

## RESEARCH AND DEVELOPMENT ON UNDERWATER ACOUSTIC SYSTEMS AT POLISH NAVAL ACADEMY AND GDANSK UNIVERSITY OF TECHNOLOGY FOR THE POLISH NAVY



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*The article begins with an overview of how the Universities and the Polish Navy have benefited from what has been nearly fifty years of cooperation. The article goes on to discuss the last decade's hydroacoustics projects for the Navy. The Naval Academy's contribution involves measurements and analyses of ships' hydroacoustic fields including the technical applications of the projects as well as the application of propagation non-linear effects of acoustic waves in water. The University of Technology's primary contribution has been the modernisation of the Polish Navy's underwater acoustic systems.*

## INTRODUCTION

The Universities and the Polish Navy have enjoyed a successful cooperation in the area of underwater acoustics over the last fifty years for a number of reasons. First, some of the Navy's hydroacoustic systems and devices are either single specimen or come in small series.

Consequently, there is no need to involve large businesses to develop, manufacture or modernise these devices and the University's academic, technical and production capacity is just right for the job. Second, with the Universities situated so close to the naval port on the Gulf of Gdansk and relatively close to the Central and Western Coast ports, installing, testing, servicing and repairs are easy to do. Direct and personal contacts between the academic staff and Navy officers are very important as well; they are used to establish the Navy's need for hydroacoustic equipment and how these needs can be met considering the situation in Poland.

We must not leave out the economic aspects of the cooperation, offering benefits to the Universities and the Navy, especially when you consider the price differences between Polish and imported specialised military equipment.

In their statements the commanders of the Navy have always made it clear that the Polish Navy's demand for hydroacoustic equipment should be met by Polish researchers and Polish industry as much as possible.

At the 1997 Symposium professor Kozaczka presented the paper "Fifty Years of Polish Hydroacoustics" [1], in which he gave a short overview of how this field developed, saying that the work for the Navy was one of the main drivers of development. The cooperation continues to grow and this is why this year's Symposium provides a good opportunity to talk about the recent achievements of both Universities in this area.

When the Gdansk University of Technology celebrated its hundredth anniversary, in Gdansk in 2004 a special edition of the Marine Review, a monthly of the Navy, was published. Professor Rachoń, the University's Rector, wrote the foreword and the entire edition was about how scientists from different fields worked together with the Navy after WW2. The publication has two articles on hydroacoustics [2],[3]. In the first article retired commander Narcyz Klatka, D.Sc. suggests that 1957 was the official start date of the cooperation. Next year will be a jubilee year, especially because it was about that time that the Naval Academy launched its ship acoustic field research programme.

The next two sections are seen as a continuation of the paper [1] and present hydroacoustic projects delivered for the Navy in the recent years.

### 1. POLISH NAVAL ACADEMY PROJECTS

At the Naval Academy the area in question is primarily handled at the Faculty of Radiolocation and Underwater Acoustic. In general, the research draws on previous projects and the work can be divided into three thematic groups. They are:

- measurements and analyses of hydroacoustic ships fields with applications in modernised and extended physical field measurement sites;
- analysis of the propagation non-linear effects of acoustic waves in water including the application in parametric sonars;
- prognoses of the marine acoustic climate and practical ranges of underwater acoustic systems.

The research covering some 20 detailed subjects, was conducted under research grants, special grants and user contracts.

The first group of topics had the widest coverage. There were about twenty projects, headed by captain Ignacy Gloza, prof. Eugeniusz Kozaczka and commander Karol Listewnik.

The results included the demos of the technology (e.g. projects under the code names of HYDROTRANS, BARIBAL), documentation (MINIPOL, PŁOTKA), a doctoral dissertation (IDENTYFIKACJA) and important implementations (AZYMUT, MORŚWIN, RÓŻANKA, BŁĘKITEK).

An example of an implementation is the parameter's controller of acoustic disturbance sources generated by a moving ship (fig. 1). This system consists of a set of high sensitivity sensors in a configuration, which enables measurements of acoustic field pressure and intensity. On the basis of measurement results, it is possible to locate the main sources of the ship noise, assess their level and contribution to total noise. The system enables data acquisition and determination of the trend of technical parameters change in function of time, during the lifetime of the ship. It is very important for the ship's passive defence and effective maintenance of ship machinery. This and other systems have been applied to modernise measurement stations at the naval ports in Gdynia and Świnoujście.



Fig.1 The parameter's controller of acoustic disturbance sources generated by a moving ship

Running the projects from the second group was professor Grażyna Grelowska. The technology demo will mark the end of the grant under the code name HYDROANTENA and the same is envisaged for the grant ORFA when it ends next year.

Prof. Grelowska was also in charge of the HYDROKOS project from group three, now finished and the documentation ready. This group also included the subject RANGE run by prof. Kozaczka, for which the documentation is now ready.

It is important to stress that despite its scientific achievements the team does not lose sight of the real needs of the Navy. On the contrary, it makes sure that the research can be applied in practice, of which the previous implementations are a good example.

## 2. GDANSK UNIVERSITY OF TECHNOLOGY PROJECTS

Research and implementation projects in the area in question were primarily conducted at the Department of Acoustics run by professor Roman Salamon.

In the late 1990s in a joint project with the R&D Marine Technology, the last two MCM sonars SHL-100 were manufactured and a new era of modernisation began.

The first to be modernised was the ASW sonar on the ORZEŁ submarine. Major improvements were made to a big number of ASW sonobuoys with KRAB underwater noise analysers for Navy helicopters, and dipping ASW sonars for these helicopters and the KASZUB corvette.

The term “major improvement” is in fact inadequate, because these projects leave the design of the hydroacoustic antennas and their drives untouched, but all the other blocks are completely new, made with modern signal processing methods (chirp pulses, beamforming), imaging forms and modern technologies. They are major design, construction and organisational projects.

In the years that followed MCM sonars were modernised on two minehunters and side looking sonars were modernised on three others. At present work is under way on modernising active ASW sonars with underkeel antenna on the KASZUB corvette and passive ASW sonars with towed arrays on PUŁASKI and KOŚCIUSZKO frigates.

There are more details of this work in [4], and Figures 3 and 4 show the operator console of two modernised sonars – for the helicopters and minehunters.

Apart from pure modernisation, several new devices were designed and built within this period, e.g. analyser of acoustic signals from modern sonobuoys for the BRYZA aircraft, hydroacoustic system for controlling underwater objects for the SIKORA project (topic delivered by the Department of Underwater Warfare of the Naval Academy) and several designs of hydroacoustic antennas.

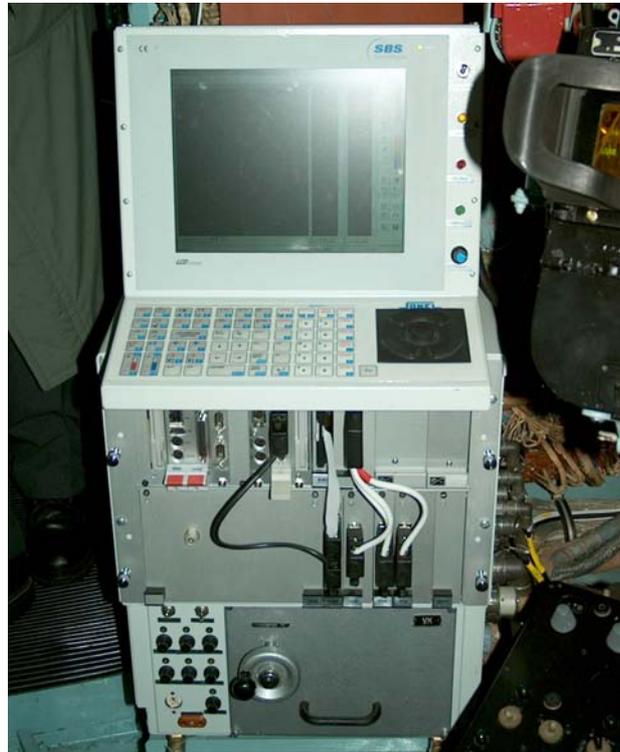


Fig.2 The operator console of the modernized ASW dipping sonar



Fig.3 The operator console of the modernized MCM sonar

It is important to say that all of these projects headed by professor Roman Salamon, dr. Jacek Marszal and dr. Lech Kilian are carried out by a small team of about fifteen people. With the money made working for the Navy the team were able to pay for state-of-the-art equipment. What is particularly important is the ability to test the hydroacoustic systems on what is called the Kashubian Sea, a large and deep lake Wdzydze with difficult hydrological conditions. The small village of Joniny is home to the team's technical base with three vessels. The facility can also be used for testing large and heavy systems, except when the lake freezes over.

It is also important to say that cooperation between the University of Technology and the Navy, as much as it is talked about at anniversaries, has had some practical implications within the University's organisational structure. The first step was the change of what was a general name of the Department of Acoustics into the Department of Marine Electronics Systems. The new name better reflects on the main theme of research conducted by the Department's specialists and the Department's teaching programme.

What was even more important was the establishment in 2004 of the Centre for Marine Military Technologies. It is the part of the University, whose statutory obligation is to conduct research and to teach. The Centre brings together teams involved in design and implementation, which previously worked in three different departments. With the establishment of the Centre it is clear that the Rector and University authorities pursue the policy of practical applications. As a result doing work for the Navy has been made less bureaucratic. Run by Andrzej Ogonowski, the Centre has been granted a license for the manufacture and sales of military devices and technologies and the ISO 2000 quality certificate, making it a full-fledged partner for the Navy when designing, implementing and manufacturing the different types of systems.

### 3. CONCLUSION

The cooperation between both Universities and the Polish Navy in the area of hydroacoustics has gone through several stages. The first period was the launch of the cooperation, trying to establish the available design and technology possibilities at universities and production companies. Despite the dogmatic reluctance of some decision-makers and the resulting lack of success [2] the cooperation continued to develop. The eighties were the peak of the cooperation, with less doctrine and regime and with more production in Poland of ships and their equipment. After a few bad years following the change of the political system, ships' equipment and naval ports are now becoming modernised, a trend which is expected to continue.

We hope that there will be more opportunity to celebrate new jubilees of cooperation in the area of hydroacoustics and refuse to believe the effectiveness of non-acoustic methods for detecting mines and submarines, which is what hydroacoustic averse groups tend to claim.

### REFERENCES

1. E. Kozaczka: Fifty Years of Polish Hydroacoustics. Proc. of the International Symposium on Hydroacoustics and Ultrasonics, pages 3 – 11, Gdańsk – Jurata 1997.
2. N. Klatka: „Prof. dr inż. Zenon Jagodziński i jego pierwsze urządzenia hydroakustyczne”. „Przegląd morski” vol. 10/LXIX, pages 21 – 24, Gdynia, 2004.
3. R. Salamon, L. Kilian, S. Wielebski: „Czterdzieści lat pracy w dziedzinie hydroakustyki Katedry Systemów Elektroniki Morskiej”. „Przegląd morski” vol. 10/LXIX, pages 25 – 35, Gdynia, 2004.
4. J. Marszał, L. Kilian, R. Salamon, A. Jedel, M. Rudnicki, J. Schmidt: “Navy Sonar’s Modernization Developed in Gdansk University of Technology”. Proc. of the IEEE International Conference on Technologies for Homeland Security and Safety, Gdańsk, 2005.