

## SELECTED CONDITIONS FOR THE MANAGEMENT OF UNDERWATER SYSTEMS UTILISING UNMANNED VEHICLES

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### ABSTRACT

The article presents selected issues related to the management of underwater systems utilising remotely controlled unmanned vehicles, constructed and used at the Faculty of Maritime Technology and Transport of the West Pomeranian University of Technology in Szczecin. System managements covers a number of activation levels connected with the current utilisation of systems, as well as developmental works. The article accentuates the conditions of use for the said systems with the main consideration of didactic purposes.

**Key words:** ROV, underwater technology.

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## INTRODUCTION

Research works within underwater technologies, including those related to the design, construction and utilisation of underwater vehicles have been carried out at the Faculty of Maritime Technology and Transport of the West Pomeranian University of Technology in Szczecin from the mid 1980s, and resulted in the construction and utilisation of several underwater systems [3,6] classified as MiniROV [3] or CompactROV [7] systems, as well as in obtaining 6 patents and 5 utility models within underwater technology. Simultaneously, 2 post-doctoral degree studies have been realised, 6 doctoral, and over a dozen MA and engineer theses have been submitted.

Moreover, the Faculty has entered into technical cooperation with such foreign institutes as: Hydrobotix (USA), Hytec (France), the Academy of Sciences in what was then the USSR, the Donetsk University of Technology, as well as numerous national institutions of the maritime economy including: PP Petrobaltic, Polish Baltic Shipping, the Polish Maritime Museum, the Polish Police forces, the Navy, Agricultural Academy in Szczecin, shipyards and diving centres.

Parallel thematic activities involve numerous domains, resulting from the university's activity.

These include:

- didactic activity at the first and second degree studies within Ocean Engineering, Transport and Security Engineering,

- research activity connected with the operation of the Student Scientific Association ABYSAL,
- didactic activity within the Children's University of Technology regarding maritime technique,
- broadly defined activity propagating underwater technology at environmental, national and international events.

The didactic activity is conducted at the Laboratory of Underwater Research utilising two abyssal systems:

- Underwater Monitoring System (SMP) equipped with remotely controlled underwater vehicle (ROV) called Krab, fig. 1, 3,
- Underwater Monitoring System (SMG) equipped with a remotely controlled underwater vehicle (ROV) called MAGiS, fig. 1, 2.

Besides warehouse facilities and a workshop, the Laboratory of Underwater Research encompasses three swimming pools:

- Experimental Pool – built from a 20-foot container (6 m x 2.5 m x 1.2 m),
- Circulation Pool – measurement window of 1.2 m x 0.8 m,
- external Technological Pool with the dimensions of 24 m x 10 m and the depth of 5 m, allowing the carrying out of test runs on vehicles and other selected tests.



Fig. 1. Laboratory of Underwater Research – the photograph depicts underwater vehicles MAGiS and KRAB.



Fig. 2. Underwater vehicle MAGiS undergoing tests conducted by the Scientific Association ABYSAL in the Technological Pool of the Faculty.

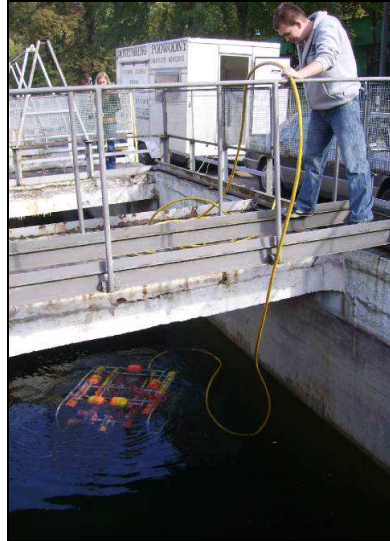


Fig. 3. Underwater vehicle KRAB undergoing tests conducted by the Scientific Association ABYSAL in the Technological Pool of the Faculty .

### THE DIDACTIC ACTIVITY AT THE FIRST AND SECOND DEGREE STUDIES WITHIN OCEAN ENGINEERING, TRANSPORT AND SECURITY ENGINEERING

Courses consisting in lectures and laboratory classes are conducted at particular faculties.

A particularly rich underwater technology is presented within Ocean Engineering courses. The courses "Underwater Technology" and "Operation, control and

utilisation of ROVs", besides laboratory practice entail test runs of vehicles performed in the technological pool, pic. 6, as well as field tests carried out in selected bodies of water, usually in one of the lakes of West Pomerania or the Baltic, fig. 4, 7.

The topic related to the underwater technology has been discussed in interim and diploma theses. In this case, there is usually an accumulation of experiences gained during didactic classes as well as the activity within the Scientific Association ABYSAL.



Fig. 4. Field research conducted at the Wądół lake within the didactic classes.

This type of class requires great involvement not just on the part of the students but also on the part of the staff conducting and supervising them.

The systems are powered either directly from a conventional power supply or, more commonly, via portable electrical generators. The underwater vehicles KRAB and MAGiS as well as SMP and SMG systems operate on 230 Volts and 400 Volts respectively.

This requires a great deal of self-control on the part of the students and awareness accompanied with high levels of concentration and professionalism on the part of the staff. The classes are preceded with mandatory training concerning work place safety.

### THE RESEARCH ACTIVITY CONNECTED WITH THE OPERATION OF THE STUDENT SCIENTIFIC ASSOCIATION ABYSAL

The Association Abysal was established in 2001, and within the 13 years of its activity it had over 70 members. The activity of the Association focuses mainly on modernisation of the System of Underwater Monitoring (SMP) in relation to the planned research and commercial tasks, including carrying out tests on particular components, with special attention paid to control systems of the remotely controlled unmanned underwater vehicle KRAB.

Tests are conducted in the technological pool of the Faculty, fig. 6, and in field conditions in inland bodies of water of West Pomerania and the Baltic [1, 4].

The classes are highly popular and inspected by the Dean of the Faculty. Additional tests are conducted on the System of Abyssal Monitoring (SMG) utilising the abyssal vehicle MAGIS [2].

In the course of activity, nine research expeditions (field tests) have been organised, in the Stoki, Woświn, Wądoł and Port lakes, as well as in the Baltic, including expeditions participated by naval units. Moreover, the students took an active part in the studies implemented within the research projects (grants) in the technological pool of the Faculty. The said research was

mainly concerned with movement control of underwater vehicles, fig. 5.

Working with students entails different kinds of events and surprises, which provides additional emotions and values, particularly in the course of field research.

An example is the situation presented in fig. 7 (entanglement of the remote vehicle's own umbilical in the propeller of the mother ship its pilot was operating from) filmed by the vehicle KRAB.

The results of research and conducted works are presented by students during environmental, national and international conferences [1, 2, 4], fig. 8.

This is a very effective form of participation of students in the University's activity.

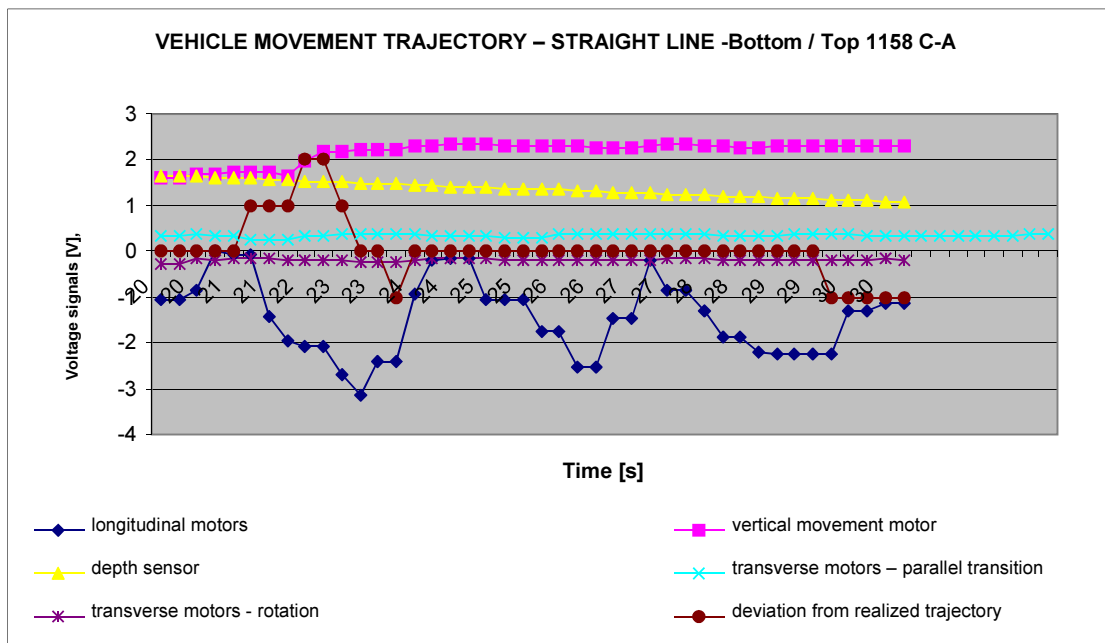


Fig. 5. Changes in the voltage steering the propeller of the KRAB vehicle and generated by the depth sensor and deviation from the realised trajectory in the function of time in a vertical movement along a straight line in the relation bottom / top of the KRAB vehicle [5].

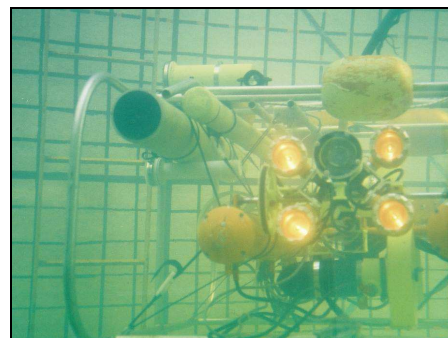


Fig. 6. Underwater vehicle KRAB during the tests carried out in the technological pool of the Faculty.

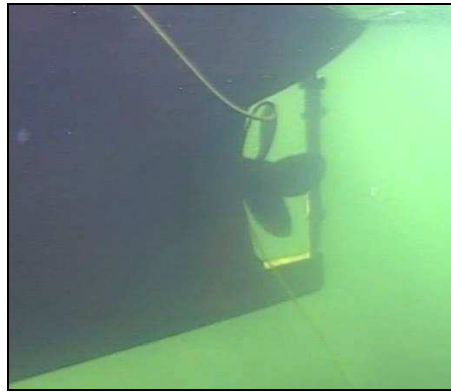


Fig. 7. The umbilical of the KRAB vehicle entangled in the propeller of the mother ship in the course of wreck searches near Kołobrzeg.

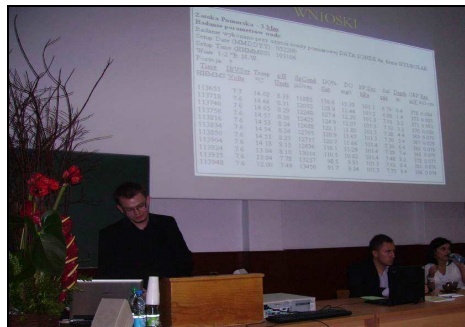


Fig. 8. Student Scientific Association ABYSAL – Presentation of research results during the Fifth Scientific Session of the Student Scientific Associations of the West Pomeranian University of Technology in Szczecin, December 2013.

### THE DIDACTIC ACTIVITY WITHIN THE CHILDREN'S UNIVERSITY OF TECHNOLOGY RELATED TO MARITIME TECHNIQUE

The courses within the Children's University of Technology DUTEK commenced 5 years ago. They are attended by elementary and secondary school children of the Szczecin schools.

The discussed topics include human behaviour in the aquatic environment, diving techniques and underwater monitoring with the use of remotely controlled underwater vehicles.

The courses are conducted during the school year and, on average, have ca. 20 participants. In the period of 5 years it has allowed approximately 100 pupils to interact with the discussed underwater technologies.

It should also be mentioned that the participants

react very lively to the presented issues, ask numerous questions and take an active part in the classes, Fig. 9.

### THE ACTIVITY PROPAGATING THE UNDERWATER TECHNOLOGY AT ENVIRONMENTAL, NATIONAL AND INTERNATIONAL EVENTS

This type of activity is carried out within the open days of the University, the Scientists' Night, the Science Festival and cyclic regional, national and international events such as – the Days of the Sea, Tall Ship Races and others, Fig. 10, 11. Equipment exhibition and presentation of applications of the vehicles evoke large interest among visitors.



Fig. 9. Children's University DUTEK – a group during laboratory classes.



Fig. 10. Presentation of underwater technology during Open Days (WPUT) – June 2013.

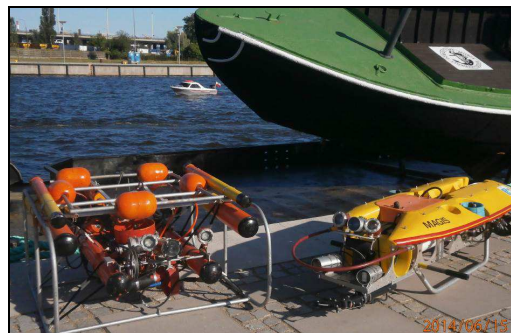


Fig. 11. Presentation of underwater vehicles KRAB and MAGiS during the Days of the Sea 2014.

## CONCLUSIONS

Abyssal vehicles are among little known devices represented only in a limited number of scientific and industrial centres, mostly involved in the maritime economy. However, their use is not restricted to marine waters.

They are known for their application in inland waters, mines and the energy industry. Thus, deeper

knowledge of the abyssal technique in the utilisation of such vehicles is necessary.

The research and didactic activities of the Faculty of Maritime Technology and Transport at the West Pomeranian University of Technology in Szczecin try to meet those expectations by preparing the staff for the implementation of the abyssal technology in the economy.

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