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## Contribution of the Croatian Academy of Sciences and Arts to the Development of Marine Technology in Croatia

### Abstract

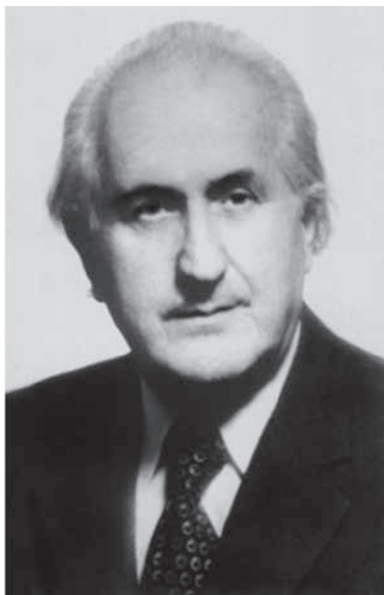
Contribution of the Croatian Academy of Sciences and Arts to the development of marine technology in Croatia is described in this paper. Intensive research and development of marine technology in Croatia was initiated by Prof. Zlatko Winkler, fellow of the Croatian Academy of Sciences and Arts, in 1979 when the first Conference on Marine Technology was organized. Since 2005 the Conference on Marine Technology is organized by the Scientific Council of Maritime Affairs of the Croatian Academy of Sciences and Arts and the Faculty of Engineering in Rijeka in memory of Zlatko Winkler (1917 – 1996), president of the Scientific Council of Maritime Affairs between 1994 and 1996. Grateful for his contribution to the research and development, the Croatian Academy of Sciences and Arts continuously and generously supports the conference organization. Until today in total seven Conferences on Marine Technology were organized. As pointed out in the paper, the most important contribution of the Academy to development of the marine technology is organization of round tables on this challenging topic.

**Keywords:** Marine technology, Croatian Academy of Sciences and Arts, Scientific Council for Maritime Affairs, Croatian shipbuilding, Research and development

### 1. Introduction

Prof. dr. sc. Zlatko Winkler, Figure 1, fellow of the Croatian Academy of Sciences and Arts (CASA), visionary anticipated the importance of marine technology in research and exploitation of new energy resources and its potential impact to Croatian economy, [1]. In order to encourage its development, implementation and wider recognition Zlatko Winkler enthusiastically organized six Conferences on marine technology, namely:

1. The first Conference on Marine Technology in 1979,
2. Marine technology colloquium, 1980,
3. Perspectives of marine technology development in The Adriatic Sea, 1983,
4. Structural strength of marine technology objects, 1987,
5. International Round Table on Coastal and Underwater Aspects of the Adriatic Sea, 1994,
6. International Conference on Coastal and Underwater Aspects of the Adriatic Sea, 1994.



*Figure 1 Zlatko Winkler, Fellow of the Croatian Academy of Science and Arts (1917 – 1996)*

Importance of Prof. Winkler's activities were recognized by CASA as he became Corresponding member in 1986 and Full member in 1994. During his chairmanships of the Scientific Council of Maritime Affairs Prof. Winkler founded Section for Marine Technology enabling in such a way further contribution of CASA to development of this perspective scientific field, [2].

Since 2005 the Conference on Marine Technology in memoriam of the academician Zlatko Winkler was organized on regular basis every second year by the Scientific Council of Maritime Affairs, Croatian Academy of Sciences and Arts and the Faculty of Engineering, University of Rijeka. The main goals of the conference are to:

- originate and encourage collaboration between science and economy in marine technology,
- report on the latest scientific achievements in marine technology,
- steer development and implementation of the long term development strategies,

- present the impact of research to the economy representatives,
- enable international technology transfer.

## 2. Scientific conferences and books on Croatian economy

Along with organization and financial support to Conference on Marine Technology, CASA directly contributed to development of this field by organizing several scientific congresses. Probably the most important ones were organized in 2014 and 2016 resulting with publication of two books. The first scientific conference was organized by the Faculty of Economy of the University of Zagreb aiming toward identification of the most important components of the Croatian economy. Amongst all, shipbuilding industry is characterized as very important business acting as a lever toward overall economical development, both globally and nationally, [3]. In 2016 CASA organized very important and noted conference on the Croatian natural wealth where wind power, both onshore and offshore, was elaborated and highlighted as one of the most important future energy resources, [4]. The former conference resulted with distinguish book edition presented in Figure 2.



Figure 2 Book "Croatian natural welth" by the Croatian Academy of Sciences and Arts

## 3. Round tables on shipbuilding and marine technology

CASA continuously organizes round tables on current topics and problems of modern science and technology. Primary purposes of round tables can be summarized as CASA contribution to production organization, rational process and product design as well as to educational system and universities.

Starting from 1998 to 2014, the CASA successfully organized three round tables on shipbuilding and marine technology where invited speakers elaborated current status and development trends of particular scientific fields emphasizing importance of the Croatian shipbuilding industry, [5].

The first round table was organized by the CASA's Department of Technical Sciences, Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb and Brodarski Institute, Zagreb, in 1998. Topics including ship design, marine technology, offshore hydrodynamics, ship production technology and Croatian shipbuilding - 2000 were elaborated by prominent speakers like Prof. I. Grubišić, Prof. V. Čorić, Prof. Senjanović, N. Bobanac, M. Sambolek, Prof. Ž. Sladoljev, V. Andročec and Prof. V. Žanić. All of the invited speakers unanimously emphasized conclusions leading towards existence of the Croatian shipbuilding industry.

In 2011 the CASA's Department of Technical Sciences organized the second round table entitled *Perspectives of special ships and offshore wind turbines production in Croatian shipyards*. The first lecture was dedicated to current activities of CASA departments in the field of the Croatian economy development (M. Zelić), while the second one elaborated current state and perspectives of the Croatian shipbuilding industry (I. Senjanović). The third lecture entitled *The European plans on offshore wind power plants until 2020* (B. Liščić) enlightened the perspectives of offshore renewable energy sector future development. It was pointed out that the United Kingdom has strong ambitions in construction of offshore wind power plants with 32000 MW of the total installed power. This example is followed by the developed communities like Germany, Denmark, Sweden, Spain, France, etc. Particular importance of such development is reflected within ship production industry as it requires construction of special and sophisticated ships for offshore operations. Such vessels are characterized as expensive products capable of adding additional value and profit to the surrounding economy.

In 2014 CASA's Scientific Council for Maritime Affairs and Technological Development organized the third round table on Offshore technology as perspective field for the Croatian economy, [6]. The main intention of the round table was steering of the social and economical development towards coherent formulation of the development strategies. The assembly was lead off by the lecture on capacities to marine technology to become one of the development priorities in Croatia. This complex field was carefully elaborated within five follow up invited lectures on oil and gas offshore structures (V. Čorić), design of offshore special purpose ships (S. Reljić), offshore wind power plants (B. Klarin), offshore mariculture (N. Hadžić) and underwater systems and technologies (Z. Vukić). Each lecture clearly demonstrated importance of marine technology and inevitable necessity of further efforts in order to enable wider societal acceptance and contribution to the Croatian economy. Illustration of related complex and added value products of marine technology is presented in Figure 3. Main conclusions of the round table can be summarized in several points:

- Marine technology is a multidisciplinary field involving numerous different services, particularly shipbuilding business,
- Presented development trends clearly demonstrate importance of this field and necessity to consider them as levers influencing the Croatian economy,
- Marine technology objects are characteristic as high value products with significant multiplicative factor,
- The research and development of this field is relied to collaboration between science and economy.

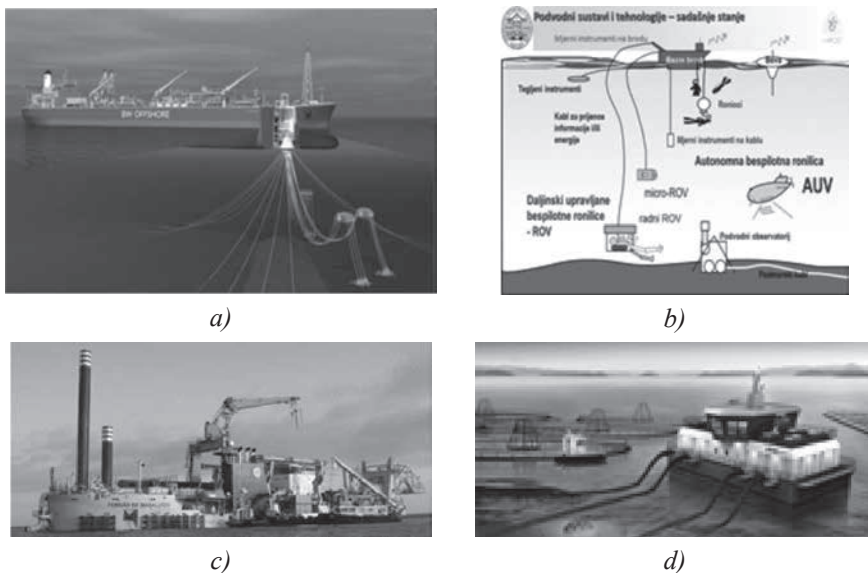


Figure 3 Complex marine technology products:  
a) FPSO unit, b) underwater systems, c) modern dredger, d) mariculture systems

#### 4. Organization of international congresses and invited lectures

Fellows of the CASA continuously and actively participate in organization of international congresses. Two most prominent conferences on marine technology resulted with recognized proceedings as follows:

1. Proceedings of the 22<sup>nd</sup> International Workshop on Water Waves and Floating Bodies, Plitvice, Croatia, 2007 (under the auspices of the CASA, Scientific Council for Maritime Affairs). Editors: Š. Malenica and I. Senjanović.
2. Proceeding of the 7<sup>th</sup> International Conference on Hydroelasticity in Marine Technology, Split, Croatia, 2015. Editors: Š. Malenica, N. Vladimir, I. Senjanović.

Along with that, two very important invited lectures were organized in 2002 and 2007 on offshore hydrodynamic emphasizing new challenges in development of that field:

1. Š. Malenica, Bureau Veritas, Paris, France: Review of numerical simulations in Offshore hydrodynamics, 2002, [7], and
2. O.M. Faltinsen, NTNU Trondheim, Norway: Challenges in Hydrodynamics of Ships and Ocean structures, 2007, [8].

## 5. Lectures at Scientific Council for Maritime Affairs annual assemblies

Each year, Scientific Council for Maritime Affairs organizes regular meetings including lectures on maritime technology, recent advances and development perspectives. The most important ones in the last five years are:

1. L.R. Luttenberg (Komunalac, Opatija), 2013: Development perspectives of small navigation in Croatia,
2. J. Dulčić (Oceanography Institute, Split), 2013: New species in the Adriatic ichthyology – some potential socio-economic consequences to the Croatian fisheries,
3. V. Medica, O. Bukovac, V. Mrzljak (Faculty of Engineering, Rijeka), 2014: Contribution to optimal operation of smart ship diesel motors,
4. B. Klarin, (FESB, Split), 2015: Adriatic energy islands – present vision,
5. G. Gligora (Uljanik, Pula), 2015: Dredger design and construction,
6. L.R. Luttenberg (Ministry of environmental protection), 2016: Estimation of environmental impact in coastal areas,
7. B. Klarin (FESB, Split), 2016: Modern ships with assisted sail propulsion,
8. V. Žanić (FSB, Zagreb), 2017: Report on Scientific Council members activities related to transformation of Brodarski Institute, Zagreb.

## 6. Lectures and scientific papers

Continuity of CASA's fellows in scientific research and development resulted with numerous invited lectures at congresses organized by third parties as well as recognized publications in international top scientific journals. Members of the Scientific Council for Maritime Affairs contributed significantly to congresses on subsea objects. The first one entitled *Croatian capacity in development, production and maintenance of subsea objects* was organized in Pula in 2016 including lectures, [9],

1. A. Korbar: The short report about 150 years old Croatian naval shipbuilding,
2. I. Senjanović, N. Vladimir: Submarine pressure hull design and the application of gained experience to the design of other pressure structures,
3. Z. Vukić, N. Mišković: Laboratory for underwater systems and technology – maritime security type projects,

4. Adriamar Shipbuilding: Development of submarines and manned submersibles in Croatia,
5. Brodosplit: Brodosplit can build submarines.

The second conference on *Proposal of addendum to the national security strategy draft* was organized by the Faculty of Mechanical Engineering and Naval Architecture, Zagreb, and CASA's Scientific Council for Maritime Affairs in 2017. The invited lectures carefully elaborated different aspect of the proposed addendum as follows:

1. A. Korbar: Proposal of addendum to the national security strategy draft,
2. A. Zaninović: Marine type shipbuilding at Brodarski Institute – past, present and future,
3. H. Orešković, G. Paladin: Design of Drakon 220 and offshore ship OPV60,
4. Z. Vukić: Current state and development of underwater remotely guided vehicles,
5. I. Senjanović: Impact of the underwater systems development on scientific research.

Selected papers published in recent years in top international journals related to maritime technology and state-of-the art developments are:

1. B. Liščić, I. Senjanović, V. Čorić, H. Kozmar, M. Tomić, N. Hadžić: Offshore wind power plant in the Adriatic Sea: An opportunity for the Croatian economy, *Transactions of Maritime Science*, 02, 2014, pp. 103-110.
2. N. Hadžić, M. Tomić, I. Senjanović: Harmonic loading of horizontal axis tidal turbines due to non-uniform stream profile, *Ocean Engineering*, 91, 2014, pp. 196-207.
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4. I. Senjanović, M. Tomić, N. Vladimir: An advanced procedure for hydroelastic analysis of very large floating airport exposed to airplane load. *Proceedings of the 7<sup>th</sup> International Conference on Hydroelasticity in Marine Technology*, Split, 2015.

## 7. Co-financing of scientific activities

CASA co-finances scientific activities like publication of books, organization of conferences and scientific research via CASA Foundation. Until today, three books on shipbuilding were published including CASA's financial support, Figure 4:

1. A. Korbar: *Podmorničarstvo*, Laurana, Zagreb, 2007, [10].
2. A. Korbar: *A bit more on subs*, Laurana, Zagreb, 2009, [11].
3. N. Hadžić, *Tehnologija brodogradnje I*, Fakultet strojarstva i brodogradnje, Zagreb, 2018, [12].

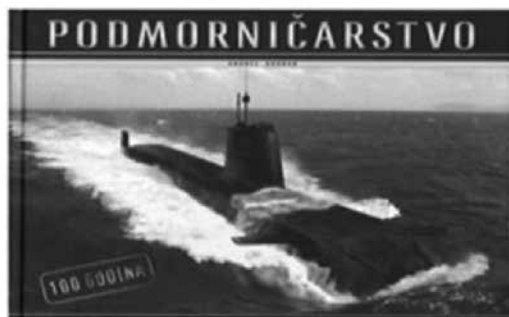


Figure 4 *Podmorničarstvo* book cover

Except that CASA's foundation financially supported organization of the 7<sup>th</sup> interdisciplinary congress on subsea robotics *Breaking the surface*, Biograd na moru, Croatia, 2016.

## 8. Awards and new fellows election

Every year CASA awards a prominent scientist for noted achievement in the past year for each scientific field covered by the Academy Departments. In the field of Maritime Affairs three awards were assigned to:

1. J. Prpić-Oršić and V. Čorić for the book *Pomorstvenost plovnih objekata*, University of Rijeka, Rijeka 2006,
2. A. Korbar for the book *Podmorničarstvo*, Laurana, Zagreb, 2007,
3. Š. Malenica, Bureau Veritas, Paris, to his remarkable achievement in the field of hydroelasticity in marine technology, [13].

Election of new fellows of the CASA is probably the most significant contribution to the marine technology. In 2014 and 2016 two new corresponding fellows strongly related to marine technology were elected:

1. Prof. dr. sc. O. M. Faltinsen, NTNU, Trondheim, Norway, in 2014, [14], Figure 5,
2. Prof. dr. sc. Š. Malenica, Bureau Veritas, Paris, France, 2016, [15], Figure 5.





*Figure 5 Election of the new corresponding fellows,  
a) Prof. dr. sc. O.M. Faltinsen and b) Prof. dr. sc. Š. Malenica*

## 9. Achievements of the Croatian shipbuilding and marine technology

Consistent support of the CASA to the development of marine technology in Croatia resulted with noted projects and products reflecting capability of the Croatian shipbuilding industry to carry out some of the most complex tasks. The first example is the platform Labin build according to Levingston 111c design in class of American Bureau of Shipping, Figure 6. The platform was built in 1986 in collaboration of four Croatian shipyards (3. maj, Brodosplit, Uljanik and V. Lenac) and resized in 2004 in Lamiana shipyard according to the project developed by the Faculty of Mechanical Engineering and Naval Architecture in Zagreb, [16].



*Figure 6 Platform Labin*

This achievement was followed by the design and production of the catamaran crane of 12000 kN lifting capacity built and equipped in 1989 by 3. maj, Rijeka, Metalna Maribor and Jugoturbina, Karlovac [17], Figure 7, as well as gas platform Marica built

in 2004 by Viktor Lenac, Brodosplit and Ravena Shipyards according to the Tecon Milano Design, [18], Figure 8.



*Figure 7 Catamaran crane of 12000 kN lifting capacity*



*Figure 8 Gas platform Marica*

Recent significant achievement of the Uljanik shipyard is construction of several dredgers for the Dredging and Maritime Management, Jan de Nul (Luxemburg) company starting from 2010 until today, [19], Figure 9. Except that, experience gained in the field of submarine structural design was successfully applied by the Faculty of Mechanical Engineering and Naval Architecture in case of the pressure tanks design for Hartman Schiffahrts GmbH & Co. and Hamworthy Gas Companies, [20].



*Figure 9 Niccolo Machiavelli dredger, Uljanik shipyard*

Finally, experienced Croatian researcher successfully conducted the project on subsea pipe laying between Punta Oštro (Kraljevica) and Mala Srčica (the Island of Krk). The project was elaborated for the SUBMAR company by the Faculty of Mechanical Engineering and Naval Architecture, Zagreb, [21], in case of four lined pipeline transferring fresh and industrial water, Figure 10.



*Figure 10 Pipeline between Kraljevica and the Island of Krk*

## 10. Conclusion

The first Conference on marine technology in Croatia organized in 1979 by the Faculty of Engineering in Rijeka can be considered as the very beginning of the marine technology development in Croatia. The following conferences, organized by Zlatko Winkler significantly contributed to popularization and further development in this field. Since 2007 until today the CASA's Scientific Council for Maritime Affairs

together with the Faculty of Engineering, Rijeka, organized in total seven Conferences on marine technology. The main purpose of organized conferences is to present the latest research in marine technology to Croatian scientists, engineers and managers in order to emphasize the importance of its development in context of the Croatian economy. Along with organizational and financial support, the Croatian Academy of Sciences and Arts has successfully organized and supported numerous other activities like round tables, invited lectures, etc. contributing in such a way to the development of the marine technology in Croatia.

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**Ivo Senjanović, Neven, Hadžić**

## **Doprinos Hrvatske akademije znansti i umjetnosti razvoju morske tehnologije u Republici Hrvatskoj**

### **Sažetak**

Opisan je pregled aktivnosti koje je Hrvatska akademija znanosti i umjetnosti (HAZU) poduzimala tijekom godina kao podršku razvoju područja morske tehnologije u Republici Hrvatskoj. Uvid u početak znanstveno-istraživačkog rada na ovom području u Hrvatskoj može se sagledati kroz šest Savjetovanja o morskoj tehnologiji koje je organizirao akademik Zlatko Winkler (1917. – 1996.) u razdoblju od 1979. do 1995. godine. Od 2005. godine Savjetovanje o morskoj tehnologiji organizira Znanstveno vijeće za pomorstvo HAZU i Tehnički fakultet u Rijeci pod pokroviteljstvom Akademije u spomen na akademika Zlatka Winklera, kao znak zahvalnosti svom dugogodišnjem članu i predsjedniku Znanstvenog savjeta za pomorstvo (1994. – 1996). Do danas je održano sedam Savjetovanja uključujući i ovogodišnje. Podrška Akademije ogleda se u više vidova, od kojih je najznačajniji organiziranje okruglih stolova o morskoj tehnologiji.

**Cljučne riječi:** morska tehnologije, Hrvatska akademija znanosti i umjetnosti, Znanstveno vijeće za pomorstvo, hrvatska brodogradnja, istraživanje i razvoj

