424 F • rotating pump stand equipped with the rotordynamic liquid ring pump, type SK6-01-1 and S-21-4-1 • hydrophore stand • stand for adjusting multi-section injection pumps, type MOTORPAL

Name of laboratory/ working room	Purpose and brief characteristic
Laboratory of marine power plant operation	<ul style="list-style-type: none"> • air compressor stand equipped with marine piston air compressors, type K2-150 and S2W-50 • fuel injector control and adjustment stand, equipped with a sampler for controlling PRW-3 injectors • refrigerated store stand with a marine compressor • stand for examining FKM-250 van • stand for examining a gear pump • stand for aligning the shaft line and adjusting the timing gear.
Laboratory of metal technology	<p>Equipped with w strength, fatigue and hardness testers, cryostats, impact hammers with relevant cooperating instrumentation, scanning microscopes, etc. The following experimental stands are situated in the laboratory:</p> <ul style="list-style-type: none"> • stand for mechanical working, equipped with lathes TSB 16; TSB 20; TUM 2117 and two millers Fu2 • stand for manual working, equipped with machines and tools for manual working • welding stand, equipped with: 3 electric welders SPM 200; welding apparatus PSP 251; welders RZP 2A and Mini-Mag 161 • stand do casting and plastic working, equipped with the electric muffle furnace 4kW; lithium box-type furnace KS 520/14; sylithium box-type furnace PSK-1; laboratory dryer KC 100/200 • stand for strength tests, equipped with strength testers MTS 810-12; 1231Y-10 INSTRON and Fu1000 • stand for fatigue strength tests, equipped with the fatigue tester DSO150; and a horizontal machine for fatigue tests in liquid environment • stand for abrasion tests, equipped with a machine for measuring the rate of abrasion of the construction • stand for impact tests, equipped with the pendulum hammer PS-30; PS-5; the rotating impact hammer RSO and the drop-weight hammer MBO for testing large material samples • stand for hardness tests, equipped with hardness testers HPO 3000, PW 106, HPO 250 and the micro hardness tester, type PMT-3 • stand for testing corrosion and corrosion-stress resistance, equipped with the static stretcher – 12 pcs, the four-stand strength tester UMB 6000 and the brine chamber • stand for corrosion-cavitation tests • stand for metallographic tests, equipped with the transmission electron microscope BS- 540, the scanning electron microscope BS- 300, the metallographic microscope Neophot-2 and the vacuum sublimator B302 • wood modification stand, equipped with a saturation autoclave and a polymerisation autoclave; • stand for workshop measurements, equipped with the universal workshop microscope, type ZKMO0.2/150, a small workshop microscope; the Schmalz surface analyser, the Hommel surface analyser - Tester P3, slide callipers, and other small-scale measuring instruments.
Non-permanent laboratory of marine power measurements	<p>The laboratory is equipped with the following instruments:</p> <ul style="list-style-type: none"> • set for testing mechanical impurities in the lubricating oil ZBZ-1 • signal analyser FFT T2143 • set of HORIBA analysers, type MEXA 9000 • four-gas analyser HORIBA 544J • sound level meter MEDIATOR • levelling laser device OPTALIGN • exhaust gas and admission air flow meter • optical dynamometer DO 9500 • meteorological station • surface roughness meter SUTRO • coating thickness meter MINITEST 60 • portable set for calibrating measuring converters based on the MCX II calibrator and the calibrating pump PV 411 made by DRUCK • torque meter MT – 200 with the torque and rotational speed meter IMFA 20005 • set for endoscope tests, and for recording and visualisation of their results, based on baroscopes and the fibroscope made by OLIMPUS and STORZ.
Non-permanent working room of diving apparatuses	Stands for breathing equipment tests, done according to the EU directive 89/686/EEC.
Non-permanent working room of hyperbaric chambers	Equipped with the experimental deep-diving unit DGKN – 120, which provides opportunities for full exposition and realisation of investigations connected with long lasting stay of a human being under water.
Non-permanent physical and chemical laboratory	Equipped with a gas chromatograph with the mass spectrometer AGILENT 5973, the laboratory shaker LAB – 11 – 200, the gas chromatograph Varian Aerograph 1400, and the laboratory scales AD 500.

Name of laboratory/ working room	Purpose and brief characteristic
Non-permanent laboratory of unmanned underwater vehicles	Underwater vehicle ROV SUPER Achilles, underwater navigation system for ROV type vehicles.
Marine power plant simulator	Equipped with: <ul style="list-style-type: none"> • corvette power plant simulator - 4 stands with access to internet • simulator of marine low-speed engine - 1 stand with access to internet • computer system for training operation on marine auxiliary installations - 4 stands with access to internet • stand for computer-aided diagnostics of the combustion process in a marine engine, with access to internet.
Didactic room of electronics, automatics and digital systems	Equipped with universal meters, general purpose and specialised oscilloscopes, and didactic computer stands.
Non-permanent didactic laboratory of visualisation systems.	Equipped with a radiolocation situation simulator which delivers information to the data visualisation systems, to be used for steering the ship, groups of ships, and tactic unions (within the framework of the subject entitled Automated Systems of Command and Sea Situation Visualisation). Moreover, the laboratory has the system that simulates the motion of a ship.
Non-permanent didactic laboratory of electric machines	Equipped with 10 sets of machines and measuring stands providing opportunities for conducting basic laboratory activities with electric machines.
Non-permanent laboratory of electric ship propulsion systems	Equipped with 3 sets of electric machines and 5 laboratory stands equipped with specialised meters to conduct laboratory activities on electric ship propulsion systems.
Non-permanent didactic laboratory of fundamentals of electrotechnics and electric measuring	Equipped with 13 laboratory stands providing opportunities for conducting Laboratory activities on electric measurements, and other ship measurements.
Non-permanent laboratory of marine power plant	Equipped with three generating sets and necessary instrumentation, along with digital system of control measurements and visualisation of power plant operation states.
Working room of computer design	Equipped with 10 CAD/CAM stands.

CONCLUSIONS

The state of didactic and scientific achievements observed in the jubilee 75-th year of the existence of the Faculty of Mechanical and Electrical Engineering obliges its authorities to take relevant actions towards starting at the Faculty the second major of civilian studies, and towards submitting for the rights to confer D.Sc. degrees in technical sciences, in the discipline: machine building and operation.

The performed analysis of the employment structure of independent and assistant research workers in the context of represented scientific specialisations and professional experience, along with the prognoses on further didactic development of the Faculty make the basis for expecting that since the academic year 2007/2008 all rights will be obtained for conducting first-level intramural and extramural studies (with further possible extension to the second level) on the second major of mechatronics, in the following specialisations: „Identification and diagnostics of naval technical systems” and „Computer assistance in mechatronics”.

Having analysed the present composition of the Faculty Council, and individual and collective achievements of particular research workers in the context of the regulations in force of the Minister of Science and Higher Education concerning conditions for obtaining habilitation rights, we

can expect that within the next 3-4 years the intellectual potential and research base of the Faculty will entitle the Dean to submit for granting the Faculty Council these rights. It is noteworthy that as far as the number of research workers with relevant titles is concerned, the Faculty has already met these criteria.

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