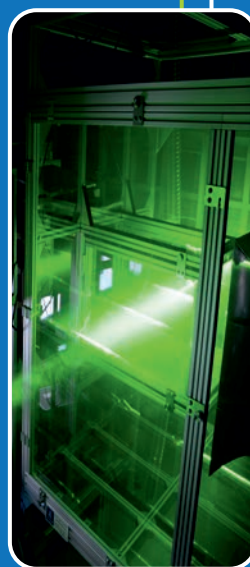
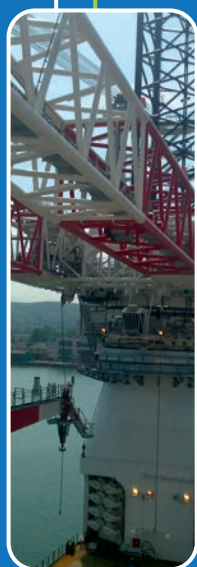




# CENTRUM TECHNIKI OKRĘTOWEJ S.A.

## SHIP DESIGN AND RESEARCH CENTRE



Edition II - 2015

Gdansk  
POLAND

[www.cto.gda.pl](http://www.cto.gda.pl)

# ABOUT US



Office building at 65 Szczecinska St., Gdansk, Poland

The Ship Design and Research Centre S.A. (CTO) is a modern, multidisciplinary research and design centre, well recognized and respected in many countries due to the high level of its services and range of activities.

The company's products and services are targeted at clients from various sectors of industry, both maritime and land based.

The company's field of activity includes the design, manufacture and supply of technologically advanced products, such as fully equipped research labs, tailored research facilities and measuring equipment.



Complex of CTO facilities







New complex of environmental labs

CTO employs experienced and talented engineers - designers and specialists in hydro-mechanics, aerodynamics, structural mechanics, acoustics, material science and flammability, as well as highly qualified technicians to maintain our specialized, modern research facilities and measuring equipment.

The well-equipped laboratory complex, which includes fire testing, acoustic and dynamic test laboratories, conducts numerous tests accredited by the Polish Centre for Accreditation (PCA). In considering the needs of our clients, the company's range of service activities has been extended by the certification of products, as well as achieving the status of a Notified Body.



CTO's research capabilities is strengthened by new investments in the Offshore Laboratory, equipped with facilities for hydro- and aerodynamic model tests, and the Dynamic Test Laboratory, equipped with stations for testing resistance to vibration, single and multiple shocks and seismic shocks (the largest such laboratory in Poland).

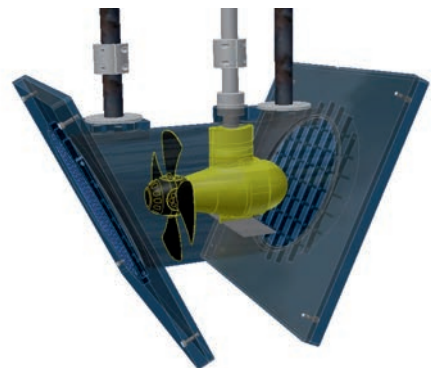
CTO is still improving and modernizing its research facilities, as we are fully convinced of the need to develop our potential with increasing enthusiasm and creativity to face the new technical challenges of the future.

# DESIGNS OF SHIPS, OFFSHORE STRUCTURES AND RESEARCH FACILITIES

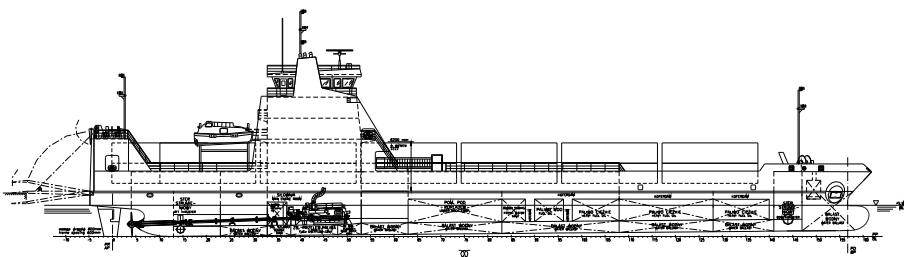
## Innovative designs

CTO develops conceptual and contractual designs for ships, naval vessels and offshore structures. The company also provides support for ship owners, production shipyards and design offices.

We use our design services to assist clients from both Poland and the rest of the world.



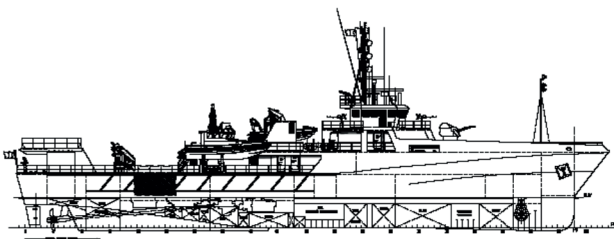
Trustee of reduced noise and vibrations level



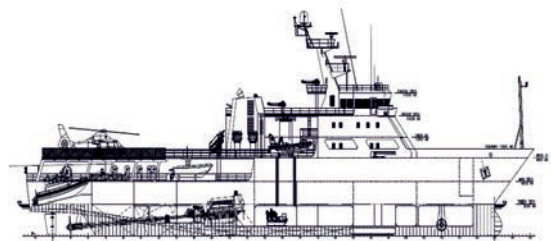
Design of 2500 DWT Ro-Ro ship

CTO also gives technical advice on marine and offshore system solutions, as well as on innovative propulsion systems for newly designed and built units.

In the past few years the following ship designs developed by CTO are worthy of mention: logistic support vessels (SSV type), patrol boats (FPV and OPV type), and rescue vessels (SAR type).



Design of a 60 m patrol boat



Design of a SAR ship



Towing carriage for model basin



Platform for model tests of the offshore structures

The design of new research facilities forms an important element of the CTO design team's activity, including: subsonic wind tunnels, cavitation tunnels, towing carriages for model basins and facilities for offshore structure testing. Equipment of this type is of significant importance for research centres serving a number of sectors, for both waterborne and land-based industries.



Closed wind tunnel



Open wind tunnel

## WWW

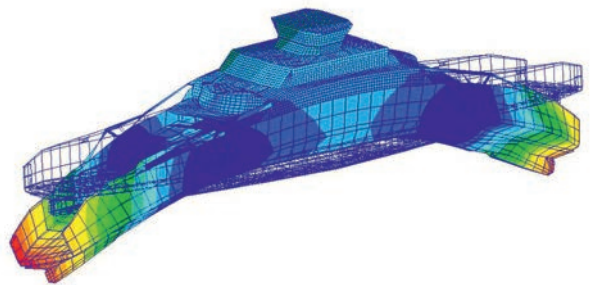
More information  
on design of research facilities  
can be found at  
[www.researchequipment.eu](http://www.researchequipment.eu)



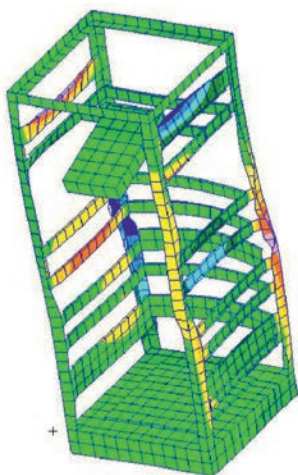
# STRUCTURAL MECHANICS

## Vibration, shock and seismic resistance

While vibrations may sometimes be introduced intentionally to a machine or structure, more often it is an undesirable result of using the same. CTO specialists measure vibrations and determine their causes, and if the acceptable levels of vibration or the individual characteristics of the system are exceeded, then modifications to eliminate or reduce the existing dysfunctions are proposed.



Analysis of ship hull vibration

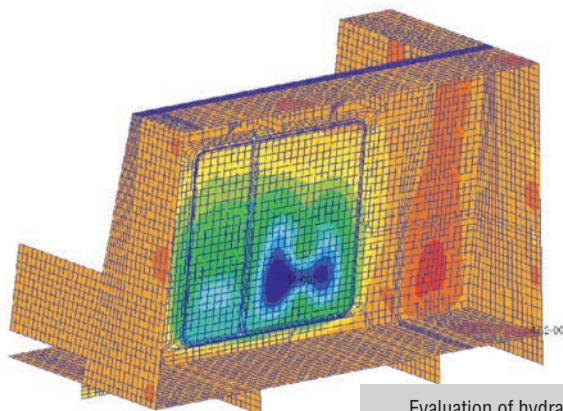


Evaluation of energy switchboard's seismic resistance

CTO uses a range of numerical analysis tools based on the finite element method in solving various problems of structural mechanics.

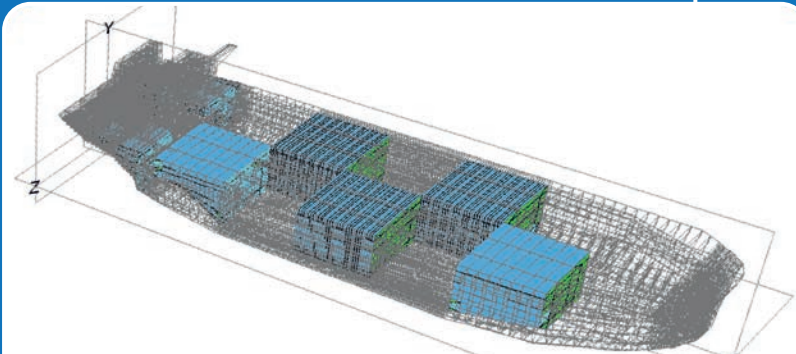
The analyses relate to following areas:

- shipbuilding and offshore: global local and partition strength, free and forced vibration, shock resistance, safety, optimization of weight construction;
- energy and land-based structures: seismic resistance and safety of machines and structures, incline tests, free and forced vibrations, and fatigue analysis;
- defence industry: shock resistance, vibrations, strength of machines and structures, and fatigue analysis.



Evaluation of hydraulic door's shock resistance

# Structural strength



Aframax model for numerical analysis the structural strength of the hull

CTO specialists perform load measurements of both waterborne and land-based structures as well as other mechanical devices through the use of advanced measuring equipment and software.

The expertise and recommendations related to structure safety and optimisation are developed on the basis of the actual measurements supplemented with thorough analyses.

## Field measurements

CTO specialists perform different measuring services in almost every environmental condition, for both waterborne and civil engineering projects, using advanced measuring equipment as well as conducting diagnostic services and giving technical advice in accordance with the requirements of the European standards and regulations of the relevant classification societies.

The services provided cover the measurement of ship speed and manoeuvrability, shaft power, bollard pull, noise level, local and global vibration of the structures as well as accommodation illumination. Moreover, monitoring and other expertise related to shaft line torsional vibration is provided.

CTO solves the problems of acoustic protection for the crew space on ships and other objects. The prediction of noise and vibration levels form the basis for the development of solutions, in accordance with the noise standards or other special requirements specified by the customer, at reasonable costs in terms of construction and equipment.

To meet the latest demands of the market and classification societies, the CTO specialists perform measurements of noise emitted into the water by ships.



Measurement of the noise level on the ship

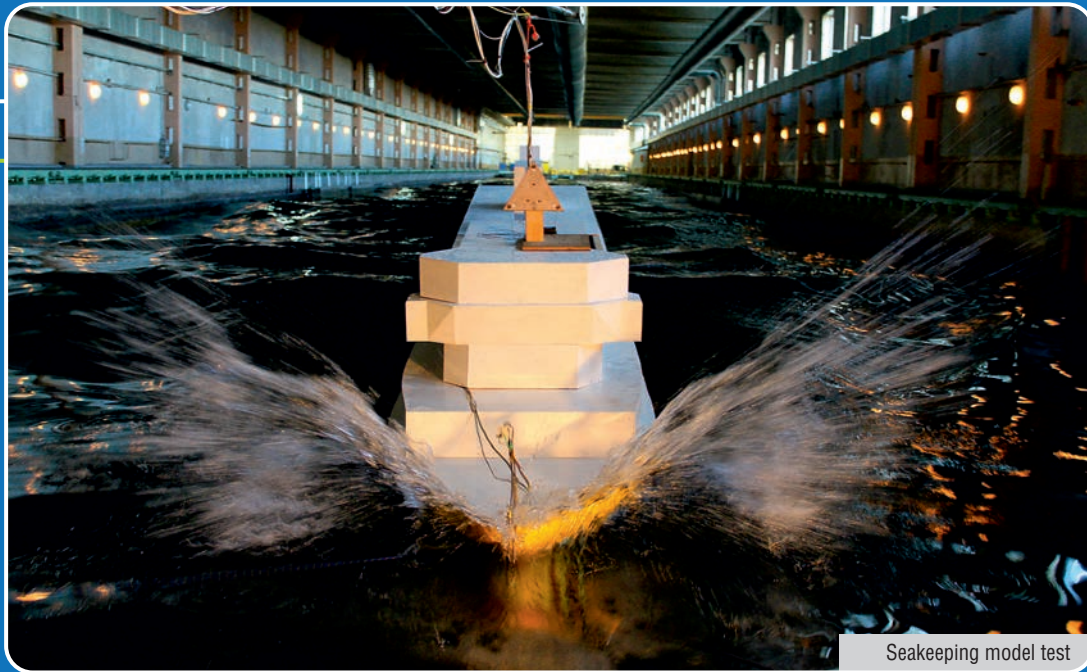


Vibration measurement of the shaking screen



Measurements of noise emitted into the water by ship

# HYDROMECHANICS

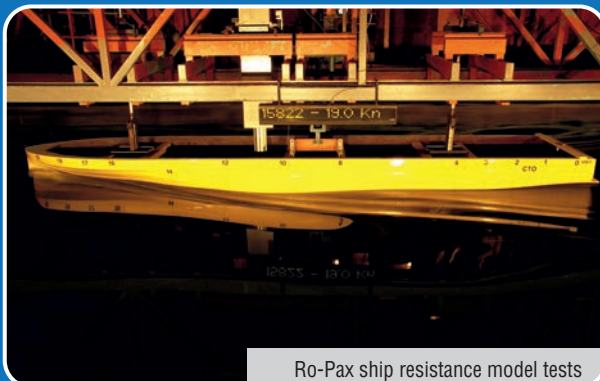


Seakeeping model test

## Optimal ship

CTO is generally recognised as a research centre able to conduct experimental model tests related to ships, yachts, offshore structures and other floating or hydro-engineering objects in towing tanks, as well as in cavitation and wind tunnels.

Thanks to the physical testing in combination with hydrodynamic numerical analysis, a vessel can be evaluated in terms of its optimal properties in terms of resistance, propulsion, seakeeping and manoeuvring qualities. Ship manoeuvrability is predicted also on the basis of experimental model tests carried out with free running models in the CTO shore station on Lake Wdzydze.



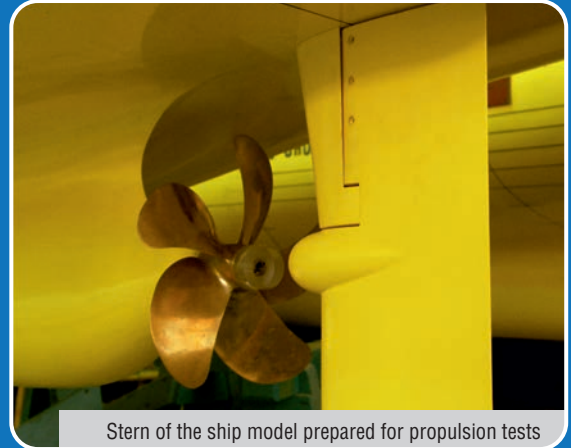
Ro-Pax ship resistance model tests



Rescue boat model tests



CTO specialists also design ship propellers taking into consideration all their real operational aspects. Particular attention is paid to eliminating the undesirable effects of cavitation, including noise or erosion, and to reducing pressure pulses on the hull as well as forces and bearing moments acting upon the propeller shaft.



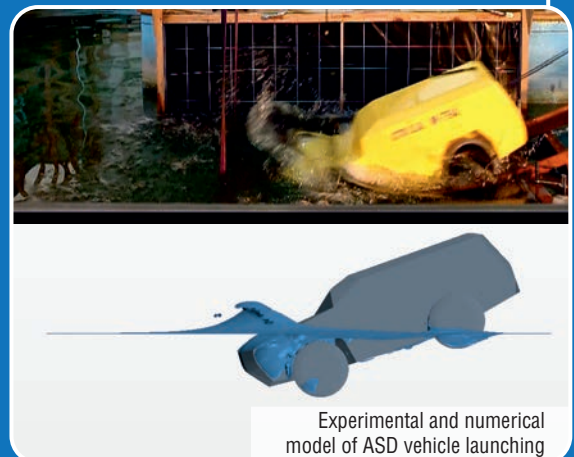
Stern of the ship model prepared for propulsion tests



Model tests of passenger ferry in the wind tunnel

CTO also carries out the experimental aerodynamic tests for sailing yachts, motor boats and both offshore and other floating objects. While aerodynamics are believed to form a key factor in the performance of racing yachts, it is also of significance for any vessel, since the wind loads either when running at speed or stationary influence the propulsion system parameters.

Ensuring adequate hydrodynamic properties for any ship is vital for operational safety, economy and efficiency. There is little doubt as to the importance of paying attention to the properties of a ship right from the early design stage, as this will yield considerable advantages during her operation.

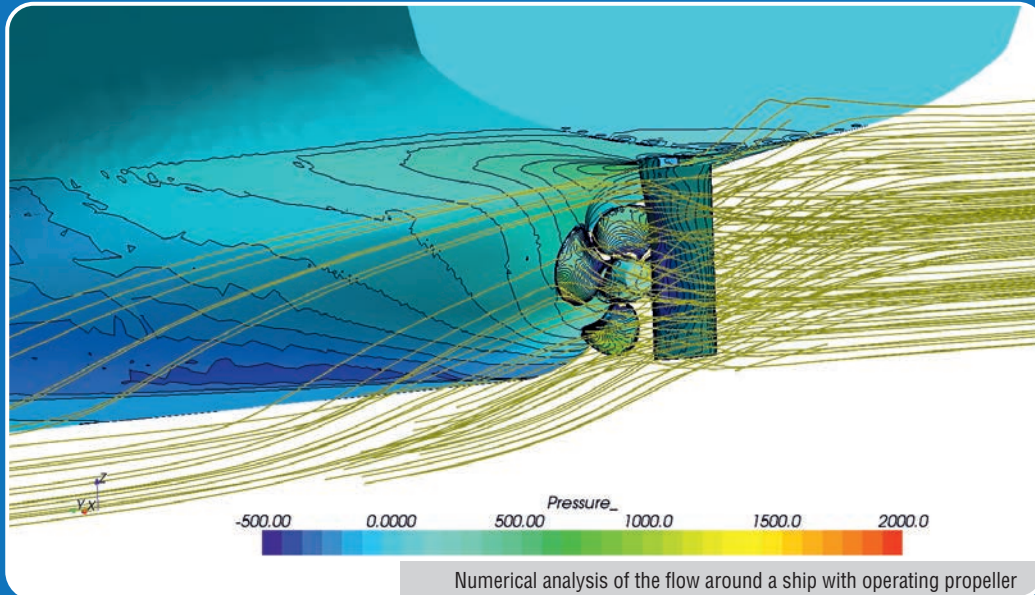


Experimental and numerical model of ASD vehicle launching

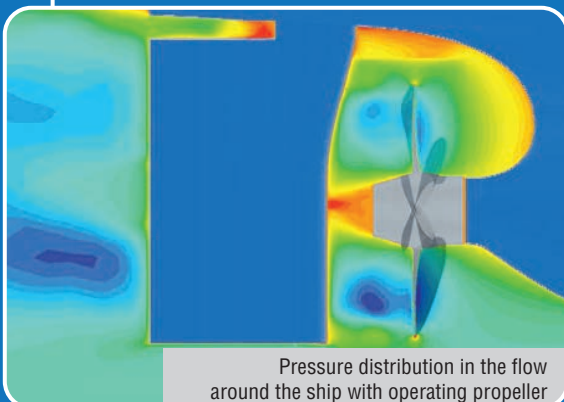
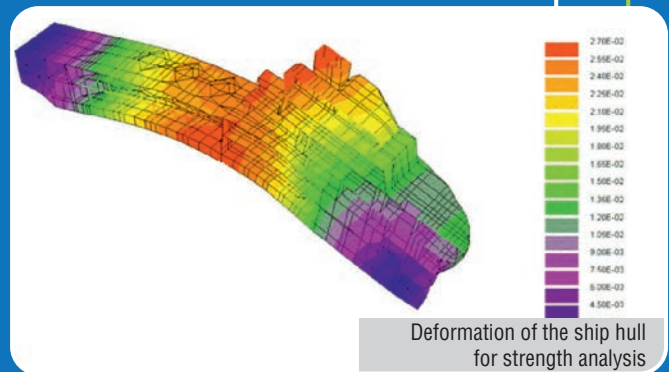
## WWW

Information on the programme supporting the sailing and motor yacht designing can be found at [www.yachtresearch.eu](http://www.yachtresearch.eu)

# NUMERICAL SIMULATIONS

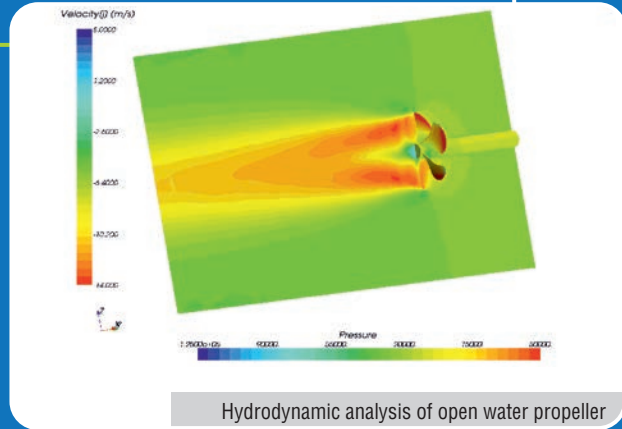
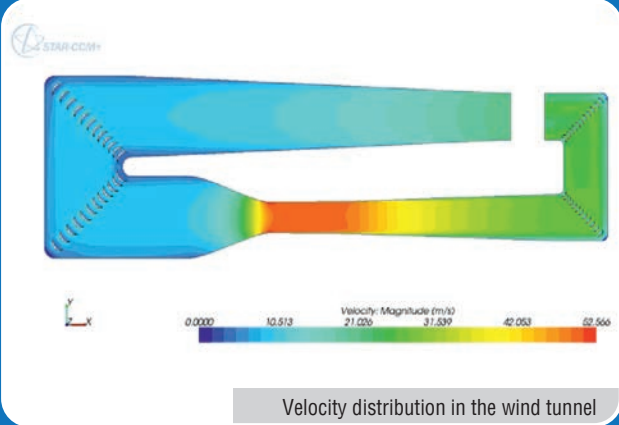


CTO performs a wide range of numerical analyses, of which the most vital for ship design are local and global stress-strength analyses with fatigue calculations, as well as vibration predictions of the hull structure and propulsion system. Apart from ships, other technically advanced civil engineering constructions and offshore structures can be analysed to determine their operational safety. The various commercial and in-house software programs developed by CTO are employed for these numerical analyses and computations.



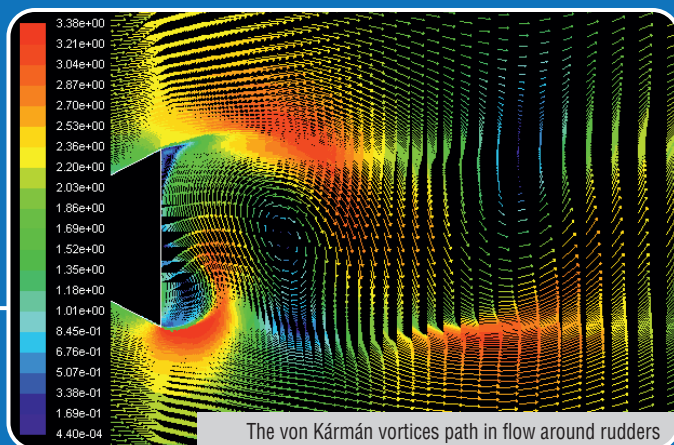
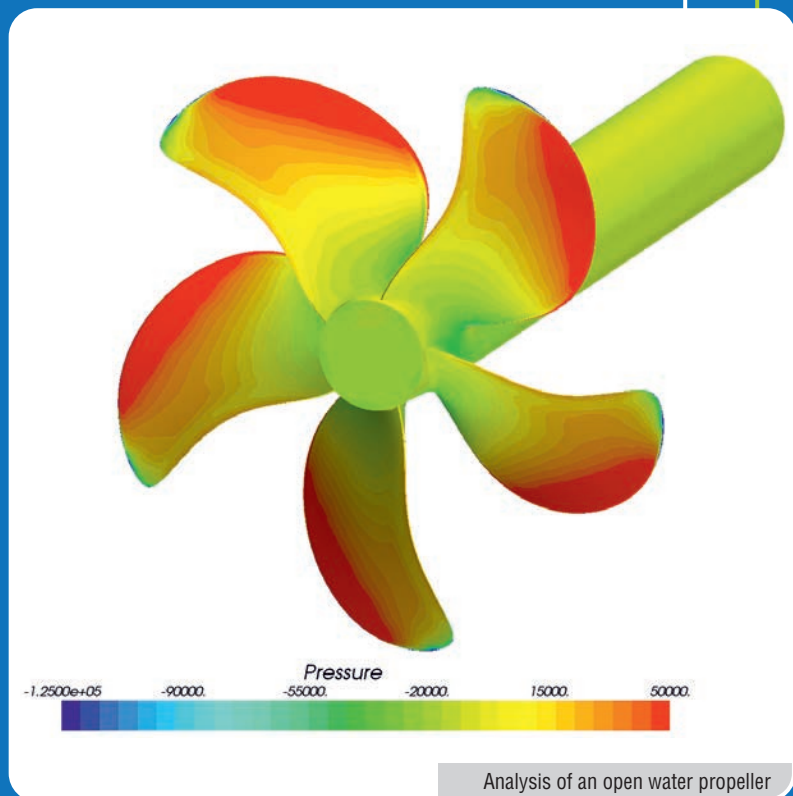
CTO offers services related to strength computations based on the Finite Element Method (FEM), thermal stress predictions, fatigue strength computations and vibration analyses in order to develop the optimal solution from a technical point of view, as well as from economic and operational safety perspectives.





CTO specialists perform CFD (Computational Fluid Dynamic) simulations, principally using professional calculation packages, which can be used to analyse the flow around ships, simulate heavy wind loadings upon constructions (i.e. wind generators, the above-water parts of ship hulls, buildings, etc.), analyse flow through various fluid-flow machines, heat exchangers and many others.

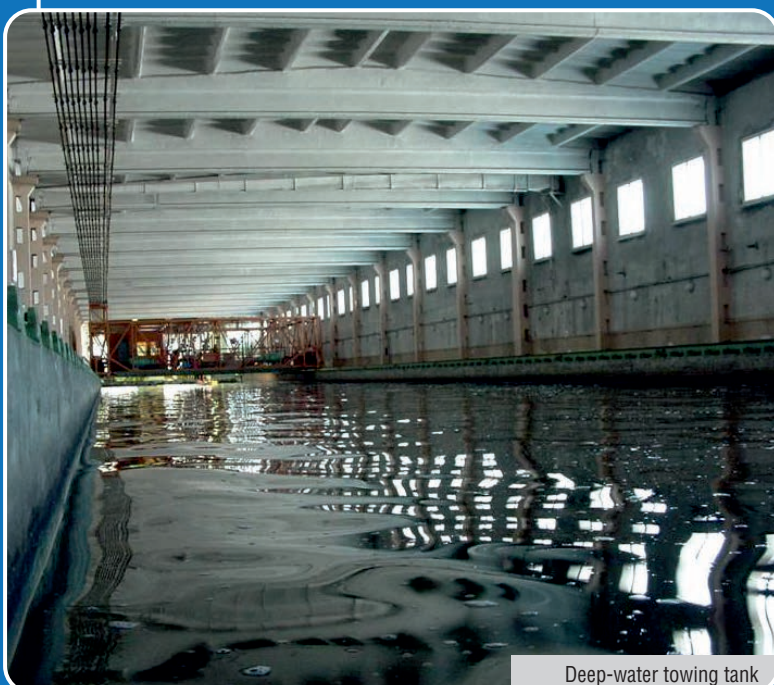
A significant range of the hydro-mechanic computations at CTO are conducted using our own software, developed and verified based on our many years of experience.



# RESEARCH FACILITIES

CTO possesses a number of unique facilities at the national level, in which the company has always taken great pride, as well as some new laboratories providing services to both waterborne and civil industries.

## Deep-water towing tank



Deep-water towing tank

This serves as a basic research facility used in the field of experimental ship hydromechanics. Its main purpose is to test models of a ship hull in terms of resistance and power demand for the ship's propulsion system. The results of the model tests form the basis of predicting the actual ship propulsion parameters, hence determining the key decisions to be made in the design process.

The deep-water towing tank is equipped with a wave generator to determine the seakeeping nature using models of the vessels. The results of these tests are vital for safety and the economics of navigation.

The potential of the deep-water towing tank is not limited to the ship-related purposes, it forms a convenient environment in which to conduct model tests for devices intended to convert renewable energy acquired from the sea, investigate how moving objects interfere with the free water surface (e.g. simulating emergency plane landings on water), tests of coatings designed to reduce friction drag, and other tests of basic flows.

The CTO deep-water towing tank is equipped with a towing carriage, planar motion mechanism (PMM) and wave generator for both regular and irregular waves corresponding to a sea state up to 8-9 on a 1:25 scale.



Model test of motor yacht in deep-water towing tank



# Offshore Test Laboratory

The Offshore Test Laboratory is designed for the testing of hydro- and aerodynamic models intended to represent offshore facilities, i.e. semi-submersibles; self-lift platforms; Floating Production, Storage and Offloading Unit (FPSO); TLP platforms; SPAR platforms; and other hydro-technical installations.



Model tests of offshore platform



Offshore Tests Laboratory

The laboratory is equipped with:

- wave generator, using a system of active and passive muting wave devices (also for the simulation of oceanic conditions),
- stand for testing seabed located objects - the main element is the turntable for correct model positioning,
- stand for testing anchored objects - those connected with the ground or other structures through rope and chain systems,
- stand for testing dynamically positioned objects (DP),
- wind generator,
- measurement system to register movements of the model,
- subsonic wind tunnel,
- machining centre with 5-axis lathe,
- system for computer-aided 3D modeling and for numerical analysis.



UNIA EUROPEJSKA  
EUROPEJSKI FUNDUSZ  
ROZWOJU REGIONALNEGO



*The project has been financed within Regional Operation Programme for Pomerania in 2007-2013 years*

# RESEARCH FACILITIES

## Shore station for manoeuvrability model tests

With its shore station for manoeuvrability model tests located on Lake Wdzydze, CTO is able to carry out manoeuvrability tests using exactly the same hull models as used in the towing tanks. The testing involves self-propelled models with a remote control system to ensure that the manoeuvres can be performed in a repeatable manner. The facility is equipped with an automatic system to identify the model's trajectory.

The principal aim of the model tests at the shore station is to develop predictions related to the manoeuvrability of the real vessel, and to determine whether these predictions comply with IMO requirements.



Model tests at Lake Wdzydze

## Cavitation tunnel



Cavitation model test

This particular research facility is used for experimental ship hydromechanics, mainly cavitation model testing of propellers, as well as rudders in a simulated trailing velocity field.

The tunnel is equipped with a hydro-acoustic chamber, which enables necessary tests to be performed in order to predict the level of noise generated by the ship's propeller.

The cavitation tunnel equipment consists of a high speed video system for the observation and recording of cavitation, dynamometers, a system for measuring pressure pulses on the hull surface and a laser anemometer (LDA) for the velocity field measurements, such as of the propeller discs.

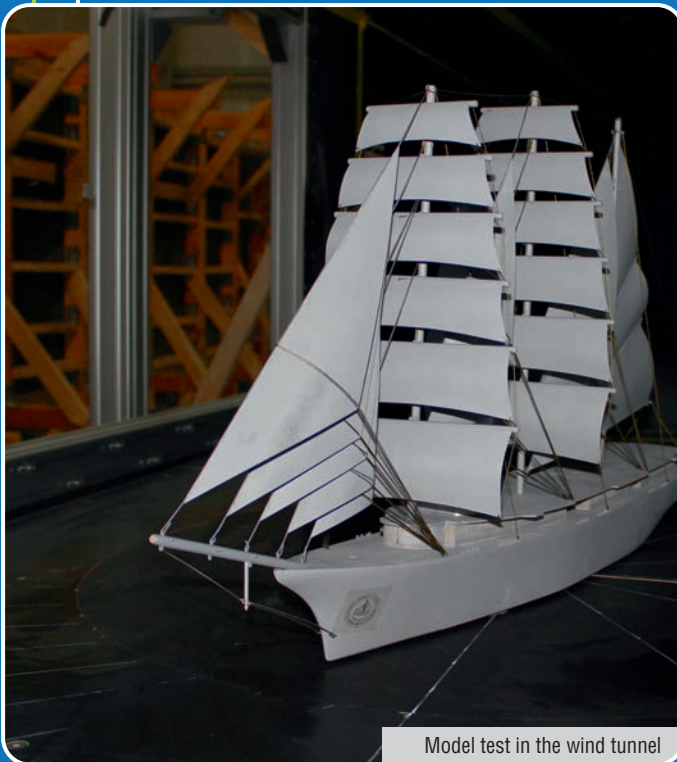


# Wind tunnel

The wind tunnel enables us to learn more about the aerodynamics of sea vessels, land objects (stationary and movable) and flying vehicles thanks to the information obtained during the experiments on models or prototypes.

The following types of aerodynamic tests are conducted:

- influence of the wind on exposed parts of ships and other floating vessels, offshore structures, as well as other hydro-engineering objects,
- aerodynamics and flow around road and rail vehicles,
- aerodynamics of wings, planes, helicopters and other flying objects,
- aerodynamics of wind turbines,
- influence of wind on buildings, communication infrastructure objects and other large civil engineering objects,
- transport of air masses and air pollution.



Model test in the wind tunnel

# Research facilities characteristic:

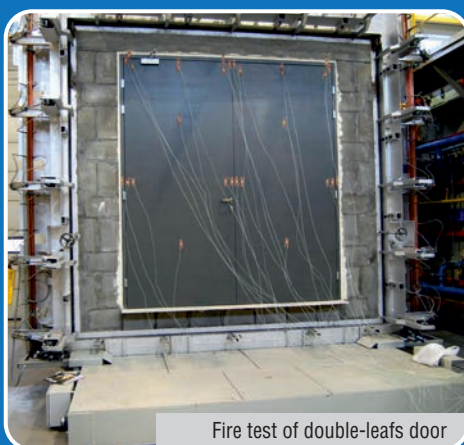
<b>Deep-water towing tank</b>	
Length:	270 m
Width:	12 m
Depth:	6 m
Towing carriage	
Max. velocity:	12 m/s
Max. acceleration:	1 m/s <sup>2</sup>
Wave generator	
Max. regular wave height:	0.7 m
Max. irregular wave height:	0.35 m
<b>Off-shore Test Laboratory</b>	
Length:	60 m
Width:	7 m
Depth:	0.0 - 3.0 m
Towing carriage	
Max. velocity:	4.5 m/s
Max. acceleration:	0.5 m/s <sup>2</sup>
Wave generator	
Max. regular wave height:	0.4 m
Max. irregular wave height:	0.18 m
Configurable wind generator	
Width x Height:	4 x 1.2 m / 2 x 2.5 m
Max. stream velocity:	5.0 m/s
<b>Side launching test basin</b>	
Length:	5 m
Width:	5 m
Depth:	0.6 m
<b>Cavitation tunnel</b>	
Dimension of test section:	3.0 x 0.8 x 0.8 m
Max. flow velocity:	20 m/s
Static pressure:	3 - 400 kPa
<b>Wind tunnel</b>	
Dimension of test chamber:	2.15 x 1.42 x 7.00 m
Max. flow velocity:	52 m/s

# ENVIRONMENTAL RESEARCH

In case of fire in a building, ship, land vehicle or other human-operated object, it is of utmost importance that key construction components such as doors, windows, walls, and partitions should have the appropriate fire resistance qualities to guarantee both life protection and evacuation time. Safes and fireproof cabinets are required to have a confirmed capacity to protect the goods sealed inside them.



Fire resistance test of door



Fire test of double-leafs door

fire tests

The main subjects of the fire resistance tests are as follows:

- civil engineering construction and ship components such as: doors, windows, non-load bearing walls, firewalls, ceilings, roofs, floors, sealing of installation through building partitions, fire protection hatches as well as channels, ventilation shafts and ducts, and lift doors,
- rail and road vehicle construction components,
- soundproof barriers,
- safes, strongboxes and fireproof cabinets for data storage.

The smoke-proof properties of doors, shutters and the materials intended for smoke curtains are tested in the fire testing laboratory. Under thoroughly controlled conditions, the rate at which fire spreads on a surface, the flammability of plastics and other materials are determined. To complement the smoke-proof testing there are also tests of mechanical properties.

CTO's [Fire Testing Laboratory](#) offers research testing according to the EU standards.



Safe after the fire test



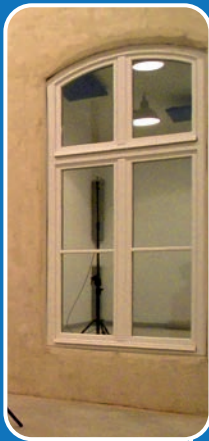
Fire resistance test of acoustic panel



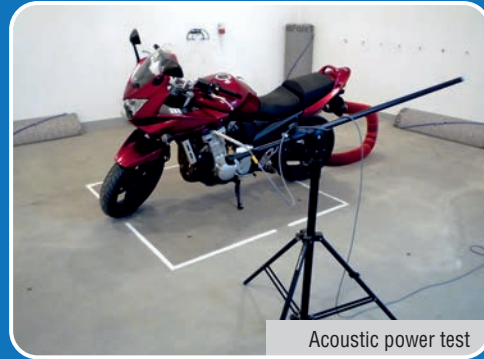
Smoke-proof chamber



Sound insulation test



Noise is a particularly harmful result of the development of modern civilisation. Windows, doors, walls, ceilings and many other building elements must fulfil increasingly stringent requirements concerning noise elimination.



Acoustic power test

The CTO **Acoustic Laboratory** enables the producers of woodwork, acoustic barriers, sound absorbing materials and ship equipment elements to gain certification of their products in terms of sound insulation, sound absorption and acoustic power under national and international standards. CTO clients can be sure of receiving professional advice on enhancing the acoustic properties of their products.

mechanical tests



Resistance test to vertical loads

An important issue in terms of durability and safety in use is the resistance of doors and windows to all kinds of mechanical forces, such as: repeated opening-closing and hard body impacts.

CTO performs mechanical testing on a specially designed and equipped stand, where the products either maintain their functionality or become deformed.

CTO specialists also perform environmental tests in situ, i.e. in public places and workplaces, residential buildings, ships, airports, near traffic routes and in open areas.



Acoustic test along traffic route



# ENVIRONMENTAL RESEARCH

## Dynamic loads



Vibration tests of voltage converter

There are tests for all kinds of electrical and electronic equipment that may be installed on warships or in seismically active areas, as well as in those installations with increased security and reliability requirements, such as voltage converters, transformers, cabinets and control panels, servers, hydraulic and pneumatic fittings, industrial monitoring systems, portholes, hatches and doors, and small electronics.

CTO can test the resistance of a facility against vibration and single, multiple or seismic shocks.

The tests determine the level of resistance of objects exposed to these factors, as well as to check the correctness of all calculations, the quality of materials (detection of potential defects) and the manufacture of the objects.



Single shock resistance test of distribution cabinet

**WWW**

More information  
on fire and acoustic test can be found at  
**[www.laboratoria-badawcze.pl](http://www.laboratoria-badawcze.pl)**

# ENVIRONMENTAL RESEARCH LABORATORIES

## Dynamic Test Laboratory



Dynamic Test Laboratory

Dynamic Tests Laboratory is equipped with:

→ stand for vibration as well as multiple and seismic shock resistance testing

Tests are performed on an electro-hydraulic stand equipped with the best MTS drivers. The measuring station is equipped with a multi-channel data acquisition system to measure acceleration, speed and displacement, supplemented as needed with additional sensors (e.g. strain gauges);

→ stand for single shock resistance tests, with the most extensive capabilities in Poland

This includes a mounting table which is lifted to the some height or lowered to an appropriate pad. The combination of table height and type of pads results in an exact pulse shape for the impact. The table is characterized by high stiffness to avoid influencing the test.

Primary parameters:

- table dimensions: 1200 x 1200 mm;
- max. acceleration: 2000 m/s<sup>2</sup>;
- max. mass of the object: 1000 kg;
- pulse duration: 4-40 ms.

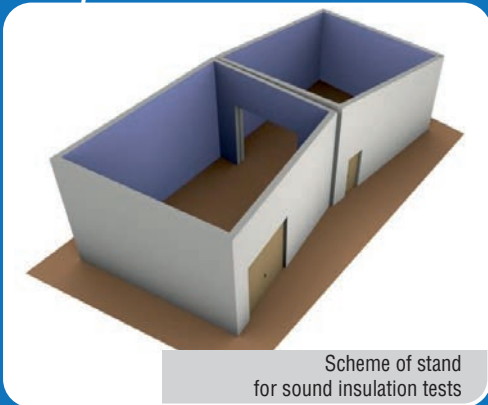
The stand for single shock resistance testing meets the requirements of military standard: **NO-20-A500-5**

# Acoustic Laboratory

The Acoustic Laboratory consists of separated reverberation chambers so that, thanks to the building construction, acoustic tests can be conducted simultaneously.



Acoustic Laboratory



Scheme of stand for sound insulation tests

The stand for acoustic insulation tests consists of both emission and reception chambers, which enable elements to be tested having surface areas of up to 10m<sup>2</sup>. The cubature of each chamber is approx. 200 m<sup>3</sup>. The transfer of sound by other paths than the tested partition and the influence of external noises is negligible.

# Fire Testing Laboratory



Fire Testing Laboratory



*The project has been co-financed by European Regional Development Fund within the Regional Operation Programme for Pomerania in 2007-2013 years*

The basic equipment for the CTO Fire Testing Laboratory consists of the following stands:

- fire resistance testing of vertical constructions measuring up to H 3.2 m × W 3.4 m, and horizontal ones of up to L 4.0 m × W 3.4 m,
- testing the smoke-proof properties of doors and shutters as well as materials intended for smoke curtains - a chamber sized 3.0 m × 3.0 m × 1.5 m,
- testing the flammability properties of materials and products,
- mechanical tests,
- impact testing of safes.

Laboratories are accredited by Polish Centre for Accreditation (PCA) No. **AB 014** for fire tests, No. **AB 1241** for acoustic tests, and have notified body statut No. **NB 2434**



AB 014



AB 1241

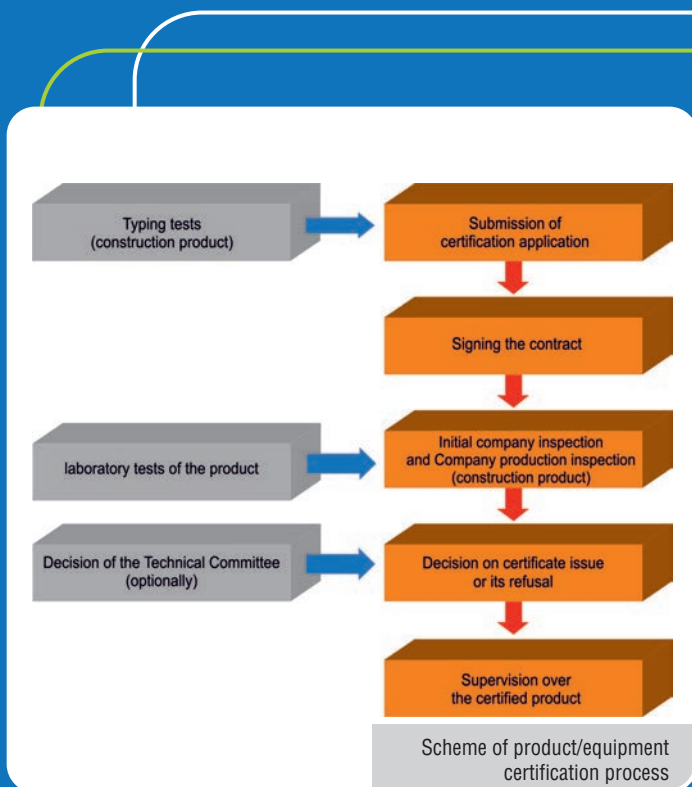


NB 2434



# PRODUCT CERTIFICATION

## Direct route to a compliance certificate



With regard to construction products placed on the domestic market, CTO offers **certification in mandatory areas according to system 1**, which assesses whether the product conforms to the requirements of the Polish standards or technical approvals, for manufacturers required to issue a National declaration of conformity and **national B Marking for a construction product**.



CTO's Product Certification Division has notified body status, entitling it to assess and verify the constancy of the performance of construction products (smoke curtains and doors used in escape routes) in relation to the harmonized standards. The certificate of constancy of performance gives the manufacturer the right to issue a Declaration of Performance and **CE Marking**.



Product Certification Division is accredited by the Polish Centre for Accreditation (PCA), No. **AC 170** and has notified body status No **NB 2434**

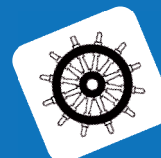


**NB 2434**



**AC 170**

CTO also assesses the conformity of marine equipment, such as the passive fire protection equipment installed on ships. The notified body status entitles CTO to assess the compliance with **module B** of Council Directive 96/98 EC.



**www**

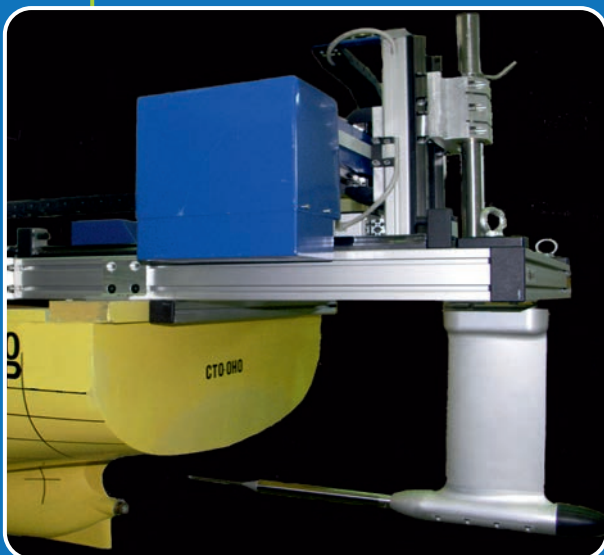
More information on the product certification process can be found at **www.certification.com.pl**

# MANUFACTURING OF RESEARCH AND TESTING EQUIPMENT

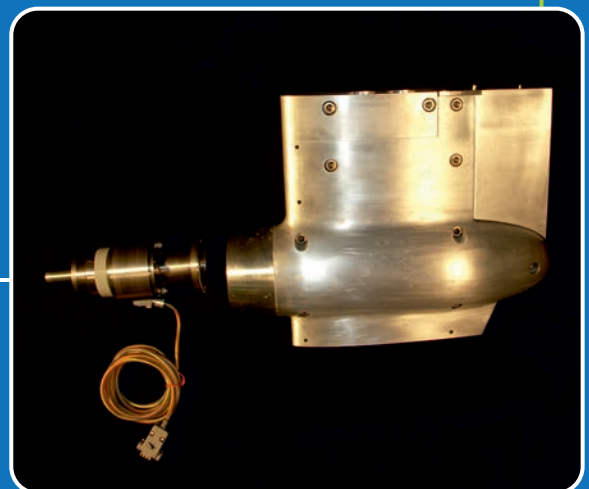
CTO specialists design, manufacture and start-up research facilities and testing equipment intended for research in the field of waterborne engineering as well as measuring equipment used for experimental fluid and solid body mechanics.

CTO also offers designs and equipment for research centres.

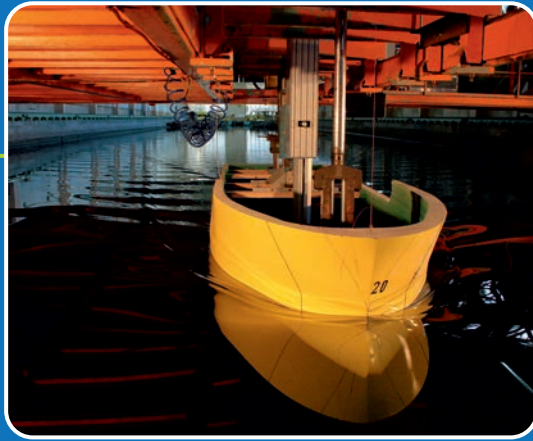
wake survey  
device



dynamometer  
for measurement  
of thrust and torque

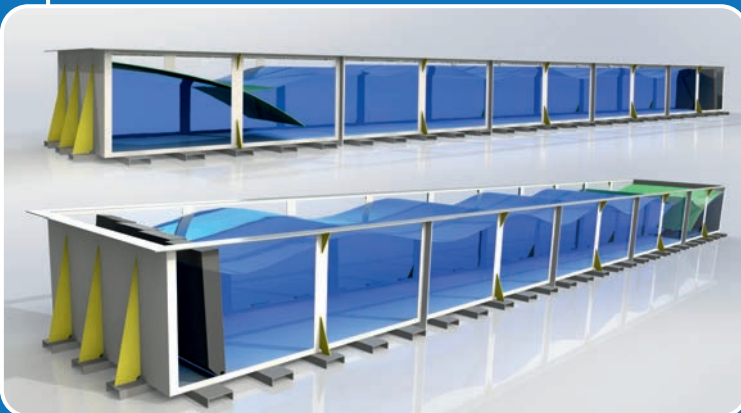


6-component balance



resistance  
dynamometer

stand for  
water turbines  
tests



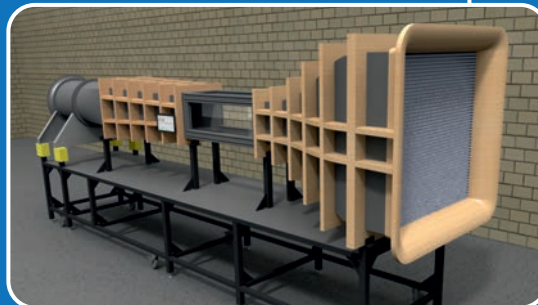
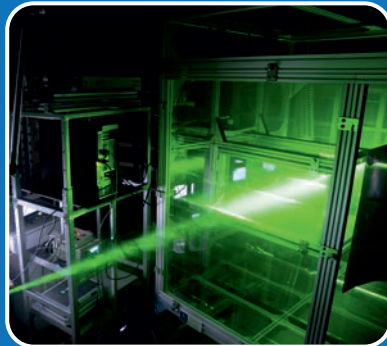
stand for  
waves tests

cavitation  
tunnel





## wind tunnels



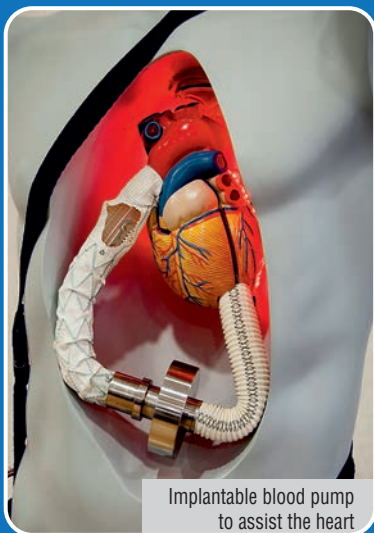
research centres  
and laboratories

# MEDICAL ENGINEERING

Medical engineering is yet another CTO interdisciplinary specialisation, linking to various rapidly developing fields in fundamental and technical sciences. Pioneering new medical engineering equipment is being invented, developed and manufactured as the result of CTO research, design work and construction activities.

Within medical engineering, the company focuses on:

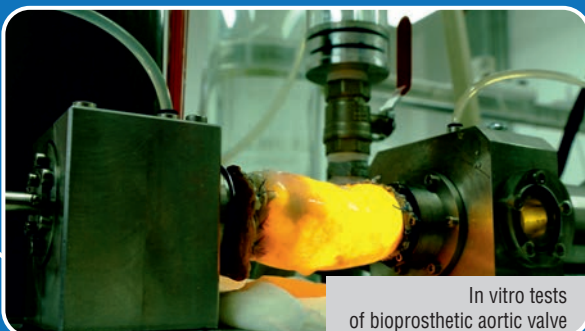
- research and development works related to laboratory and clinical equipment concerning cardiac and angioplasty surgery,
- designing and testing of devices used in the rehabilitation of disabled people,
- designing, manufacturing and implementing laboratory equipment and in-vitro test stands for use in bio-medical engineering,
- research works on materials and advanced technologies for bio-medical engineering,
- development of numerical simulations for blood flow.



Implantable blood pump  
to assist the heart

CTO has participated in the Polish government programme: “Polish Artificial Heart” in 2008-2012, under which CTO specialists developed an original design for a miniature implantable axial blood pump to assist the heart. This is a third generation pump, with contactless drive and rotor bearing arrangement.

CTO cooperates with other scientific centres in the field of bio-implants for use in cardiac and angioplasty surgery related to regenerative medicine. These tests involve both in vitro experiments and the numerical simulation of blood flows through a bioprosthetic aortic valve.



In vitro tests  
of bioprosthetic aortic valve



In vitro tests of blood pump  
to assist the heart

CTO specialists have been developing data processing systems along with the control, power and drive elements to be used in bio-medical engineering.

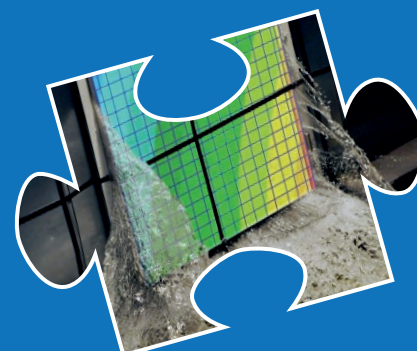
# RESEARCH AND DEVELOPMENT ACTIVITY

From the very beginning CTO has continually performed scientific research and development, with the results being implemented in different branches of industry. The economic and practical viability of this research and development contributes to the high rating of CTO as a scientific centre. The CTO R&D Department is also a research and knowledge-dissemination organisation in accordance with art. 2 pt. 83 of Commission Regulation (EU) No. 651/2014.



CTO has long-term experience in planning, performing and coordinating industry related research, development works and design. In the last 20 years the company has alone or in cooperation with domestic industrial partners successfully executed and implemented projects featuring innovative technical and technological solutions. When Poland gained access rights to the Framework Programmes of the EU, CTO began to participate actively in numerous European projects. The result of this is more than 40 international R&D&T and innovative projects within FP5, FP6 and FP7, as well as the ERA-NET Scheme.

The principal objective of CTO is to maintain its leading position at the national level and its stable, recognized position internationally for its R&D, measurement, attestation and design activities, including engineering and technology transfer where appropriate. In terms of these objectives, CTO satisfies the research and innovative needs expressed by its industrial partners, taking the fields of waterborne transport and environmental protection into special consideration.



The recognisability of CTO results not just from its highly evaluated commercial and R&D projects executed within international consortia, but also from its active membership of many organisations, such as: International Towing Tank Conference (ITTC), European Waterborne Technology Platform (WATERBORNE TP), Ships & Maritime Equipment Associations (SEA Europe RDI), International Maritime Organisation (IMO), European Patent Office (EPO), European Group of Organisations for Fire Testing, Inspection and Certification (EGOLF).

## Did you know that...

CTO's participation in European Community Framework Programmes in terms of Research, Technological Development and Demonstration activities has twice resulted in being awarded the Crystal Brussels Sprouts prize – in both 2002 and 2010





# REFERENCES

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The majority of CTO's clients are companies who have cooperated with us for many years or who have selected CTO for the first time as a result of recommendations. We make every effort to ensure our services remain first class and the opinions about us are the best.



Our client's countries of origin:

Brazil,  
Bulgaria,  
China,  
Finland,  
Netherlands,  
India,  
Germany,  
Norway,  
Poland,  
Singapore,  
Sweden,  
Turkey,  
USA,  
United Kingdom,  
Vietnam,  
Italy

and more ...

**We are looking forward to doing business with You**



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customer  
**technology**  
precision  
confidence  
timeliness  
**human resources**

## Centrum Techniki Okrętowej S.A. Ship Design and Research Centre

Szczecińska 65  
80-392 Gdańsk, Poland

phone: +48 58 307 46 97  
marketing@cto.gda.pl

GPS: N 54.399137  
E 18.585359



[www.cto.gda.pl](http://www.cto.gda.pl)