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Developments in Maritime Technology and Engineering – Guedes Soares & Santos (eds)

Forty years of teaching and research in Naval Architecture and Ocean Engineering in Portugal

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ABSTRACT: This paper provides an overview of how the teaching of Naval Architecture and Ocean Engineering has evolved at Instituto Superior Técnico since 1980. It describes the main changes in the curricula that occurred in 1988, 1998, 2007, 2017 and the planned study plan to be initiated in 2021/2022. At the same time, the evolution of the research activity of the academic staff is also described, providing an overview of the main research projects and achievements in that period. The evolution of the research centre CENTEC, which was created in the academic year of 1994/1995, and is now commemorating its 25th anniversary, is also described. A description of the research output is given, as well as information about the national and international evaluation of its performance.

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 and the Portuguese Engineering Association of Engineers (Ordem dos Engenheiros). Some of these conferences have been associated with special celebrations of significant Portuguese institutions or companies in the field, and on this occasion, the conference is associated with the celebrations of the 40th anniversary of the teaching of Naval Architecture and Ocean Engineering in Portugal and the related 25th anniversary of the Centre for Marine Technology and Ocean Engineering (CENTEC).

Therefore, it is appropriate to present an overview of the evolution of teaching and the associated research activity, which has been particularly important for the industry in Portugal and Europe in general, as a significant part of the graduates are working in various companies and institutions spread throughout Europe.

Teaching in Portugal started in 1976 with post-graduation courses, initially of one year and later of three semesters. These courses were initiated as a result of the planned expansion of the shipbuilding activity that was expected to occur in Portugal, with an increased need for engineers specialised in this area.

During the 70s, Portugal had a very large shipyard in Lisbon, Lisnave, which employed up to 10,000 workers undertaking ship repair and major conversions. There was also another shipyard in Setúbal, about 60 km from Lisbon, Setenave, building large tankers. In the early 70s, plans have been made to expand it with large docks to be able to build very large tankers, and for this planned expansion, the need to have enough engineers graduated in naval architecture and marine engineering was identified and the University of Lisbon was asked to respond.

The initial post-graduation courses have been organised directly under the aegis of the University of Lisbon, in which existing professional engineers practising in the country ensured the teaching. At the time, the largest group of these specialists were the "Naval Constructors" of the Portuguese Navy, who took up the leading role in this educational process as Adjunct Professors.

After three series of post-graduation courses, it was felt that it would make more sense to have a normal educational programme at the Engineering Faculty and thus in 1980, instead of starting the 4th post-graduation course, a regular 5-year programme started at IST.

2 TEACHING OF NAVAL ARCHITECTURE AT IST

In the academic year of 1980/1981, a new course started at IST under the designation of Shipbuilding Engineering. This was a full 5-year course that included two years of general engineering subjects common with other courses such as Mechanical Engineering. More specific subjects were taught in the last three years, including an expanded version

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of the subjects taught in the three semesters of the earlier post-graduation course.

At that time, Prof. Luciano Faria was the leading person responsible for the post-graduation courses and the initiation of teaching at IST. The group of Adjunct Professors from the Portuguese Navy was led by C. Caldeira Saraiva in the post-graduation courses and by Rogério d'Oliveira at IST.

Starting a new educational programme at IST required the training of new teaching staff, as this was the first programme in Portugal, and it was not possible to hire specialists who graduated from other Portuguese Universities. Thus, an agreement was made with the Norwegian Institute of Technology at the University of Trondheim in Norway to provide a PhD programme for four new staff members who would be the first teaching staff of the new course.

Two positions were announced in 1980 and two more in 1981, but surprisingly only the author has been selected and sent to Norway from 1980 to 1984 to complete the PhD programme. Therefore, the build-up of the specific teaching staff took longer than initially planned as new staff had to be hired from the newly formed engineers. At that time, the teaching was totally in Portuguese, and internationalisation was not the standard approach in Portugal as in many European countries.

The teaching programme has evolved gradually to increase the number of specialised Naval Architecture subjects to make the nature of the programme more specific as the appropriate teaching capability became available.

The first curricular change was in 1988, when the course changed its designation from "Shipbuilding Engineering" to the classical designation of "Naval Architecture and Marine Engineering", or "Engenharia Naval", in Portuguese. This change has corresponded to increasing the number of subjects that strengthened the capability of designing ships, widening the earlier nature of the course, where shipbuilding technology had a larger relative weight.

The next curricular change was made in 1998 when the scope of the course was widened and was organised in two specialisation profiles. One corresponded to the traditional education that was ongoing and was denoted as "Ship Design and Shipbuilding", and a new one was created under the name of "Maritime Transportation and Ports".

The rationale behind this change was the recognition of the evolution that the shipbuilding and ship repair industry was undergoing in Europe, with the closing of several major shipyards and the transfer of industrial activities to countries in Asia. This transfer of activity has also occurred in other industries and, as a result, an increasingly large number of products started being produced in Asia, which required them to be transported to Europe for final consumption, increasing the role of maritime transportation in European countries. Therefore, the professional education of naval architects had to be adapted to the new conditions of the employment market, providing them with education in a neighbouring field where they could perform their professional activity.

The approach adopted was to maintain the main educational subjects common to both specialities to ensure the essential knowledge required by a naval architect to fulfil the main professional activities. The specialist subjects were limited to provide more in-depth knowledge of the more specific aspects of each of the specialisations.

In 2007, almost keeping the same ten-year period of curricular adjustment, a new reformulation of teaching was undertaken, this time as a consequence of the Bologna Agreement, which required uniformisation of the degrees in Europe. Thus, continental Europe, which had engineering degrees based on five years of education, decided to adjust the degrees to a system mostly existing in the UK of a first Bachelor degree of 3 years and a Master degree of 2 additional years.

In Portugal, the Universities reacted to these imposed changes by defining "Integrated Master degrees", in which the Bachelor and the Master programme were "integrated", and in that way, in practice, they continued having a 5-year programme. This "smart" way of dealing with imposed changes was not unique in Portugal as it was also adopted in other countries in Europe.

However, in Portugal, this approach was adopted only for the courses of a large number of students. In most countries, the naval architecture courses are almost always much smaller in the number of students than other more generic engineering specialities like mechanical, civil, electrotechnical and chemical, for example. For the courses with a small number of students like Naval Architecture and Marine Engineering, IST has chosen to have two separate cycles of Bachelor (Licenciado) and Master (Mestre).

In passing, it is interesting to note that the educational changes in Portugal have created a major problem that has not yet been solved, many years after the changes were made. The existing 5-year engineering programme in Portugal lead to a degree designated as "Licenciado". When creating a system in which the first degree was three years, the same designation of "Licenciado" was maintained. Thus, suddenly the same title designated an education of 5 years and another of 3 years.

The system that existed in Portugal and some other European countries before 2007 was to have a Master degree of about two years after the 5-year educational programme. Here also, the changes imposed by the Bologna Agreement lead to the title of a Master representing seven years or five years of education depending on whether it was before or after 2007.

While the problem associated with the designation of the degrees has not been changed, a recent law from the Ministry of Higher Education has dictated the end of the "Integrated Master" courses, so from the academic year of 2021/2022, all courses in Portugal will be functioning in strict 3+2-year cycles.

With the change of the study plan of 2007, there was the idea that the initial study cycle should have more generic education, leaving the specific subjects for the Master degree. This led to a reduction in the number of subjects specific to Naval Architecture in the first three years, and they were moved to the Master study plan. This unfortunate situation has been maintained until the present, more realistic, policy change, which allowed the return to the earlier situation in which the first three years will have a more substantial component of specific courses.

The Bachelor programme that will start functioning in 2021/2022 has the first year with mathematics and sciences, the second year with general engineering subjects and a third-year with Naval Architecture and Ocean Engineering subjects.

In 2017, a more limited change in the study plan has been implemented by creating a third specialisation profile, this one on Ocean Systems. This was a result of the interest and support of the Portuguese oil and gas company GALP, which have in more recent years become more involved in oil and gas production and exploration through joint ventures in Brasil, Mozambique and other locations worldwide. To support these activities, the company needed naval architects better prepared to deal with the specific aspects of the oil and gas industry and have supported several scholarships for students of this new specialisation.

With the addition of this new specialisation, the designation of the course was changed from Naval Architecture and Marine Engineering to Naval Architecture and Ocean Engineering, covering now the complete scope of activities where traditionally the graduates find work. This last addition to the study plan allowed it to reach the global scope of education that is found in several other countries. In Portugal, this educational programme continues to be the only one offered at any University.

The teaching of the Master course has been given for many years in English, while the Bachelor course maintained teaching in Portuguese, although starting in 2021/2022, subjects in the Bachelor programme will also be taught in English. The environment in the Master programme has been very much international with a moderate percentage of regular students from other countries and with 30 to 40 exchange students that every year take part in the study programme. The main number of exchange students come from Europe, being funded by the European ERASMUS programme, but several other international bilateral exchange programmes also bring students from other countries such as Brazil, India, China, Japan and Korea.

The third cycle of studies leads to Doctoral degrees, which has been very relevant to the built-up of the teaching staff of the Bachelor and Master programmes and also to shape the research produced at IST in this field. The PhD studies have started in the 1990s, with the traditional format based exclusively on research and in the early 2000s, following a change in all research fields at IST, Doctoral programmes were created with a full year of course work before the research component was conducted. This change has been particularly important after 2007 when the normal education period of 7 years before starting the PhD programme was reduced to 5 years. Thus, the reduction of 1 year of course work undertaken in the Master programmes after the 5-year Engineering degree was compensated by the 1-year taught programme on the Doctoral Programmes.

Several of the PhD graduates became teaching staff at IST, having produced thesis on a diversified range of subjects (Guedes Soares & Garbatov 1996; Fonseca & Guedes Soares, 1998; Santos & Guedes Soares 2008; Teixeira & Guedes Soares 2009; Gordo & Guedes Soares 2009; Ventura & Guedes Soares 2012; Ribeiro e Silva & Guedes Soares, 2013; Wang & Guedes Soares 2016a,b; Vettor & Guedes Soares 2016; Chen & Guedes Soares 2016; Campos et al. 2019).

Several other PhD graduates are now teaching staff at different Universities around the world, such as China (6), Egypt (5), Croatia, India, Germany, Japan, Norway, Peru and Romania, while others are working in the industry also in different countries such as Brasil, Italy, Netherlands, Norway, Poland and Portugal.

The PhD programme has been designated as Naval Architecture and Marine Engineering, but since 2017 it became Naval Architecture and Ocean Engineering, also aligning with the designations of the two earlier cycles of Bachelor and Master.

Some joint PhD degrees have been awarded with other Universities such as Universidade Federal do Rio de Janeiro, University of Zagreb, Universita Mediterranea de Reggio Calabria. Joint supervision of PhD's have been carried out with Universidade de Las Palmas de Gran Canaria, University of Rijeka, Universidade Federal do Rio de Janeiro, Universiti Teknologi Malaysia, Amirkabir University of Technology, Wuhan University of Technology, Ocean University of China, Shanghai Jiao Tong University, Dalian Maritime University and Northwestern Polytechnical University.

3 RESEARCH

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 volume of research produced was low as it resulted from one single researcher. A significant jump in the volume of research has occurred during the '90s as a consequence of 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 reliability-based 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 the coordination of 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 was a major project that 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 at the same time was Freak Wave Generation in the Ocean (FREAK WAVES), which run from 2002 to 2005, 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 were two large network projects. The first one 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 groups in Europe 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 major outcome of the project as this has generated a series of biannual conferences that have continued up to the present days (Guedes Soares & Fricke, 2011; Guedes Soares & Romanoff, 2013; Guedes Soares & Shenoi, 2015; Guedes Soares & Garbatov, 2017; Parunov & Guedes Soares, 2019).

Another interesting outcome is the MARSTRUCT Virtual Institute (http://www.marstruct-vi.com), which is an Association of the groups that were involved in the project, aiming at the continuation of 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 coordinated project that made the transition from the 2000s to the 2010s was Advanced Ship Design for Pollution Prevention (ASDEPP), which ran from 2006 to 2010 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 in practice major participation in those projects, which also contributed 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 run 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 run from 2006 to 2009, funded by the EU Programme Sustainable Surface Transport (SUST). This project dealt with the off-loading of LNG from platforms to shutter LNG tankers and led to several interesting hydrodynamic studies (Guedes Soares et al., 2015).

Another project with some time of overlap with that one was 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 developing 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), which was funded by the EU Energy, Environment and Sustainable Development Programme. This project was coordinated by GKSS in Germany who 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). Important 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 have been identified, and among them, renewable energies offshore was one of the most important. As a consequence, the project being coordinated presently is Adaptation and implementation of floating wind energy conversion technology for the Atlantic region (ARCWIND), which runs from 2017 to 2021 and is funded by the INTERREG Atlantic Area Programme. It reflects the new priority area of renewable energies offshore that was adopted more recently in CENTEC. This ongoing project already 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 had a significant influence on the research conducted during the time span. However, at the same time, there has been the involvement in about 95 other EU funded projects as partners, to some of which IST made substantial contribution and others with a small contribution. They were 32 projects finishing in the decade of 1990, 40 in the 2000s and 22 in the 2010s. The EU projects had a tendency of becoming 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. These have been projects mostly with one institution, and a few are a collaboration between two Portuguese institutions. The contribution of national projects has been relatively small in the 1900s, but since 2000 it became more significant. There have been 16, 25 and 28 projects respectively in the three decades of 1990, 2000 and 2010.

4 CENTRE FOR MARINE TECHNOLOGY AND OCEAN ENGINEERING (CENTEC)

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

So in 1994, the Unit of Marine Technology and Engineering (UETN) was created as a joint initiative of the author with one colleague from Mechanical Engineering and one colleague from Statistics. At that time, there was only one PhD in the field of Naval Architecture in the group, and 3 PhDs was the minimum number necessary to create a Research Unit.

When UETN was created, the group was already coordinating the two EU projects mentioned in the previous section, and thus there was already a critical mass of young researchers. The total number of researches 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 (Figure 1).

By 2007, there were already about 55 researchers, 20 of which with a PhD degree and this was already an appropriate size to change the Research Unit into a Research Centre, which was done at an occasion that IST changed its own Statutes. Then the Centre for Marine Technology and Engineering was created and organised in 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 about 45%. The number of foreign researchers has also had a similar evolution (Figure 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 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.

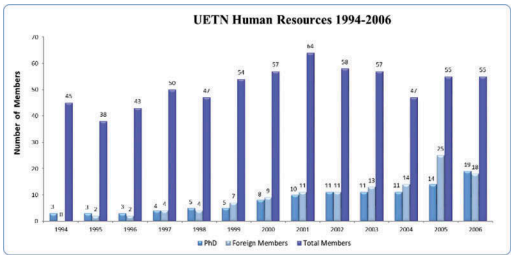

Figure 1. Evolution of human resources of UETN.

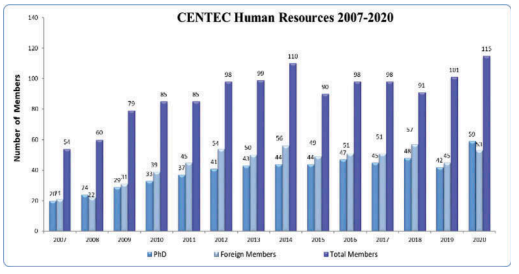

Figure 2. Evolution of human resources of CENTEC.

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 as 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

5 DISSEMINATION OF RESEARCH

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

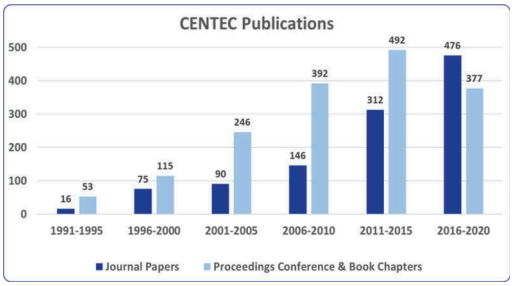

Figure 3. Evolution of CENTEC Publications.

An important difference can be observed between the first ten years and the recent years. Despite showing 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, but the number of PhD researchers showed a significant increase around 2000, continuing to increase after that.

From 2000 to 2010, there was a significant increase in journal papers, with the ratio to conference papers being almost constant at 0.37, but in the following five years this changed to 0.63, and in the last five years the journal papers were even more than the conference papers, i.e. the change was to 1.26. This resulted from a deliberate policy to reduce the participation in Conferences in relation to the submission of papers in Journals.

The public acceptance and recognition of the results can be related to the number of citations that the papers have collected, which are now about 20,000 in the Web of Science and 29,000 in SCOPUS. The evolution of the number of citations in the Web of Science is shown in Figure 4. It can be observed that during the initial six years, the number of citations was moderate (average of 445/year), but a marked increase to high values can be observed, in particular in the last six years (average of 2350/year).

Some of the papers have even gained high public acceptance, becoming highly cited papers in the Web

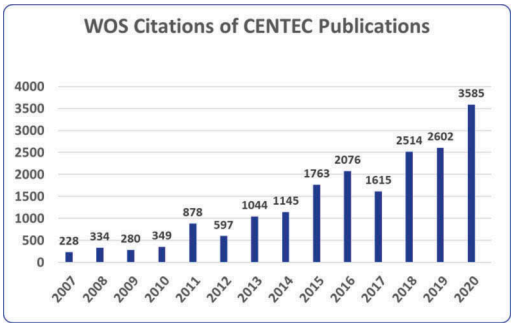

Figure 4. Evolution of WoS Citations of CENTEC Publications.

of Science. In the current year, the following papers are on this list: Mantari et al. (2012a), Rusu & Guedes Soares (2012a), Chojaczyk et al. (2015), Gaspar et al. (2017), Wu et al. (2017, 2019). In earlier years other papers have also been highly cited: Rusu & Guedes Soares (2012b), Silva et al. (2013), Gonçalves et al (2014), Mantari & Guedes Soares (2014), Mantari et al (2012b) and Wu et al. (2018).

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 10th Anniversary best paper of the journal Energies (Silva et al. 2013).

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 results presented in the Web of Science, which is as follows:

Engineering Marine – 24%
Engineering Ocean – 17%
Engineering Civil – 15%
Oceanography – 10%
Engineering Mechanical – 8%
Transportation Sci & Techn – 3%
Mechanics – 3%
Energy & Fuels – 2%
Green Sustainable Sci. Tecn – 2%
Engineering Industrial – 1%
Operations Research – 1%
Eng Multidisciplinary – 1%
Materials Sci Composites – 1%
Others - 12%

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 papers in collaboration with the various foreign institutions are as follows:

Wuhan University of Technology - 60
University of Zagreb – 47
Univ. Federal do Rio de Janeiro – 29
Jiangsu Univ Sci. Tech. - 27
Norwegian Univ Sci & Technology – 18
Harbin Engineering University – 17
Ocean University of China - 15
Univ las Palmas de Gran Canaria – 14
Shanghai Jiao Tong Univ – 13
Univ of Rijeka – 12
Univ Med. di Reggio Calabria – 11
SINTEF – 11
American Bureau Shipping – 10
Amirkabir Univ of Technology – 10
Gdansk Univ Technology – 10
Bulgarian Academy Sciences – 8

Delft Univ Technology – 7
Lloyds Register EMEA – 7
Universidade da Coruna – 7
University of Turin – 7
Nat Tech Univ Athens – 6
Tech Univ Berlin – 6
DNVGL – 5
Aalto Univ. – 5
Kuwait Univ – 5
Pol. Univ Milan – 5
Tech. Univ Varna – 5
University of Utah - 5
Hamburg Univ Tech – 5
Indian Inst Techn – 5
using 5 as the cut-off.

On the 15th anniversary of CENTEC, a commemoration book has been published mostly with state of the art 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.

The promotion of the dissemination of results through conferences has been considered an important activity, and there has been a 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 had been held (Guedes Soares, 2019a) in Trondheim.

The European Safety and Reliability (ESREL) Conferences are promoted by ESRA, the European Safety and Reliability Association to whose creation the author made a significant contribution. The ESREL Conference has been organised in Lisbon in 1997 (Guedes Soares, 1997). and in Estoril in 2006 (Guedes Soares, & Zio 2006). There has also been cooperation 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 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), also following the conference that was organised in Lisbon again (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, and initially, yearly Conferences were organised, but after some years, it stabilised in 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).

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) has been initiated at IST in 2014 and has continued biannually (Guedes Soares, 2015, 2016, 2019, 2021).

6 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 some of the evaluations conducted on a national and international scale.

The Portuguese Foundation for Science and Technology (FCT) is responsible for funding the research centres directly and indirectly through competitive calls of 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 evaluation conducted in 2014, quantitative measures have been used to characterise the performance of the centres in which 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 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 well-run 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 1st among the 14 Centres of Portugal in Mechanical Engineering & Engineering Science and 3rd among the 63 Centres of Portugal in Engineering Sciences.

CENTEC was classified 2nd among the 6 Centres of Portugal in Marine Sciences & Technologies and 2nd among the 45 Centres of Portugal in Natural & Environmental Sciences.

In 2018, a new national evaluation exercise was conducted, CENTEC was again evaluated as Excellent although in a more qualitative way.

On an international level, the evaluations are mostly quantitative and objective. The first contact with results of international rankings was at a Workshop at NTNU commemorating the 70th birthday of Profs Faltinsen and Moan, where the Rector of the University 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 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 2nd place after the Norwegian University of Science and Technology.

The next evaluation was the Shanghai Ranking of World Universities, which normally presented 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 was 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 has appeared in 3rd 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 2nd place in Europe consistently, although moving to 5th place internationally, while Chinese Universities, with their much larger manpower dimension, were moving up the ranking.

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 (1st Guedes Soares; 333rd 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 (1st Guedes Soares; 438th Garbatov) among the 900 scientists listed, which were selected from a universe of 42,000 authors in that field.

7 CONCLUSIONS

An overview has been presented on the evolution of teaching and research in Naval Architecture and Ocean Engineering at IST, which is still the only University in Portugal dealing with this subject area. This has evolved from an initial phase in which the main concern was shipbuilding to progressively dealing with ship design, maritime transportation and ports, and ocean engineering. The simultaneous evolution of research was described as well as the development of CENTEC, the research centre through which the academic staff conducts its research and where the research students conduct their research towards their PhD degrees.

In general, one can say that teaching and research has gained international recognition and is in a leading position internationally.

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The author acknowledges the dedication and hard work of the academic, research and administrative staff who have contributed to the development of Naval Architecture and Ocean Engineering at IST during the years. The students' involvement and dedication in the study and research, as well as in their professional work after graduation, have contributed to the continuous development of teaching and research and to the international recognition of the education provided.

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Education in Naval Architecture and Ocean Engineering

1980-2020

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MARTECH 2020

IST, 16 November 2020

Instituto Superior Técnico

- ✓ Is the Engineering School of the University of Lisbon
- ✓ Instituto Superior Técnico was founded in 1911
- ✓ In 1933 it became part of the newly created Tech University of Lisbon
- ✓ It has an academic staff of approximately 650, about 10 500 undergraduate students, and 1 600 PhD. Students
- ✓ The Main Campus (Alameda) has about 10 000 students while in Tagus Park there are about 1 500 students
- ✓ It is organised in 11 Departments for teaching and 23 Research Centers for research
- ✓ The members of the research Centre for Marine Technology and Ocean Engineering (CENTEC) are involved in the coordination and teaching on Naval Architecture and Ocean Engineering (NAOE).

From 1933 to 2013

Instituto Superior Tecnico is an Engineering School created in **1911**

In **1933** the Tech Univ of Lisbon was created with other Institutes

University of Lisbon

- ✓ The **University of Lisbon** (ULisboa) was founded in 1911
- ✓ In 2013 the Technical University of Lisbon merged with the University of Lisbon taking the designation of **University of Lisbon**
- ✓ At time of the merger both universities had over 22,000 students
- ✓ Largest university in Portugal and a leading one in Europe and worldwide.
- ✓ **Ranks**: Nº 1 in Portugal; Nº 100 -150 Worldwide
- ✓ Presently the **University of Lisbon** has:
  - 50,000 students (6,000 Phd stud.)
  - 18 Schools (Faculties and Institutes)
  - offers 400 degree programmes
  - supported by 4,000 academic staff
  - 100 research centers
  - accepts more than 5,000 international students (10%)

Naval Architecture and Ocean Engineering

Educational Activities

Historical data about the evolution of the education in NAOE

1st post graduate course in Shipbuilding Engineering (1976 – 1981)

Engineer degree (5 years) in Shipbuilding Engineering (1980 - 1988)

Engineer degree (5 years) in Naval Architecture and Marine Engineering (Eng. Naval) (1988 - 1998)

Engineer degree (5 years) in Naval Architecture and Marine Engineering (Eng. & Arq. Naval) (1998 - 2007)

- profiles of specialization:
  - Ship Design and Shipbuilding
  - Maritime Transportation and Ports

BSc and Master Degree in Naval Architecture and Marine Engineering (2007-2017) with the profiles of specialization in:

- Ship Design and Shipbuilding
- Maritime Transportation and Ports

Master in Naval Architecture and Ocean Engineering

In 2017 a new specialization profile on Ocean Systems was created and the designation of the degree course was changed to Naval Architecture and Ocean Engineering, with three main specializations:

- Ship Design and Shipbuilding
- Maritime Transportation and Ports
- Ocean Systems

In 2019, following a Governmental directive enforcing more strictly the principles of the Bologna agreement a new change of the curricula was made by reinforcing the specific education Naval Architecture and Ocean Engineering in the first three years of study.

The new plan of studies will start in 2021-2022.

Naval Architecture and Ocean Engineering Courses

The subjects of Bachelor programme are given in Portuguese but it is planned that from 2021-2022, at least 3rd year is in English

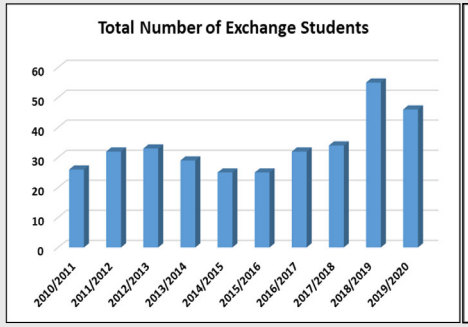
The subjects of Master programme are given in English

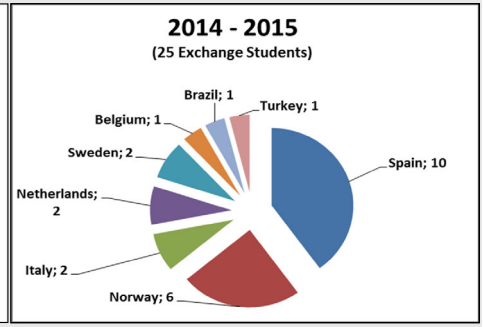
At first year of Bachelor 30-35 students are admitted.

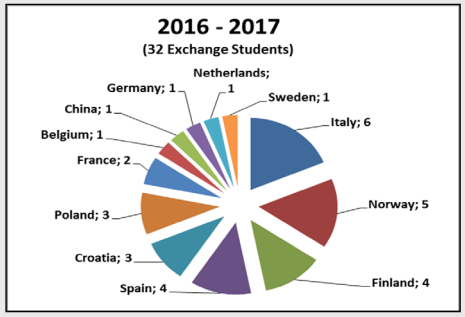
At first year of Master 20 new students are admitted in addition to the continuing Bachelor students

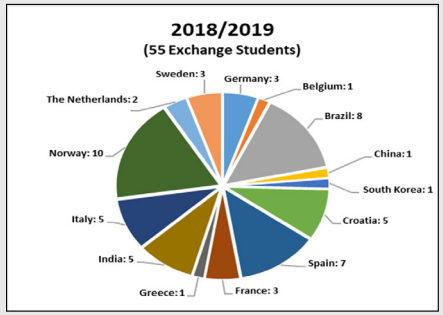
The Master course is attended each year by about 30-50 foreign exchange students

Master Exchange Students









Post graduate Education

in Assessment of Risk, Safety and Reliability

CENTEC has promoted the creation of a 3rd cycle one-year graduate study at IST, involving 5 Departments from IST.

It had the coordination of the course and is involved in teaching several courses

This course has functioned from 2007 to 2011

Doctor Degree on

Naval Architecture and Ocean Engineering

Includes one year of course work leading to an Advanced Studies Diploma followed by a dissertation performed in principle in 3 years.

The courses in this programme are given in English

The research work leading to the dissertation is conducted in CENTEC

Cooperation with several Universities for joint supervision of Phd students and for double degrees

Centre for Marine Technology and Ocean Engineering
CENTEC

Carlos Guedes Soares
c.guedes.soares@centec.tecnico.ulisboa.pt

Instituto Superior Técnico, Universidade de Lisboa
(Faculty of Engineering, University of Lisbon)

MARTECH 2020
IST, 16 November 2020

Centre for Marine Technology and Ocean Engineering

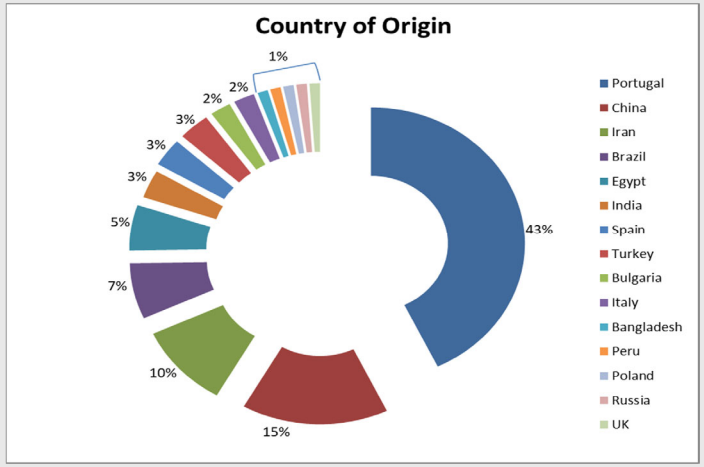
Research Team: 100 Researchers (50 Foreign)

- 45 PhD's (20 Academics)
- 55 PhD students

International Collaborators: 20 Professors

CENTEC – Research Team

CENTEC Research Team (as reported to FCT in December 2018)



Level of Studies	
51 PhD	40 MSc
56%	44%

Male	Female
78%	22%

Historical Notes of CENTEC

The **Unit of Marine Technology and Engineering** was created in **1994/95** with 3 Phd researchers and 3 main research lines:

- **Design and Reliability of Ocean Vehicles and Structures**
  - 5 research groups (Marine Environment; Ship Dynamics; Marine Structures; Ship Design and Maritime Transportation; Safety, Reliability and Maintenance)
- **Optimal Design and Control of Structures and Mechanical Systems**
- **Queueing Systems and Quality Management**

In **2007**, following new Statutes of IST the name of the Unit was changed to Centre was reorganised in 4 Research Groups:

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

Historical Notes of CENTEC

In **2015**, following the FCT evaluation procedure and the preparation of a Strategic plan for 2015-2020 the name of the Unit is changed to

Centre for Marine Technology and Ocean Engineering

with 4 Research Groups:

- **Marine Environment,**
- **Marine Dynamics and Hydrodynamics**
- **Marine Structures**
- **Safety and Logistics of Maritime Transportation** (new designation)

Becoming a multidisciplinary centre in the areas (of the Portuguese Foundation of Science and Technology – FCT) of

Mechanical Engineering and Engineering Systems

(one of two Centres of IST in this area)

Marine Sciences and Technologies

(the only Centre of IST in this area)

Aims of CENTEC

CENTEC concentrates its activities on developing scientific research, development and demonstration, and their application to **sustainable exploration and exploitation of the sea resources.**

These activities are made possible by the **design, construction, maintenance and planning of operation** of ships and other floating structures and submersibles, which constitute the main objectives of CENTEC's activities.

CENTEC puts significant emphasis on research activity in the areas of **risk analysis, safety and reliability**, including occupational safety, and promotes their application to the industrial and service sectors.

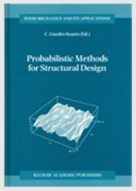
Industrial Application Areas of CENTEC

- Ship Design and Operation
- Marine Environment and Climate
- Maritime Transportation and Ports
- Ship Building and Repair
- Offshore Platforms for Oil and Gas
- Renewable Energies Offshore
- Fishing and Aquaculture
- Yachts and Recreational Vessels

- Risk Assessment in Various Industries

CENTEC Book Series

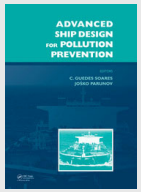
MARINE TECHNOLOGY SERIES



1997

1998

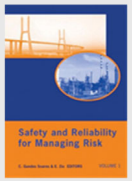

1999



2010

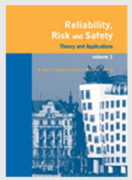
SAFETY AND RELIABILITY SERIES

1997



2006

2008



2010

2012

2010

CENTEC Book Series

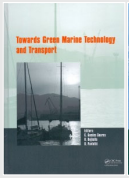
MARITIME TRANSPORTATION AND SEA RESOURCES SERIES


2005

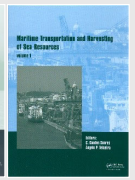

2008


2012


2014



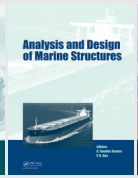
2015


2017

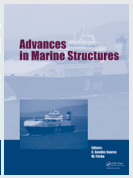

2019

MARINE STRUCTURES SERIES

2007

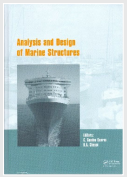


2009



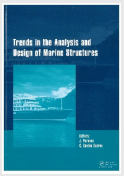
2011

2013



2015

2017

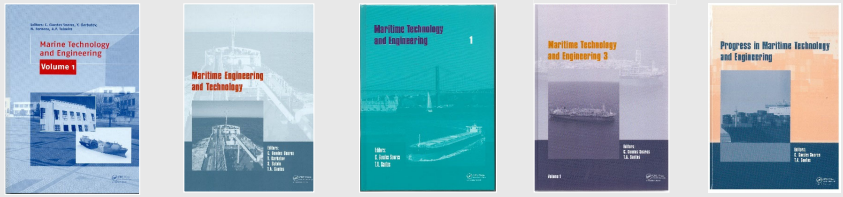


2019

CENTEC Book Series

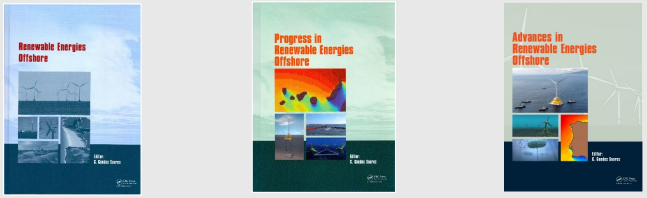
MARINE TECHNOLOGY SERIES

2011 | 2012 | 2015 | 2016 | 2018



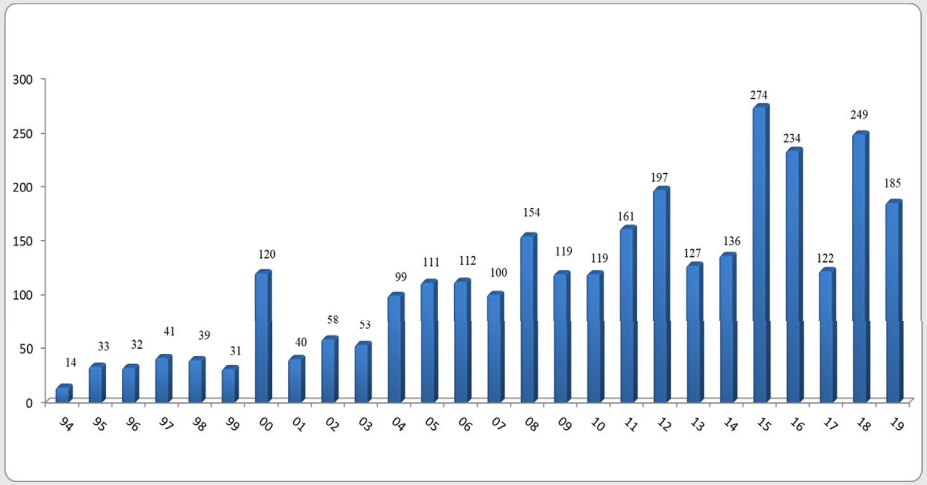
RENEWABLE ENERGIES SERIES

2015 | 2016 | 2018



CENTEC - Scientific Publications

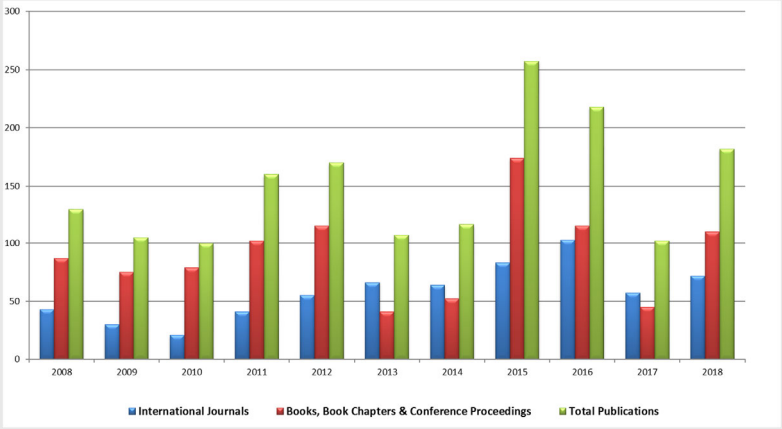
Publications (including papers, books and PhD dissertations)



1994-2003 : 42 pubs/yr 2009-2013 : 148 pubs/yr 2015-2019 : 213 pubs/yr

2004-2014 : 134 pubs/yr 2009-2013 : 50 j paps/yr 2015-2019 : 85 j paps/yr

Scientific Papers - 2008-2018



Comparing 2013-2018 averages with the period 2008-2012

100% increase in number of Journal papers

32% increase in number of Book chapters

40% reduction of number in Conference Proceedings

67% increase of WoS Publications

200% increase of WoS Citations

Papers in Web of Science - 1983-2017

1983 - 2017 (35 years)

	Scientific Area	Total N.º of Publications			CENTEC's % in IST
		UL	IST	CENTEC	
1	Marine Engineering	659	650	522	80.3%
2	Ocean Engineering	592	587	451	76.8%
3	Oceanography	914	377	227	60.2%
4	Civil Engineering	1984	1793	387	21.6%
5	Mechanical Engineering	1581	1444	231	16.0%

2013 - 2017 (5 years)

	Scientific Area	Total N.º of Publications			CENTEC's % in IST
		UL	IST	CENTEC	
1	Marine Engineering	309	303	267	88.1%
2	Ocean Engineering	271	269	228	84.8%
3	Oceanography	369	164	109	66.5%
4	Civil Engineering	898	816	159	19.5%
5	Mechanical Engineering	575	513	107	20.9%

The 5 areas consist in about 85% of the production of CENTEC

Centre for Marine Technology and Ocean Engineering

CENTEC

Funded and Evaluated by the Portuguese Foundation for Science and Technology as EXCELLENT

Among Portuguese Research Centres Ranked in 2014:

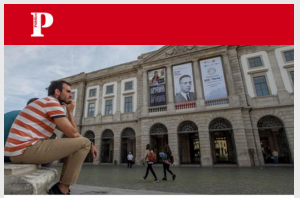
3rd in Engineering Sciences
1st in Mechanical Engineering & Engineering Science
2nd in Marine Sciences & Technologies

In 2018 was also evaluated as EXCELLENT

Naval Architecture and Ocean Engineering

2017: Naval Architecture and Ocean Engineering of Instituto Superior Técnico (Universidade de Lisboa) has been classified in **3rd place by the Shanghai ranking** of the world's top universities in this scientific area

The best national classification ever obtained in all scientific areas and of all Portuguese universities



Três instituições de ensino portuguesas entre as 50 melhores do mundo nas suas áreas científicas

Universidades de Lisboa e Porto e o Politécnico de Bragança no topo do ranking de Xangai por disciplinas. Engenharia Naval do Instituto Superior Técnico é a terceira melhor do mundo.

SAMUEL SILVA, 28 de junho de 2017 PUBLICO.PT

Field: Engineering | Subject: Marine/Ocean Engineering | Methodology

World Rank	Institution*	Country	Total Score	Score on PUB
1	Shanghai Jiao Tong University		273.9	100
2	Norwegian University of Science and Technology - NTNU		268.6	98.9
3	University of Lisbon		259.9	82.3
4	Dalian University of Technology		245.3	92.7
5	Delft University of Technology		233.1	66.4
6	University of Cantabria		222.8	46.5
7	National University of Singapore		216.2	58.6
8	Plymouth University		211.9	61.1
9	The University of Western Australia		208.7	59.7
10	Harbin Engineering University		208	67
11	Zhejiang University		203.7	76.2
12	Seoul National University		202.8	75.4
13	Colorado State University		202.7	45.1
14	University of California, San Diego		202.4	52.9
14	University of Strathclyde		202.4	58.6
16	University of Southampton		201.9	55.6
17	Technical University of Denmark		201.8	57.4
18	The University of New South Wales		200	59.1
19	University of Oklahoma - Norman		196.7	50
20	University of Michigan - Ann Arbor		195.1	57.8
21				74.5
22	University College London		193.5	49.6

ACADEMIC RANKING OF WORLD UNIVERSITIES SINCE 2003

Centre for Marine Technology and Ocean Engineering

CENTEC

Research Groups:

- Marine Environment
- Dynamics and Hydrodynamics
- Marine Structures
- Safety and Logistics of Maritime Transportation

(combining the group of Maritime Transportation and Ship Design with the group of Safety, Reliability and Maintenance)

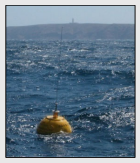
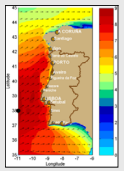
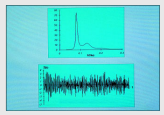
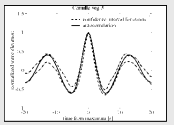
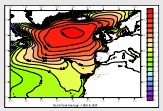
Group of Marine Environment

RESEARCH TOPICS

- Wave Spectral Models
- Time Series analysis
- Probabilistic Models
- Wave Modelling and Hindcasting
- Circulation & Oil Spill Modelling
- Oceanographic Instrumentation

RELEVANT PROJECTS

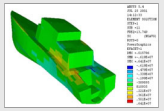
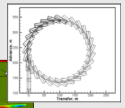
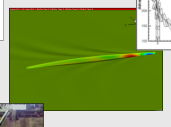
WAVEMOD
Probabilistic Methods of Coastal Site Investigation for Stochastic Modelling of Waves and Currents
REBASDO
Reliability Based Structural Design of FPSO Systems
MAXWAVE
Rogue Waves - Forecast and Impact on Marine Structures
SafeFLOW
Safe Floating Offshore Structures under Impact Loading of Shipped Green Water and Waves
HIPOCAS
Hindcast of Dynamic Processess of the Ocean and Coastal Areas of Europe
RADMONITOR
Radar Monitoring of the Sea States at the Port of Sines

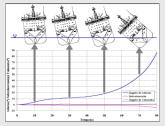






Group of Dynamics and Hydrodynamics

RESEARCH TOPICS

- Dynamics of Moored Floaters
- Nonlinear Motions of Ships
- Ship Manoeuvring and Control
- Computational Fluid Dynamics
- Full-Scale Trials
- 3D Virtual Environments in Ship Dynamics

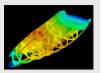






RELEVANT PROJECTS

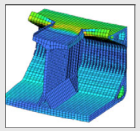
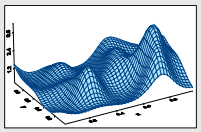
OCTOPLUS
Optimum Concept to Produce and Load with Underwater Storage
WAVELOADS
Advanced Methods to Predict Wave-Induced Loads for High-Speed Ships
NEREUS
Design for Damage Resistance against Capsize
SPAN
Safe Passage and Navigation
SAFE OFFLOAD
Safe Offloading from Floating LNG Platforms
MASSTER
Standardized Simulator Training Exercises Register
COMFORTABLE
Advanced Benefits for Logical VTS Equipment
VRSHIPS
Life-Cycle Virtual Reality Ship Systems
HANDLING WAVES
Decision Support System for Ship Operation in Rough Weather

Group of Marine Structures



RESEARCH TOPICS

- Ultimate Strength
- Fatigue Strength
- Impact Strength
- Structures in Composite Materials
- Geometric Modeling of Ship Structures
- Experimental Analysis

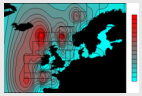
RELEVANT PROJECTS

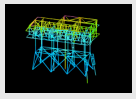
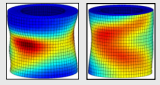
MARSTRUCT
Network of Excellence in Marine Structures
SHIPREL
Reliability Methods for Ship Structural Design
FatHTS
Fatigue Based Design Rules for the Application of High Tensile Steels in Ships
FASDHTS
High Tensile Steel 690 in Fast Ship Structures
CRASHCOASTER
Crashworthy Side Structures for Improved Collision Damage Survivability of Coasters and Medium Size RoRo Cargo Ships
COMAST
Composite Materials in Marine Structures and Components
COMPOSITES
Optimum Structural Design of Ships Made from Advanced Fiber Reinforced Plastic Materials
SHIPMATES
Ship Repair to Maintain Transport Environmentally Sustainable
RISPECT
Risk-based Expert System for Through-Life Ship Structural Inspection & Maintenance
SENSE&REACT
Context-aware and User-Centric Information Distribution Systems for Manufacturing
MOSAIC
Materials Onboard – Steel Advancements and Integrated Composites

Group Safety and Logistics of Maritime Transportation

RESEARCH TOPICS

- Maritime Safety and Human Factors
- Structural Safety
- Systems Reliability and Availability
- Logistics of Maritime Transportation & Port Operations
- Economic and Technological Analysis of Maritime Clusters



RELEVANT PROJECTS

STOCHASTIC
Stochastic Mechanics in Structural and Mechanical Engineering
SAFECO
Safety of Shipping in Coastal Waters
SAFEDOR
Design, Operation and Regulation for Safety
OFSOS
Optimized Fire Safety of Offshore Structures
CASMET
Casualty Analysis Methodology for Maritime Operations
MARNIS
Maritime Navigation and Information Services
SAFECRAFTS
Safe Abandoning of Ships
EFFORTS
Effective Operations in Ports
ROROPROB
Probabilistic Rules-Based Optimal Design of Ro-Ro Passenger Ships
SAFERELNET
Safety and Reliability of Industrial Products, Systems and Structures
EFFORTS
Effective Operations in Ports
ADAPTREL
Adaptive Methods for Reliability Analysis of Complex Structures
CYCLADES
CREw-centered Design and Operations of Ships and Ship Systems

Strategic plan

–Consolidate the existing areas of knowledge, reinforcing the competence of the 4 research groups

–Increase internationalization through cooperative research projects and joint PhD education

–Expand the research to new areas creating new research lines

Strategic plan

International Cooperation (Number of WoS Joint papers)

Wuhan University of Technology (55) Joint PhD supervision; Joint Int. Lab

University of Zagreb (41) Joint PhDs

Universidade Federal do Rio de Janeiro (25) Joint PhDs

Jiangsu University of Science and Technology (23)

Norwegian University of Science and Technology (18) Cooperation in PhD Sup.

Ocean University of China (15) Joint PhD supervision

Harbin Engineering University (14) Joint International Laboratory

University of Las Palmas de Gran Canária (14) Joint PhD supervision

Shanghai Jiao Tong University (12) Joint PhD supervision

Universita Mediterranea de Reggio Calabria (11) Joint PhDs

University of Rijeka (11) Joint PhD supervision

Amirkabir University of Technology (8) Joint PhD supervision

Strategic plan

International Cooperation (Number of WoS Joint papers)

SINTEF Ocean (8)

American Bureau of Shipping (7)

Lloyds Register (7)

Universidade de Coruna (7)

Delft University of Technology (7)

University of Torino (7)

Bulgarian Academy of Sciences (7)

National Technical University of Athens (6)

Technical University of Berlin (6)

DNVGL (5)

University of Strathclyde (4)

Indian Institute of Technology (4)

Strategic plan

Priorities for research (New Areas)

Renewable Energy Offshore

Energy Efficiency of Maritime Transportation

Subsea Engineering

Blue Economy

Education in Naval Architecture and Ocean Engineering

1980-2020

CENTEC 1994-2019

Carlos Guedes Soares

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Instituto Superior Técnico, Universidade de Lisboa
(Faculty of Engineering of the University of Lisbon)

MARTECH2020

IST, 16 November 2020

Master graduates in various countries

Too many to mention individually…

From PhD Candidate to Professor at IST




First generation of PhDs teaching at IST




Second generation of PhDs teaching at IST



PhDs Teaching in China



PhDs Teaching in Egypt





PhDs Teaching in Romania, Norway, India, Peru




Joint PhDs with Zagred, Rijeka, UFRJ, Reggio Cal.




PhDs working in Industry abroad and in Portugal




PhDs that keep the Gender Balance…



PhDs in wave modelling and statistics




PhDs in Maritime Transportation




PhDs in Autonomous Vehicles





PhDs in Composite Materials

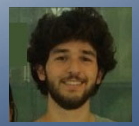



PhDs in Renewable Energies










PhDs that are no longer with us…


But we keep their legacy…

On the background….

…and all of this was accomplished with the support of a skilful administrative and technical support team…

In Conclusion…

Time passes…

New generations are formed…

..and continue contributing to industry
and
promoting education and research…