# Thirty years of the Centre for Marine Technology and Engineering in Portugal

C. Guedes Soares & Y. Garbatov

Centre for Marine Technology and Ocean Engineering (CENTEC), Instituto Superior Técnico, Universidade de Lisboa, Portugal

ABSTRACT: An overview of the Centre for Marine Technology and Ocean Engineering's (CENTEC) activities since its founding is given in this paper. It describes the circumstances surrounding its creation as well as the various stages of its growth. In addition, a description of the research activity's evolution is given, providing a summary of the major initiatives and accomplishments during that time. The research output is described, and de-tails regarding the national and international assessments of its performance are provided.

# 1 INTRODUCTION

The MARTECH international conferences evolved from a series of Portuguese biannual conferences organised by the Engineering Faculty (IST, Instituto Superior Técnico) of the University of Lisbon (formerly Technical University of Lisbon) and the Portuguese Engineering Association of Engineers (Ordem dos Engenheiros) initiated in 1987 and becoming MARTECH international conferences in 2011.

Some of these conferences have been associated with special celebrations of significant Portuguese institutions or companies in the field, and the MARTECH 2020 conference was associated with the celebrations of the 40<sup>th</sup> anniversary of the teaching of Naval Architecture and Ocean Engineering in Portugal. This year, it is the commemoration of the 30th anniversary of the Centre for Marine Technology and Ocean Engineering (CENTEC) that is associated with this conference, as CENTEC is the group within IST that has been the co-organiser of these conferences.

At MARTECH 2020, an overview of the evolution of teaching and the associated research activity in Portugal was presented. In presenting now an overview of the thirty years of evolution of CENTEC, there is a significant overlap with the description of the research presented by Guedes Soares (2021). Instead of referring to that paper for the descriptions already provided, those relevant parts of the text are reproduced here for the convenience of the reader to have a complete overview of the activities developed.

Teaching in Portugal started in 1976 with postgraduation courses, initially one year in duration and later three semesters later. After three post-graduation courses, it was felt that having a regular educational programme at the Engineering Faculty would be more appropriate. Thus, in 1980, instead of starting the 4<sup>th</sup> post-graduation course, a regular 5-year programme was initiated at IST. The research activity of the academics involved in this program at IST only became visible from the mid-80s, and only one decade later was there enough critical mass to start a research unit addressing this subject area.

The following section describes how the research centre was created and how it has evolved up to the present. The main projects that have supported the development of the centre are described in section 3. The research dissemination activity is discussed in section 4, and the results of national and international evaluation are discussed in section 5.

# 2 CENTRE FOR MARINE TECHNOLOGY AND OCEAN ENGINEERING (CENTEC)

Until the early 1990s, research activity in Portugal was conducted through the National Institute of Scientific Research (INIC), which had centres in various universities, in a system that resembles what still exists in France and Italy. However, INIC was dissolved, and at that time, the research was transferred to the universities that created their own research centres.

So, in 1994, the Unit of Marine Technology and Engineering (UETN) was created as a joint initiative

of the first author with one colleague from Mechanical Engineering and another from Statistics. At that time, there was only one PhD in the field of Naval Architecture in the group, and 3 PhDs were the minimum necessary to create a Research Unit.

When UETN was created, the group was already coordinating the two EU projects described in the following section, and thus, there was already a critical mass of young researchers. The total number of researchers of UETN has been relatively stable at around 55, but the number of researchers with PhD has increased from 3 to almost 20. Another interesting evolution is the internationalisation of the group, which went from a situation of a national group in 1994 to a group with about 35% of foreign researchers in 2006 (Fig 1).



Fig 1. Evolution of human resources of UETN (1994-2006)

By 2007, there were about 55 researchers, 20 of whom had a PhD degree, and this was already an appropriate size for changing the Research Unit into a Research Centre, which was done when IST changed its Statutes. Then, the Centre for Marine Technology and Engineering was created and organised into 4 research groups:

- Marine Environment,
- Marine Dynamics and Hydrodynamics
- Marine Structures
- Safety, Reliability and Maintenance

The research groups represent the main scientific areas in which the members are active, and they are further subdivided into research lines that represent specialised topics in which there is a relatively permanent research activity and in which there is a minimum of two active PhD researchers.

The evolution of CENTEC up to the present day has witnessed an increase in size from 55 to an average level of about 100 researchers, which has been maintained in the last ten years. The other evolution was the number of PhD researchers, which increased from 20 to about 50 or 39% to 45%. The number of foreign researchers has also evolved similarly (Fig 2).

In 2014, an external evaluation of the research centres in Portugal was conducted under the leadership of the Portuguese Foundation for Science and Technology. This led to a review of the research activity and its projection for the future, and the name was readjusted to become the Centre for Marine Technology and Ocean Engineering, giving a more accurate reflection of the research in Ocean Engineering that had been ongoing since the early '90s.



Fig 2. Evolution of human resources of CENTEC (from 2007)

At this time, Maritime Transportation, which had been defined as one priority area for research, was developing but still did not have a critical mass of researchers, so to have consistency in the size of the groups, the fourth group was renamed Safety and Logistics of Maritime Transportation, becoming, in fact, the junction of two subgroups.

So, the present organisation of CENTEC's Groups in research lines is as follows:

# Marine Environment Group

- Wave Spectral Models and Time Series Models
- Probabilistic Models of Wave Parameters
- Wave Modelling and Hindcasting
- Circulation and Oil Spill Modelling
- Oceanographic Instrumentation

Marine Dynamics and Hydrodynamics

- Dynamics of Moored Floaters
- Non-linear Motions and Loads
- Ship Manoeuvring and Control
- Computational Fluid Dynamics
- 3D Virtual Environments in Ship Dynamics
- Full-Scale Trials and Model Tests

# Marine Structures

- Ultimate Strength
- Fatigue Strength
- Impact Strength
- Structures in Composite Materials
- Geometric Modelling of Ship Structures
- Offshore and Subsea Structures
- Experimental Analysis
- Safety and Logistics of Maritime Transportation
- Structural Safety
- Reliability-Based Structural Maintenance
- System Reliability and Availability
- Maritime Safety and Human Factors
- Industrial and Occupational Safety
- Logistics of Maritime Transportation and Port Operations

# **3 RESEARCH PROJECTS**

At the same time, as the teaching staff was trained and increased in number, the research activity has also expanded, as it is indispensable for high-quality university teaching. During the '80s, the research volume produced was low as it resulted from one researcher. A significant jump in the research volume occurred during the '90s due to being the Coordinator of two important EU projects.

One was Reliability Methods for Ship Structural Design (SHIPREL), which ran from 1991 to 1995 and was funded by the industrial-based EU Programme BRITE-EURAM. This project was conducted with three major Classification Societies: Bureau Veritas, Germanischer Lloyds and Registro Italiano Navale, and the Technical University of Denmark. Among the various advances achieved, it proposed a reliabilitybased design format based on the ultimate hull strength (Guedes Soares et al. 1996), which was adopted ten years later by the Common Structural Rules of the Classification Societies. The earlier midship section design requirement was based on elastic stresses and the first yield concept, specifying the minimum acceptable section modulus.

The other project was Probabilistic Methodology for Coastal Site Investigation Based on Stochastic Modelling of Waves and Current (WAVEMOD), which ran from 1993 to 1996 and was financed by the EU Marine Science and Technology (MAST) Programme. This project allowed the development of several probabilistic formulations of the variability of waves and currents, which are essential input information for reliability models (Guedes Soares, 2000). This project was followed by coordinating the project Hindcast of Dynamic Processes of the Ocean and Coastal Areas of Europe (HIPOCAS), which ran from 2000 to 2004 and was financed by the EU Programme Energy, Environment and Sustainable Development (EESD). This major project produced hindcasts of about 40 years of the seas around Europe (Guedes Soares et al. 2002; Guedes Soares, 2008). It was funded in the same call as another project in which the EU funded ECMWF to conduct a global hindcast that led to the well-known ERA40 database. A comparison of these databases showed a good agreement for waves up to moderate significant wave heights (Campos and Guedes Soares, 2016), which is the limit that present-day hindcasting can be trusted, as significant difficulties still exist with the modelling of extreme sea states and new approaches continue being proposed to deal with this problem (Campos et al. 2018).

Another project that was coordinated almost simultaneously was Freak Wave Generation in the Ocean (FREAK WAVES), which ran from 2002 to 2005 and was financed by the EU Programme INTAS. This was a project with a small number of partners, but it reached the interesting conclusion at the time that freak waves tend to be generated when there are sudden significant changes in the shape of the wave spectra (Lopatoukhin et al., 2005).

The follow-up of SHIPREL in the 2000s was two large network projects. The first was Safety and Reliability of Industrial Products, Systems and Structures (SAFERELNET), which ran from 2001 to 2005 and was financed by the industry-based EU Programme GROWTH. This project had 69 partners, collecting thus the contributions of a significant number of European groups, which produced many relevant papers and a book with the main outcomes (Guedes Soares, 2010).

The next project coordinated by CENTEC was the Network of Excellence on Marine Structures (MARSTRUCT), which ran from 2004 to 2010 and was funded by the EU Programme on Sustainable Development (SUSTDEV). This project involved 33 partners, including almost all European groups that worked with Marine Structures. It has been a very successful project that produced a very large number of papers (more than 400). This project also initiated a series of Conferences, the first two of which were held during the project (Guedes Soares & Das 2007, 2009). This was also a significant outcome of the project as this has generated a series of biannual conferences that have continued up to the present day (Guedes Soares & Fricke, 2011; Guedes Soares & Romanoff, 2013; Guedes Soares & Shenoi, 2015; Guedes Soares & Garbatov, 2017; Parunov & Guedes Soares, 2019; Amdahl & Guedes Soares, 2022; Ringsberg, & Guedes Soares, 2023).

Another exciting outcome is the MARSTRUCT Virtual Institute (http://www.marstruct-vi.com), which is an Association of the groups involved in the project, aiming to continue the cooperation. In addition to the collaboration in the organisation of the biannual MARSTRUCT Conferences, it also conducts benchmark studies (e.g. Ringsberg et al. 2018; Parunov et al. 2020).

Another coordination project that transitioned from the 2000s to the 2010s was Advanced Ship Design for Pollution Prevention (ASDEPP), which ran from 2006 to 2010 and was funded by the EU TEMPUS Programme. This project has organised and conducted several PhD courses and produced a book as one of the outcomes (Guedes Soares & Parunov, 2010).

At the same time as this series of projects had a major impact on the development of the research performed at IST, as a result of the number of researchers they allowed to hire, there were another series of important projects that had a similar level of involvement of the IST research group. For a relatively long period, the EU wanted industrially oriented projects to be led by a company, and therefore the strategy adopted in various projects was to have a company as the Administrative Coordinator and IST as the Technical Coordinator. This allowed IST to have a major

participation in those projects, contributing also to shaping the overall research profile at IST.

The first of these projects was Advanced Method to Predict Wave Induced Loads for High-Speed Ships (WAVELOADS), which ran from 1998 to 2001, funded by the EU Programme BRITE-EURAM and coordinated by Germanischer Lloyds (Schellin et al., 2003).

The second project was Reliability-Based Structural Design of FPSO Systems (REBASDO), which ran from 2001 to 2003, funded by the EU Programme on Energy, Environment and Sustainable Development (EESD) coordinated by Shell International Exploration and Production. This project led to advances in reliability formulations (Garbatov et al. 2004) in addition to producing high-quality experimental results (Skourup et al. 2004) and improvements in wave descriptions (Ewans et al. 2006).

The next project, also coordinated by Shell, was Safe Offloading from Floating LNG Platforms (SAFEOFFLOAD), which ran from 2006 to 2009 and was funded by the EU Programme Sustainable Surface Transport (SUST). This project dealt with offloading LNG from platforms to shutter LNG tankers and led to several interesting hydrodynamic studies (Guedes Soares et al., 2015).

Another project with some time overlap with that one was the Decision Support System for Ship Operation in Rough Weather (HANDLING WAVES), which was held from 2007 to 2010, funded by the EU Programme Sustainable Surface Transport (SUST) and coordinated by Registro Italiano Navale. This project produced interesting experimental results (Rajendran et al., 2011) and led to the development of a decision support system that was installed in one ship of Grimaldi Lines (Perera et al., 2012).

Another project undertaken from 2000 to 2003 was Rogue-Waves - Forecast and Impact on Marine Structures (MAXWAVE), funded by the EU Energy, Environment and Sustainable Development Programme. GKSS coordinated this project in Germany, which was responsible for the group of partners dealing with wave modelling, while IST was responsible for the group of partners dealing with wave-induced responses. This was a very important project that made significant progress towards the description of abnormal or rogue waves (Guedes Soares et al., 2003) and the ship (Guedes Soares et al., 2008) and offshore structures (Guedes Soares et al. 2006) responses to them. This project recognised the important contribution of Prof Douglas Faulkner (Guedes Soares & Das 2008) to this field and invited him to be a consultant to the project.

The follow-up project, with technical coordination, of IST was Design for Ship Safety in Extreme Seas (EXTREME SEAS), which ran from 2009 to 2013, funded by the EU Sustainable Surface Transport Programme and was coordinated by Det Norske Veritas. This was also an important project with advances in modelling abnormal and extreme waves (Zhang et al., 2014) and responses to extreme waves represented by advanced models (Klein et al., 2016; Wang et al., 2016). Significant experimental results were also obtained, allowing, for example, the analysis of pressures in the bow flare and stern of a containership (Wang and Guedes Soares 2016a, b).

In the mid-2010s, some new research areas were identified, among which renewable energy offshore was among the most important. This interest has originated the initiation of one project coordinated by CENTEC addressing the Adaptation and implementation of floating wind energy conversion technology for the Atlantic region (ARCWIND), which ran from 2017 to 2023 and was funded by the INTERREG Atlantic Area Programme. This project allowed the identification of the status of present-day wind farms and the development of a siting approach (Diaz & Guedes Soares, 2020a, b), the establishment of a cost assessment procedure (Castro-Santos et al. 2020), the identification of the relevant maintenance policies (Kang et al. 2019) and even the design of a new platform concept (Uzunoglu & Guedes Soares, 2020).

The involvement in these projects has significantly influenced the research conducted during the time span. However, at the same time, there has been involvement in about 95 other EU-funded projects as partners, some of which IST made substantial contributions and others with a small contribution. There were 32 projects finishing in the decade of 1990, 40 in the 2000s and 22 in the 2010s. The EU projects tended to become larger with time, with typical projects in 2010 having 3 to 4 times the budget of the ones in the 1990s.

Another source of project funding has been the national funding agencies, mainly FCT the Foundation for Science and Technology. These projects have been mostly with one institution, and a few are collaborations between two Portuguese institutions. The contribution of national projects was relatively small in the 1900s, but it has become more significant since 2000. There were 16, 25, and 28 projects, respectively, in the three decades 1990, 2000, and 2010.

Among the projects of the Marine Environment Group, reference can be made to the use of navigation radar to measure waves and estimate surface currents and wind and to the development of numerical wave prediction, starting with hindcast data, continuing to the establishment of an operational forecast system for the Portuguese Ports and the development of assimilation methods for the forecasts. Later, the work focused on predicting the consequences of climate change on wind and wave conditions. Work on circulation models allowed the development of a system for predicting the fate of accidental oil slicks at sea.

The Group on Dynamics had several projects related to ship manoeuvrability and control, including autonomous vessels, and others on the dynamics of

renewable energy devices, mainly wave converters and wind turbines.

The Marine Structures Group had projects on composite materials, fatigue of ship components, ship collision and crashworthiness, ship repair, condition assessment and structural maintenance.

The Safety and Reliability Group had some projects on occupational safety, human factors, maritime safety, and modelling maritime traffic risk assessment. Structural reliability was also addressed by developing computational methods and applying them to marine structures.

Several projects have also addressed ports and shipping, such as effective operation in ports, tools and routines to assist ports and improve shipping and safe, efficient and environmentally friendly ship operations.

The last call for projects that FCT opened before the pandemic period was in 2017, and the approved projects started at the end of 2018 and typically lasted until 2022. At that call, CENTEC was awarded 10 projects on various topics such as autonomous ocean observing systems, extreme wind and wave modelling, climate change impacts, ship manoeuvrability, power take-off systems for wave energy converters, oscillating water column devices, hydroelastic behaviour of flexible floating structures, pipelines for deep waters, short sea shipping, risk in maritime traffic.

After the 2017 call for projects, FCT support for new research projects has been extremely limited due to the economic conditions prevailing in Europe during and after the pandemic. The first significant call for project proposals was in early 2024, but the results of proposal evaluation have not yet been released.

# 4 DISSEMINATION OF RESEARCH

Scientific publications are the end product of any research activity; thus, they are one important objective of any researcher. They have been an essential index of the activity of CENTEC, and the productivity has changed over the years, as can be observed in Fig 3, which shows all indexed publications and journal papers. Fig 4 shows the output over each five-year period, separating the papers published in international journals from those presented in Conferences and published as book chapters or proceedings.

Both figures show an important difference between the first ten years and the recent years. Despite a permanent increase in the total number of publications, the increase was sharper after the first ten years. When correlating this with the number of researchers, it can be observed that the total number did not change much in the period. Still, the number of PhD researchers showed a significant increase around 2000, continuing to increase after that.



Fig 3. Evolution of CENTEC WoS Publications

From 2000 to 2010, there was a significant increase in journal papers, with the ratio of journal to conference papers being almost constant at 0.37. Still, in the following five years, this changed to 0.63, and in 2016-2020, the journal papers were even more than the conference papers, i.e. the change was to 1.26, increasing to 1.53 in the last three years period. This resulted from a deliberate policy to reduce the participation in Conferences compared to submitting papers in Journals.



Fig 4. Evolution of CENTEC WoS Publications

The journal papers have been spread over many journals, but some have been preferred. Figures 5 to 7 show some of them grouped by major subject areas.



Fig 5. Publications in Ocean Engineering journals



Fig 6. Publications in Structures journals



Fig 7. Publications in Safety and Reliability journals

The public acceptance and recognition of the results can be related to the number of citations the papers have collected, now about 38,000 in the Web of Science and 53,000 in SCOPUS. The evolution of the number of citations in the Web of Science is shown in Fig.8. It can be observed that in 2010-2014, the number of citations was relatively low (average of 811/year), but a marked increase to high values can be observed since then, in particular in the last three years (average of 5200/year).



Fig 8. Evolution of WoS Citations of CENTEC Publications

Some of the papers have even gained high public acceptance, becoming highly cited papers in the Web of Science. In the current year, the following papers have been listed: Chojaczyk et al. (2015), Wu et al. (2017; 2022), Diaz & Guedes Soares, (2020); Diaz et

al. (2022), Li & Guedes Soares (2022), Li et al. (2020; 2021b; 2022), Tadros et al. (2023).

In earlier years, other papers have also been highly cited: Rusu & Guedes Soares (2012a; 2012b), Silva et al. (2013), Gonçalves et al. (2014), Mantari & Guedes Soares (2014), Mantari et al. (2012a; 2012b), Gaspar et al. (2017), and Wu et al. (2018; 2019), Li et al. (2021a). Fig 9 shows the number of highly cited papers in the WoS during the last ten years, with an increasing trend.



Fig 9. Evolution of Number of Highly Cited papers in WoS

It may also be of interest to identify the main scientific area that has been covered by the publications, both in journals and in some conferences that are indexed in Web of Science. This identification is based on the areas and results presented in the Web of Science, which is as follows:

Scientific Area	Percentage
Engineering Marine	26%
Engineering Ocean	19%
Engineering Civil	15%
Oceanography	12%
Engineering Mechanical	7%
Transportation Sci. & Techn.	3%
Mechanics	3%
Energy & Fuels	2%
Green Sustainable Sci. Techn.	2%
Engineering Industrial	2%
Operations Research	2%
Meteorology Atmospheric Sciences	1%
Materials Sci. Composites	1%
Others	5%

Other papers have won distinctions and awards, such as the significant papers in the Journal of Ship Research (Saad-Eldeen et al., 2011; Sutulo et al. 2012;

Teixeira et al., 2013; Corak et al. 2015), the Best Paper Award of the Ship and Offshore Structures Journal (Saad-Eldeen et al. 2013) and of the International Journal of Maritime Engineering (Cubells et al. 2014; Zhou et al. 2016) the top paper award of the Renewable Energy Journal (Rusu & Guedes Soares 2012b) and the 10<sup>th</sup> Anniversary best paper of the journal Energies (Silva et al. 2013).

Another interesting aspect that can be derived from the analysis of the publications is the identification of the international collaborations that they reflect. Again, using the information from the Web of Science, the number of journal papers (all publications in parenthesis) in collaboration with the various foreign institutions are as follows (using 6 as the cut-off):

Institution	Journal Papers	All Publications				
Wuhan University of Techn.	79	94				
Jiangsu Univ. Sci. & Techn.	24	32				
University of Zagreb	23	32				
Gdansk Univ. of Technology	23	26				
Univ. Fed. do Rio de Janeiro	20	34				
Harbin Engineering Univ.	19	28				
Ocean University of China	19	21				
Norwegian Univ. Sci. & Techn.	16	21				
Shanghai Jiao Tong University	14	16				
Alexandria University	13	16				
Univ. Las Palmas Gran Canaria	12	15				
Technical University of Varna	10	15				
Amirkabir Univ. of Technology	8	10				
CSSRC	8	9				
Universidade da Coruña	8	9				
University Electronic Sc. Techn.	8	8				
Huazong Univ. Sci. & Techn.	7	7				
Istanbul Technical University	7	8				
Lloyds Register EMEA	7	8				
SINTEF	7	8				
South China Univ. of Technol- ogy	7	8				
Tianjin University	7	7				

In addition to identifying the universities with which more intensive cooperation has been maintained, it is also interesting to identify the countries where the cooperation has been ongoing. Using as the indicator the number of joint journal papers (all publications in parenthesis) indexed in the Web of Science results in the following list using 10 journal papers as the cut-off number.

On the 15<sup>th</sup> anniversary of CENTEC, a commemoration book was published mostly with state-of-theart review papers by CENTEC members and by several foreign collaborators at the time (Guedes Soares et al. 2011). This has been a very important source of information about the work performed in the period just before its publication.

Country	Journal Pa- pers	All Publications
China	211	252
Spain	42	57
Brazil	31	48
Croatia	29	45
Norway	29	41
UK	27	32
USA	27	35
Italy	23	36
Poland	23	28
Germany	18	29
Egypt	17	21
Bulgaria	15	23
The Netherlands	12	21
India	11	21

The promotion of the dissemination of results through conferences has been considered an important activity, and there has been significant engagement in organising conferences. There has been a direct involvement in the organisation of the yearly Offshore Mechanics and Arctic Engineering (OMAE) Conferences by coordinating Symposium 2 of that Conference, which initially was the Safety and Reliability Symposium and later became the Structures, Safety and Reliability Symposium. In addition, the OMAE Conference was organised in Lisbon in 1998 and Estoril in 2008. During OMAE2018, which was held in Madrid, a "special Symposium on Marine Technology and Ocean Engineering Honoring Prof. Carlos Guedes Soares" was organised with about 120 papers (Garbatov, 2020). In the previous year, the Honouring Symposium of Prof Torgeir Moan was held (Guedes Soares, 2019a) in Trondheim.

The European Safety and Reliability (ESREL) Conferences are promoted by ESRA, the European Safety and Reliability Association, whose creation the first author made a significant contribution. The ESREL Conference was organised in Lisbon in 1997 (Guedes Soares, 1997). and in Estoril in 2006 (Guedes Soares, & Zio 2006). Cooperation has also been established in some of the Conferences organised in other years (Martorell et al., 2009; Bris et al., 2010; Berenguer et al., 2011).

A short series of biannual national conferences associated with the Portuguese ESRA chapter was conducted on the Analysis and Management of Risk, Safety and Reliability from 2005 to 2012, leading to 4 sets of proceedings in Portuguese.

The Congress of the International Maritime Association of the Mediterranean (IMAM) was organised

in Lisbon in 2005 (Guedes Soares et al. 2005), which was the first time the proceedings were published in book format. This was done in most of the following Congresses (Guedes Soares & Kolev, 2008; Rizzuto & Guedes Soares, 2012; Guedes Soares & Lopez Peña, 2014; Georgiev & Guedes Soares, 2020; Ergin, & Guedes Soares, 2023), also following the conference that was organised in Lisbon for the second time (Guedes Soares & Teixeira 2018).

Another series of Conferences was the biannual series jointly organised by IST and the Portuguese Association of Engineers, which started in 1987. Initially, yearly conferences were organised, but after some years, they stabilised into biannual conferences. In total, 16 books were edited in Portuguese with the proceedings of those conferences. In 2011, those conferences became international, leading to the Maritime Engineering & Technology (MARTECH) series, which have been organised biannually (Guedes Soares et al. 2012, Guedes Soares & Santos, 2015, 2016, 2018, 2021, 2022, 2024).

With the interest in renewable energies offshore and the priority that was given to research in this subject, a new series of Conferences on Renewable Energies Offshore (RENEW) was initiated by CENTEC in 2014 and has continued biannually (Guedes Soares, 2015, 2016, 2019, 2021, 2023).

# 5 NATIONAL AND INTERNATIONAL EVALUATION

The evaluation of work by peers is the normal process in academic environments, and thus, while one can describe the research activities developed, their significance can only be independently ascertained by the opinion of others. Therefore, it is worth mentioning that some of the evaluations were conducted on a national and others in an international scale.

The Portuguese Foundation for Science and Technology (FCT) is responsible for funding the research centres directly and indirectly through competitive calls for research projects, research contracts and scholarships. Periodically, FCT promotes the external evaluation of research centres, which is carried out by panels of foreign scientists.

In the 2014 evaluation, quantitative measures were used to characterise the performance of the centres, and bibliographic production and citation levels were taken into consideration across the various scientific areas.

In that evaluation, CENTEC was considered a multidisciplinary centre covering the areas of Mechanical Engineering and Engineering Science and of Marine Sciences and Technologies and was evaluated as Excellent with a total of 24/25 points. A selection of the Evaluation Panel comments reads as: "The unit has a unique position in Portugal and is one of the leading centres in its field worldwide. It has contributed very significantly to the high international ranking of IST. The centre demonstrates a high scientific impact and is highly relevant to economic development. It is clear that the centre is wellrun and has clear strategic goals. The site visit confirmed that the culture of the centre is forward-thinking and supportive of its members."

CENTEC was classified 1<sup>st</sup> among the 14 Centres of Portugal in Mechanical Engineering & Engineering Science and 3<sup>rd</sup> among the 63 Centres of Portugal in Engineering Sciences.

CENTEC was classified second among the 6 Portuguese centres in Marine Sciences and Technologies and second among the 45 Portuguese centres in Natural and Environmental Sciences.

In 2018, a new national evaluation exercise was conducted by FCT, and CENTEC was again evaluated as Excellent. However, the evaluation process was more qualitative, not allowing any ranking among centres to be determined.

On an international level, the evaluations are mostly quantitative and objective. The first contact with international rankings results was at a Workshop at NTNU commemorating the 70th birthday of Profs Faltinsen and Moan, where the NTNU's Rector announced the results of a study conducted by the Center for Measuring University Performance in the USA and the International Institute for Software Technology of The United Nations University, covering 250 disciplines, one of each in Ocean Engineering.

The ranking criteria were the volume of total publications and their impact, based on SCOPUS in 2008-2011. Out of the 49 universities listed, the Technical University of Lisbon appeared in 2<sup>nd</sup> place after the Norwegian University of Science and Technology.

Another evaluation result is the Shanghai Ranking of World Universities, which used to present the ranking of universities for the broad area of Engineering but has since 2017 started presenting results for the various branches of engineering. The ranking criteria were also based on publications but now using publications indexed in the Web of Science.

In the area of Marine & Ocean Engineering, the University of Lisbon appeared in 3<sup>rd</sup> place, immediately after the Norwegian University of Science and Technology, while in the first place was the Shanghai Jiao Tong University. In the following years, the University of Lisbon maintained 2<sup>nd</sup> place in Europe consistently, although moving to 6<sup>th</sup> place internationally,

while Chinese Universities, with their much larger manpower dimension, were moving up the ranking.

However, in the 2023 ranking, the University of Lisbon was upgraded to 4th place internationally and, more importantly, to 1st place in Europe. The ranking in Europe is considered a very important one because it is made among universities that have Marine and Ocean Engineering groups of comparable size, while the Chinese Universities that occupy the first places in the world ranking have significantly larger departments.

The most recent result is the Stanford World Ranking of Scientists (Ioannidis et al. 2020), which prepared the ranking based on the published work indexed in Scopus and made available the list of the 2% highest ranking scientists. It was interesting to note that CENTEC had two individual researchers among the 385 Portuguese scientists from all scientific areas on the list (1<sup>st</sup> Guedes Soares; 333<sup>rd</sup> Garbatov). In the area of Civil Engineering, which in this database includes the papers of Naval Architecture and Ocean Engineering, the same two individuals are included (1<sup>st</sup> Guedes Soares; 438<sup>th</sup> Garbatov) among the 900 scientists listed, which were selected from a universe of 42,000 authors in that field. The situation between 2020 and 2024 did not change much, but in 2024, the total number of Portuguese scientists from all scientific areas on the list had increased from 385 to 572, and the number of CENTEC members on that list increased to four (1st Guedes Soares; 267th Garbatov; 516<sup>th</sup> Sutherland; 560<sup>th</sup> Teixeira).

# 6 CONCLUSIONS

The research development in Naval Architecture and Ocean Engineering at CENTEC, which is still the only centre in Portugal dedicated to this field of study, has been presented. Over time, the focus has shifted from shipbuilding during the initial phase to ship design, ports, maritime transportation, and ocean engineering. Research has generally become more internationally recognised and holds a prominent position.

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LISBOA	Ocean Engineering	The Unit of Marine Technology and Engineering was created in
UNIVERSIDADE De Lisboa	CENTEC	<b>1994/95</b> with 3 Phd researchers and 3 main research lines: <ul> <li>Design and Reliability of Ocean Vehicles and Structures</li> </ul>
5		<ul> <li>5 research groups (Marine Environment; Ship Dynamics; Marine Structures; Ship Design and Maritime Transportation; Safety, Reliability and Maintenance)</li> </ul>
<b>ECNIC</b> ISBOA	C. Guedes Soares, Y. Garbatov	<ul> <li>Optimal Design and Control of Structures and Mechanical Systems</li> </ul>
	c.guedes.soares@centec.tecnico.ulisboa.pt	<ul> <li>Queueing Systems and Quality Management</li> </ul>
	y.garbatov@centec.tecnico.ulisboa.pt	In 2007, following new Statutes of IST the name of the Unit was
	Instituto Superior Tácnico, Universidade de Lishoa	changed to Centre, which was reorganised in 4 Research
	(School of Engineering of the University of Lisbon)	II88A O O O PO- Marine Environment,
	May 2024	II – Marine Dynamics and Hydrodynamics – Marine Structures
	http://www.centec.tecnico.ulisboa.pt/	TECHNO - Safety, Reliability and Maintenance
ENTEC	Centre for Marine Technology and Ocean Engineering	Gente www.centec.tecnico.ulisboa.pt MARTECH 2024 2
	Historical Notes of centec	centec Organisation
	In <b>2015</b> , following the FCT evaluation procedure and the preparation of a Strategic plan for 2015-2020 the name of the Unit is changed to	- A Scientific Council made up of all researchers with PhD degrees.
	<b>Centre for Marine Technology and Ocean Engineering</b>	<ul> <li>The President is elected by the Scientific Council.</li> <li>The Executive Committee, consists of members proposed by the</li> </ul>
	with 4 Research Groups:	President, including the Vice-President and is ratified by the Scientific Council.
	<ul> <li>Marine Environment,</li> <li>Marine Dynamics and Hydrodynamics</li> </ul>	- The <b>Scientific Coordinator</b> ensures the coordination of the scientific activities in and among the various Research Groups.
	<ul> <li>Marine Structures</li> <li>Safety and Logistics of Maritime Transportation (new designation)</li> </ul>	- The members are organized into <b>Research Groups</b> according to their main scientific area of work.
	Becoming in 2015 a multidisciplinary centre in the areas of	- Each Research Group is organized in <b>Research Lines</b> that represent a consistent body of knowledge.
LISB0A Intersiant Delissan	Mechanical Engineering and Engineering Systems (one of two Centres of IST recognized by FCT in this area)	<ul> <li>Each Research Line needs to have at least 2 PhD researchers and a visible body of journal publications.</li> </ul>
5	Marine Sciences and Technologies	The Research Lines contribute to the various <b>projects</b> that normally involve several lines.
SBOA	(the only Centre of IST recognized by FCT in this area)	
ENTEC	www.centec.tecnico.ulisboa.pt MARTECH 2024 3	CENTED www.centec.tecnico.ulisboa.pt MARTECH 2024 4



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