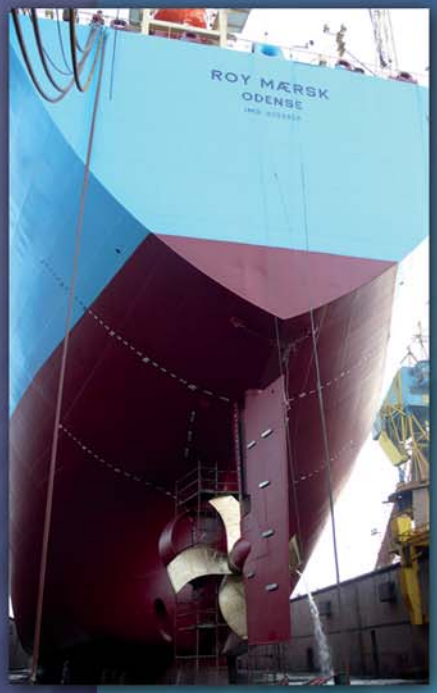
# Major Shipowners and R&D projects open new horizons for CLT propellers®







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# Hull form optimisation, Preliminary Propeller Design, Power Prediction… The work carried out by CEHIPAR makes a decisive contribution to the energy efficiency of ships

**CEHIPAR** Study, experimentation and research of the hydrodynamic aspects of the building of naval, merchant, fishing and recreational vessels.

# Sistemar communicates the successful conclusion of the Roy Maersk CLT Propeller® Project

*In 2006, A.P. Moller-Maersk (APMM) performed an internal study of different devices and solutions capable of reducing the fuel consumption and the emissions of the fleet of the Group. Initially, 31 energy saving alternatives were considered. Subsequently APMM narrowed the investigation to a short list of the most promising alternatives. CLT propellers were included on the short list and APMM and Sistemar started working together on a joint project.*

*A series of calculations and model tests were carried out on different vessels, ranging from 2,500 TEU to 8,500 TEU container vessels and from 35,000 DWT to 320,000 DWT tankers.* **M/V Roy Maersk**, *a 35,000 DWT tanker, delivered in 2005, was selected to be used as test case for a CLT propeller project.*

*Sistemar, part of the Cintranaval Group, designed the CLT propeller.*

*The model test results obtained both at CEHIPAR (Madrid, Spain) and HSVA (Hamburg, Germany) were encouraging so APMM decided to proceed to full scale testing.*

*The CLT propeller was manufactured by Wärtsilä (Drunen, The Netherlands) and installed at Lisnave shipyard (Setubal, Portugal) during an ordinary dry-dock at the beginning of November 2009.*

*After the installation, the vessel was monitored by APMM in order to compare the performance of the vessel with the original conventional propeller and with the CLT propeller and also to check the reliability of the CLT propeller open water test scaling procedure.*

*In addition, cavitation observation and pressure pulses measurements were performed at full scale by HSVA and compared with the model test results.*

*The CLT propeller was also inspected from time to time to check its condition and any possible sign of cavitation/erosion.*

*The results of the above can be summarised as follows:*

- *There is a reasonable correlation between model tests and full scale measurements with regard to the open water propeller characteristics, pressure pulses and cavitation pattern*
- *the performance gain looks promising at the design speed and draft*
- *according to the crew, the CLT propeller has resulted in a decrease of the vibrations in the stern area of the vessel*
- *no traces of cavitation erosion were found on the CLT propeller during the diving inspections.*

*From the complete project carried out with* **M/V Roy Maersk**, *it can be concluded that the CLT propeller has shown itself to be a technology that functions well and a potentially advantageous energy saving device.*

*CLT propellers, thanks to their greater efficiency, help to reduce fuel consumption, emissions and both the Energy Efficiency Design Index (EEDI) and the Energy Efficiency Operational Index (EEOI) without requiring any modification to the vessel.*

The CLT propeller installed on M/V Roy Maersk

*APMM and Sistemar are currently involved in the TRIPOD R&D project, together with ABB, VTT, CEHIPAR and Cintranaval-Defcar. The aim of the TRIPOD project is to study the installation of CLT propellers and propulsion pods on large container vessels, also in Contra Rotating Configuration.*

*APMM will consider CLT propellers for future projects.*

# NICOP CLT Project: Energy Efficient Contracted-Loaded Tip (CLT) Propellers for Naval Ships

*Sistemar has received a grant from the Office of Naval Research Global of the U.S. Navy (ONR Global) to perform a two-year R&D project on CLT propellers within the framework of the NICOP (Naval International Cooperative Opportunities in Science & Technology Program).*

*The objectives of this NICOP project are two-fold: (1) develop and demonstrate CLT-type propellers for naval ships that would improve efficiency by the comparable range demonstrated for commercial ships (i.e., 4-8%) over conventional open propellers without sacrificing cavitation performance, and (2) develop a scaling method for full-scale CLT propeller performance based on model-scale testing in the water tunnel.*

*Recent studies at NSWCCD (Naval Surface Warfare Center Carderock Division) on tip-loaded propellers (TLP) similar to CLT propeller concepts have found only marginal gains in efficiency when implementing TLP technology to current USN ship applications. Through collaborative efforts, Sistemar and NSWCCD will develop a set of design requirements for a new propeller design for a naval ship (TBD). These requirements will address tip vortex, suction side and root cavitation inception, required thrust coefficient, diameter, and pressure pulse severity.*

*There is renewed worldwide interest in energy-efficient contracted loaded tip (CLT) propellers due to steadily increasing oil costs and the uncertain future of oil supply. Reducing fuel consumption through increased propeller efficiency is an obvious means to reduce the life cycle cost of ships. Propellers are designed to satisfy a host of requirements, including efficiency, cavitation inception, thrust breakdown, radiated noise, hull vibration, structural integrity, weight, and maintainability. Improving one performance metric, such as propeller efficiency, typically must be traded off against one or more other metrics, such as cavitation and noise.*

*One propeller concept which shows promise in increasing efficiency without sacrificing cavitation performance is the contracted loaded tip (CLT) propeller. The tips of CLT propeller have winglet-like tip plates on the pressure side that would improve the blade loading distribution and reduce tip vortex strength, thus improving overall propeller efficiency by 5-8% over conventional open tip propellers.*

*The application of CLT propellers for naval ships would pose major challenges to the propeller designers due to different performance requirements. For example, naval ships may have more stringent cavitation performance requirements.*

*Once these requirements are set and agreed upon, engineers at Sistemar will develop a CLT design which meets these requirements using their standard practices. Engineers at NSWCCD will do the same, using standard USN practices for propeller design. Sistemar will be engaged in the manufacturing of both designs and test them in the variable pressure cavitation tunnel at the Canal de Experiencias Hidrodinámicas de El Pardo (CEHIPAR). Computations will be made both by NSWCCD and Sistemar/CEHIPAR for the two propeller designs using RANS methods at model and full-scale Reynolds numbers. Computational results obtained by the two organizations will be compared in detail to understand the physics of the tip flow of CLT-type propellers and the scale effects.*

*The US Navy has never built CLT-type propellers. The NICOP efforts will provide the US Navy with an energy-efficient propeller concept for their consideration for retrofit or for newbuildings.*

*Sistemar will act as project coordinator and will subcontract the work performed at CEHIPAR.*

# Carnival Corporation Advanced Propeller Project

*Carnival Corporation is carrying out an R&D study into the potential application of advanced propellers on their cruise ships. Most of the Group's vessels are currently operating at a lower ship speed than the design speed used for the optimisation at project stage.*

*The objective of the project is to select a reference vessel from the fleet and to compare at model field the performance of the existing conventional propeller operating at a lower ship speed with newly designed conventional and CLT propellers optimised for the new operating conditions.*

*Providing that the results of model tests are sufficiently encouraging, a second phase of the R&D study will be carried out. This will include the manufacturing and installation on the real ship of the set of propellers with the highest efficiency and best cavitation performance.*

*The new conventional propellers will be designed by a leading propulsion system supplier and the CLT propellers will be designed by Sistemar, the project coordinator.*

## *Cruise Vessel* Grand Princess *as Reference Ship*

*The cruise vessel* Grand Princess*, owned by Carnival Corporation and operated by Princess Cruisses, has been selected as the reference ship for the project. The vessel was built in 1998.*

*Two fixed pitch propellers each driven by a Siemens diesel electric propulsion motor of 21MW provide the main power, while propulsion power and the ship's service power comes from six Siemens generators, each of 11,520kW (15,662BHP), driven by Fincantieri GMT V-16 diesel engines. Total power output is 93,972BHP. There are two emergency generators, each of 900kW.*

*The models of the hull and appendages, the existing conventional propellers and the CLT propellers will be manufactured by CEHIPAR (Madrid, Spain). The new conventional propeller models will be supplied by the designer.*

*Propulsion model tests with all three sets of propellers will be performed by CEHIPAR while cavitation tests and pressure pulses measurements for all three sets of propellers will be performed by HSVA (Hamburg, Germany) at the HYKAT.*

*The results of the complete experimental program will provide Carnival Corporation with very valuable information in selecting the optimum propeller option to be applied on their vessels for the new operating conditions.*

# European R&D Project TRIPOD

*The 'TRIple Energy Saving by Use of CRP, CLT and PODded Propulsion' (TRIPOD) project has been approved within the 7th Framework Program of the EU (FP7-SST-2010-RTD-1). The project started on 1st November 2010 and has a scheduled duration of 30 months.*

*The main objective of the TRIPOD project is the development and validation of a new propulsion concept for improved energy efficiency of ships. Ship propulsion efficiency will be optimised through the advanced combination of three existing propulsion technologies. In particular, TRIPOD explores the feasibility of a new propulsion concept resulting from the integration of two promising EU-grown technologies (podded propulsion and tip loaded endplate propellers) in combination with energy recovery based on the Counter-Rotating Propeller (CRP) principle.*

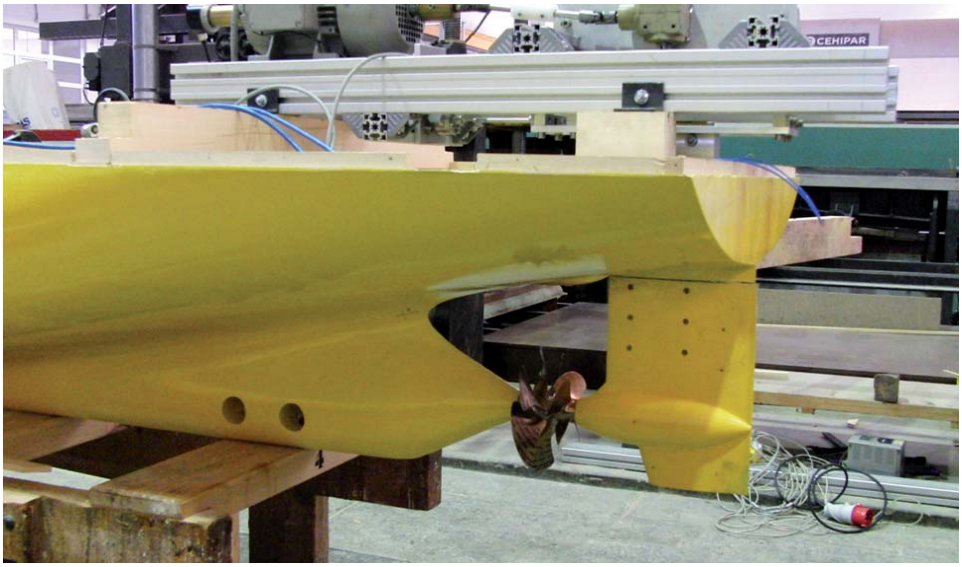
*The three existing technologies have been used separately and are known to improve overall ship propulsion efficiency as compared to conventional propulsion. However, they have never been combined together in a single propulsion package. TRIPOD contemplates two types of propulsive innovations, which will be tested for the first time:*

- *Using CLT propellers in combination with PODs*
- *using CLT propellers in combination with CRP propulsion and with PODs.*

*The work methodology consists of both model tests and CFD methods. Once both numerical analysis and model tests are finalised for different propulsion arrangements, a concept validation will be carried out with the objective of estimating the energy savings and noise reduction afforded by the CRP-CLT-POD concept with respect to conventional propulsion. A technical feasibility study will be carried out on the use of the new propulsion concept in new ship designs and for retrofitting on existing vessels. There will also be an economic analysis of the viability of the new propulsion concept for retrofitting and for new ship designs.*

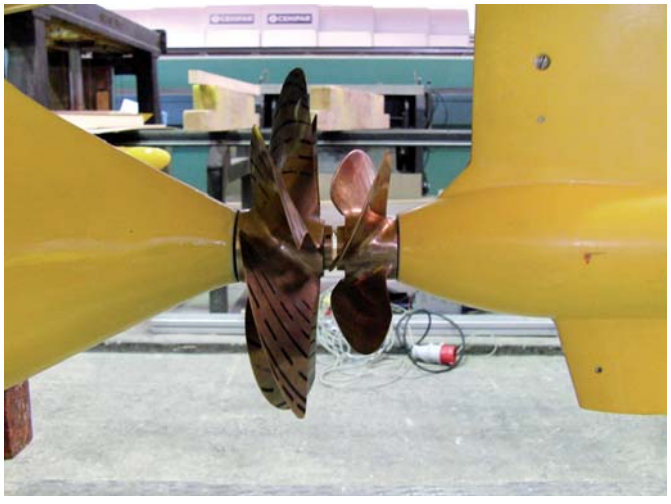
*The consortium is made up of firms and research institutes that specialise in the different technological*

*areas of research involved in the project. ABB, a world leader in the design of podded propulsors, introduced the concept of podded propulsion for the first time approximately two decades ago. This represented an important milestone in the history of marine propulsion.*




*Sistemar, the world leader in number of tip loaded propeller designs installed on actual ships, pioneered research into tip loaded propellers and was the first company to achieve practical applications of the concept in the form of CLT propellers.*
*VTT is at the forefront of hydrodynamic research in the area of pods, with respect to both model tests and CFD, and is also a leader in CFD applied to endplate propellers. CEHIPAR has the greatest experience and largest data base of model tests on CLT propellers and also boasts unrivalled expertise in noise evaluation. CND, an engineering office with expert know-how in ship design, makes a contribution of great importance to the project in terms of obtaining practical engineering/technical solutions. Maersk is a leading operator of cargo ships worldwide, whose participation in the project enables practical solutions to be found from an economic/operational standpoint.*

*The 8,500 TEU container vessel* **Gudrun Maersk** *was selected as the as reference case for the project. During the initial stages of the project, the retrofitting scenario was defined. The shipowner wished to know if a retrofit scenario in which both the hull and the original propeller were maintained as part of the CRP unit would prove to be cost-effective. Two alternatives were selected with the aft POD propeller being either of conventional or CLT type. Then the study cases were set for three different retrofit alternatives as follows: CLT propeller alone instead of the original propeller, CRP case 1 with original main propeller and conventional POD propeller, and CRP case 2 with original main propeller and CLT POD propeller.*



*The set of tests corresponding to the retrofitting scenario is currently being carried out and new challenges concerning testing and extrapolation of results to full scale are being addressed.*

*The main interim achievements can be summarised as follows:*

- *Designs have been created and tested for the pod housing and for the conventional and CLT propellers in the retrofit scenario*
- *the ship hull for the new design scenario has been defined and is ready for testing*
- *a new concept of non-rotatable podded propulsor called Rudderpod has been further developed and implemented in the project in order to decrease installation and maintenance costs in the CRP units and make the TRIPOD concept feasible*
- *a new extrapolation procedure for CRP POD propellers has been developed*
- *a new method of computing effective wakes has been developed. This method is also applicable in scenarios where propeller tangential induced velocities are relevant in the effective wake, as is the case with CRP units.*

*Large energy savings and consequently lower emissions are expected from the application of TRIPOD, resulting in a cleaner environment. Energy recovery concepts based on the counter-rotating propeller principle and advanced tip loaded propellers are the key factors to produce such effects. In addition, pod propulsion makes it easier to implement CRP philosophy, avoiding complicated mechanisms in the shaft and permitting more flexibility in the definition of hull forms with more uniform wakes at the propeller plane.*

*The new propulsion system will make it possible to design propulsion units with lower noise and vibration levels. Two main factors will contribute to the reductions: smaller optimum diameter of the CRP units as compared to the original propeller (i.e. larger gaps between propeller and hulls) and reduction of loading per unit areas as a consequence of splitting the propulsive load between two propellers. Noise/vibration attenuation improves the quality of life on board and reduces harmful impact on the environment.*

# Sistemar cooperates with CEHIPAR in the development of CLT® propellers

*Sistemar is a technological SME that has developed the CLT® propeller, based on the implementation of the tip loaded concept. This concept consists of enhancing the efficiency of propellers by enabling the outer cylindrical sections of the blades to produce thrust. The physics involved dictates that conventional propeller blades have zero thrust at the tip. Apart from this, there was no appropriate theory to support this concept. Some other attempts have been made but the CLT propeller is currently the only successful product.*

*CLT propellers are now a fully developed technology and a lot of progress has been made between 1976 and the present-day situation.*

*First of all, a new theory was established based on what is known as the New Momentum Theory, whereas most designs were based on circulation models.*

*A new design method was also developed based on this theory and some very important successes were achieved by directly applying this theory to real ships.*

*But the use of CLT propellers worldwide could not have been achieved without a specific procedure to test this type of propeller, in order to demonstrate that its reliability was similar to that of conventional propellers.*

*The testing of propellers in a towing tank at model scale is part of a well established procedure to guarantee that a new vessel meets contractual conditions.*

*Before deciding on the installation of a CLT propeller on a newbuilding, all shipyards need to be able to rely on the conclusions arising from the results obtained in model tests, as is the case with conventional propellers.*

*This was a problem that needed to be addressed in order to enable the performance and cavitation behavior of CLT propellers to be predicted.*

*Sistemar undertook the task of developing these new methods, with the invaluable help of CEHIPAR (Canal de Experiencias Hidrodinámicas de El Pardo) and a number of other partners that share Sistemar's visions.*

*CEHIPAR is an internationally recognized Research Centre in the field of Hydrodynamics applied to Ship Design.*

*The new methods were developed through an R&D program lasting almost 10 years, which included several projects designed to meet objectives step by step.*

## *Sistemar and CEHIPAR Relationship*

*A close relationship has been established between Sistemar and CEHIPAR during this development period.*

*Sistemar has acquired a great deal of new knowledge on CLT behavior and CEHIPAR is currently the leading towing tank worldwide in terms of experience in the testing of tip loaded propellers.*

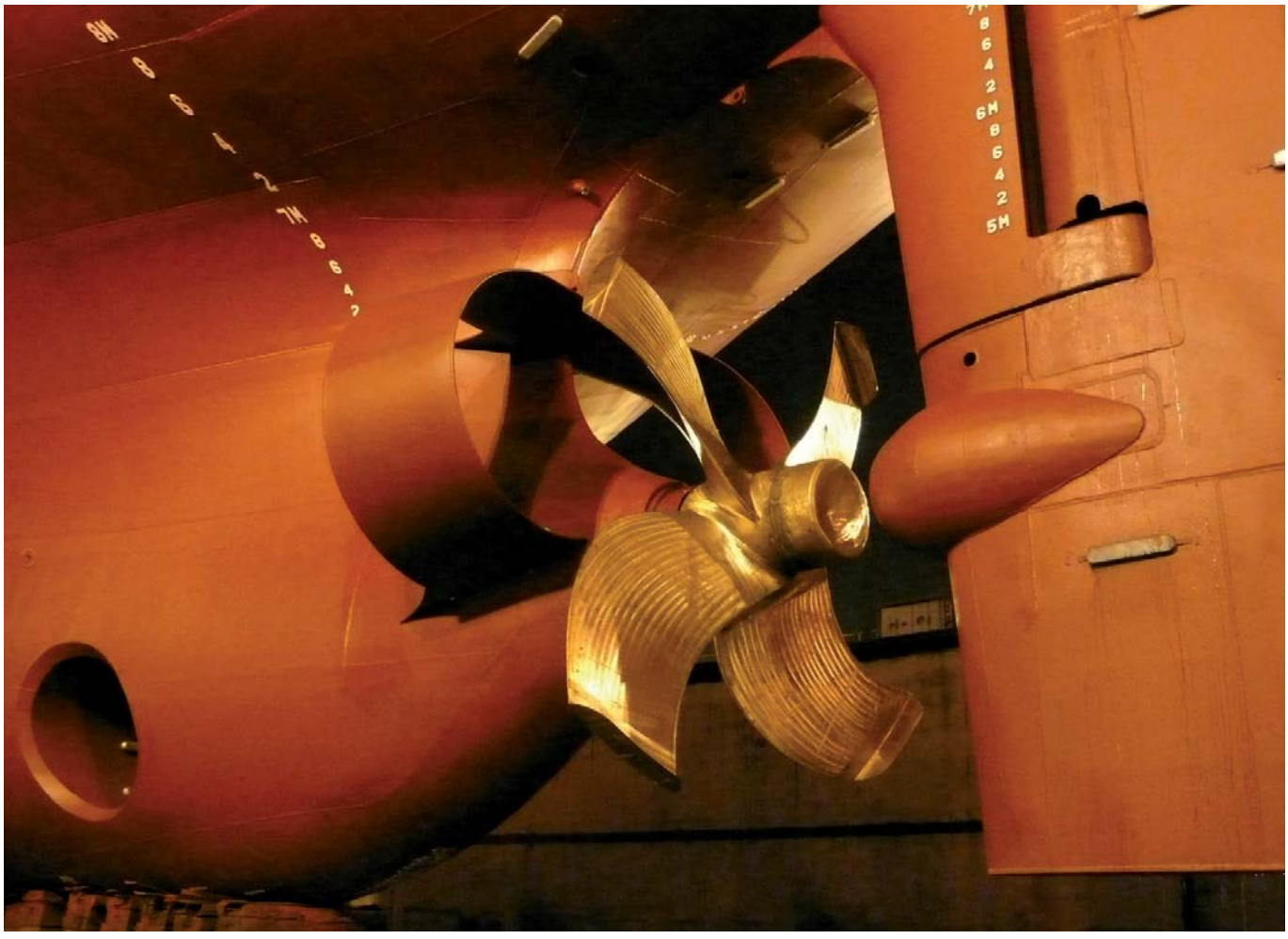
*Sistemar and CEHIPAR have worked together on projects, including:*

- *Projects funded by the Spanish National R+D+I Plan. Mainly projects for the development of the new testing method*
- *FP6 and FP7 funded Research Projects: LEADING EDGE and TIP, SILENV, TRIPOD, etc.*
- *R&D project funded by NICOP-ONR Global: 'Energy Efficient Contracted-Loaded Tip (CLT) Propellers for Naval Ships'*
- *innovative developments for commercial ships:*
  - *Retrofitting of a CLT propeller on the A.P. Moller-Maersk M/V tanker* Roy Maersk
  - *CLT propellers for a series of LPG tankers for Elcano*
  - *retrofitting of CLT propellers for enhanced fuel consumption on a Carnival Corporation cruise vessel.*
- *innovative implementation of CLT propellers on naval ships:*
  - *CLT propeller for the ship* Buque de Aprovisionamiento de Combate (BAC) Cantabria *for the Spanish Armada*
  - *CLT propeller for a series of corvette ships* Buques de Acción Marítima (BAM) *for the Spanish Armada.*

*Sistemar CLT propellers represent highly developed technology and their application to newbuildings or as retrofits to replace existing propellers affords several advantages.*

*Moreover, these benefits can be predicted through model tests with the same degree of accuracy as that achieved in the case of conventional propellers.*

*Sistemar is firmly committed to continuing the evolution of this technology in order to maintain its competitive advantages, through progress in the use of several design parameters, in the validation of these new developments by means of model tests and full scale results, and through the development of new numerical tools to analyze and predict at early design stage the behavior of CLT propellers.*



# Notes on the advantages of CLT propellers in reducing the EEDI

*The amendments to Annex VI of the MARPOL convention, based on resolutions MEPC 202 (62) and MEPC 203 (62), are scheduled to enter into force on the 1st of January 2013, pending ratification in July 2012.*

*The maximum EEDI is fixed by a simple formula included in Annex VI, taking ship type and dead weight as parameters. This maximum is expected to decrease gradually between 2013 and 2025.*

*The Interim Guidelines for the calculations of the EEDI for each vessel were published by the IMO in MEPC 1/circ 681 of 17/8/2009. This guide has been the subject of heated debate and has been questioned, particularly by the main shipowner associations. A large number of studies have been carried out by engine manufacturers, classification societies, shipowners, etc. on the possible methods and initiatives to be implemented in order to obtain an EEDI below the maximum permitted.*

*It must be taken into account that the rules require the EEDI of the ship to be measured during the sea trials and that the value obtained must be lower than the maximum set out in Annex VI. Failure to comply with this requirement constitutes an infringement of the MARPOL regulation and the ship would be unable to sail legally.*

*All the studies carried out highlight that increased propeller efficiency is a total or partial solution to achieving an EEDI value under the maximum allowed in newbuildings.*

*CLT propellers installed on real ships have registered propulsion power savings of between 4 and 10% compared to well designed conventional propellers. This reduction would be reflected in a similar decrease in the vessel's EEDI.*

*The most significant change is the adoption of the EEDI (Energy Efficiency Design Index) applicable to most new merchant ships. This index fixes the maximum level of contamination due to burned oil in accordance with the type of ship, the tons transported and the miles sailed. The index must be considered a first step because it excludes many types of ships and focuses primarily on commercial navigation and conventional diesel propulsion.*

*The CLT propeller has already been considered among the possible solutions to decrease the EEDI value in the studies previously mentioned. It must be highlighted that the replacement of a conventional propeller by a CLT propeller does not involve any change in the shaft line or any other propulsive element. CLT propeller maintenance is similar to that of any other propeller type and does not require the installation, operation and maintenance of additional equipment.*

# The need for Failure Investigation and Technical Litigation Support

*Dott. Ing. Andrea Gennaro, President of SINM

*Nowadays, even a small accident may result in very large costs and it is therefore vital for the parties involved to recover losses, limit their liability and protect their assets.*

*It is true that part of the expense is absorbed by Insurers and P&I Clubs but it should be recalled that the interests of the Insurers and those of the Insured might diverge, that deductibles are increasing and that many failures are caused by design errors, which are unlikely to be recoverable under the terms of standard insurance policies.*

*In addition, the costs of the repairs are in general only a fraction of the cost of the consequences of the damage (e.g. loss of hire, disruption, pollution...).*

*For such reasons, it is advisable to seek the help of a consultant specialising in Failure Investigation and in Technical Litigation Support as soon as a failure or accident occurs, with the goal of identifying the cause of the damage, who is actually responsible for the damage and to what extent.*

*Historically, Technical Managers and Insurance Surveyors have played the role of both failure investigators and technical experts. This is no longer advisable due to the specialised and interdisciplinary skills (e.g. mechanics, physics, metallurgy, chemistry...) needed to achieve a high degree of confidence and a high success rate.*

*The activities of the consultant in the field of Failure Investigation and Technical Litigation Support range from the initial in-the-field accident investigation to the specification and review of laboratory analyses, to the theoretical calculations and investigations. The intended goal is to advise Clients on how best to protect their interests with respect to the other parties involved (Insurers, Manufacturers, Shipyards, Maintenance Service Companies, third parties...).*

*In addition the consultant might also be required to propose a series of solutions or modifications to some components of the failed equipment in order to resolve the problem definitively and prevent the failure from occurring anew.*

*In fact, this is a very important yet neglected aspect of failure investigations. Even today, especially in the maritime sector, the scope of repairs is too often restricted to the substitution of the failed components, with little consideration of the root cause of the failure. This approach might appear the cheapest in the short term but it is usually the most expensive in the long run, due to repeated failures, unplanned downtime, damaged machinery, overtime expenditure...*

*In cases where an amicable solution is not possible, the consultant is required to shift his focus from Failure Investigation to Forensic Engineering, thereby acting also as technical advisor to the Lawyers of the Clients in reviewing the technical arguments of the opposition and as the expert witness in court.*

*To hire a reputable failure investigator at the onset of a failure might sound mundane to the untrained ear but, on the contrary, it is probably one of the soundest courses of action: the failure investigator can advise Clients on their actual liability, thereby allowing them to implement a strategy for the control of expenses and for the recovery of their losses.*

(*) Dott. Ing. Andrea Gennaro, President of SINM, has many years of experience and is highly regarded in the field of Failure Investigation and Forensic Engineering. He has successfully worked for major shipowners, shipyards and machinery manufacturers and in many complex engineering cases involving propulsion pods, diesel engines, lubricating oil filtering systems, gearboxes, shafting, propellers, turbo chargers, etc. He is member of AIPAM, the Italian Association of Experts in Maritime Casualties. He is the coordinator of the Panel of Machinery Experts of Registro Italiano Navale, RINA. SINM is an Italian engineering consultancy firm and the company is a partner and shareholder of Sistemar.

# Cintranaval Group: Designer of all type of vessels based on a continous CAD/CAM software development

*Since its foundation, the design office Cintranaval-Defcar, S.L. has become one of the top technological companies in the Spanish shipbuilding industry. A high degree of specialisation as a designer of all type of vessels allied to a program of continuous CAD/CAM software development is the key factor in the company's success.*


*From its origins as Cintra, S.A. (founded in 1964), Cintranaval, S.L. claims a special position because of its prolific activity, having designed more than 580 vessels to date. This vast experience ranges from preliminary design to production engineering, spanning all the stages of the project and subsequent construction.*

*In March 2003, Cintranaval, S.L. merged with the Madrid-based technical consultancy firm Defcar Ingenieros, S.L., a company of CAD/CAM software programmers and originator of the Defcar System, which is used in 24 countries. This move combined design and programming experience, with the aim of offering new and innovative products and services in the marine sector. The result was Cintranaval-Defcar, S.L.*

*With the goal of responding to increasingly demanding market requirements, and being conscious that swift response and capacity to offer complete packages are essential requirements for success, the Cintranaval Group was founded in June 2005.*

*The Cintranaval Group is currently made up of four different companies linked by very close cooperation agreements. Their services focus on:*

1. *Ship design and marine CAD/CAM software: Cintranaval-Defcar, S.L.*
2. *Hydrodynamics and ship propulsion: Sistemar, S.A.*
3. *Shipping consultancy: Bilbao Plaza Marítima Shipping, S.L.*
4. *International project coordination: Siateg, S.L.*

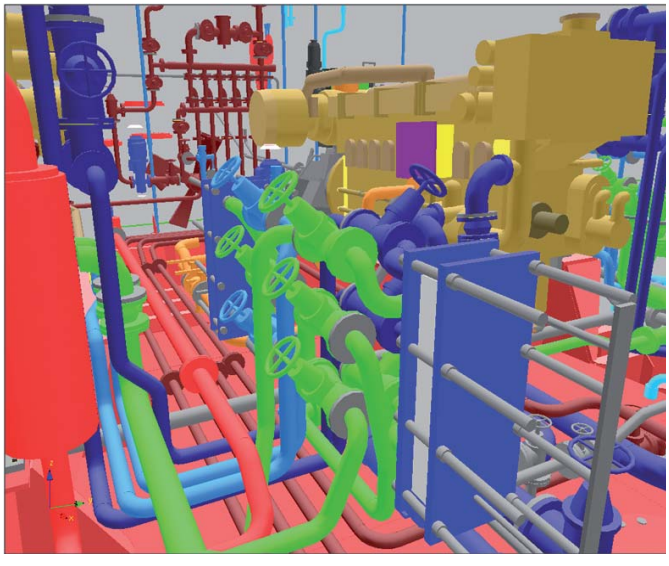
*All of these companies seek synergies to give a more complete and efficient service to the client, working under the same common culture:*

- *Customised service*
- *high flexibility and swift response*
- *close cooperation with the best specialists*
- *complete independence from governmental and financial institutions, shipyards and shipowners.*

## Hydrodynamics and Ship Propulsion

*In accordance with this policy, Cintranaval-Defcar, S.L. became the reference shareholder of Sistemar, S.A., a company highly specialised in hydrodynamics and ship propulsion.*

*Staffed by naval architects noted for their important research into hydrodynamics, Sistemar is the exclusive designer worldwide of the high-efficiency CLT*




*Bilbao Plaza Marítima Shipping has broad experience in the provision of marine consultancy services. The company has carried out many studies and provided technical advisory services all over the world. Through its work for European organisations and Port Authorities, the company has made a significant contribution to Short Sea Shipping (SSS). In addition, it has carried out several feasibility studies for shipyards and fishing ports from South America to South East Asia.*

*(Contracted and Loaded Tip) Propeller. After many years of research and development, using unconventional blade geometry, Sistemar has developed this special design, which can offer not only lower fuel consumption, but also a substantial reduction in noise and vibration levels compared with conventional propellers. To date, more than 280 CLT propellers have been installed.*

*In addition to promoting high-efficiency CLT propellers and its involvement in international research, development and innovation (R&D&i) programmes, Sistemar works as a consultant in hydrodynamics. This is a key stage of vessel design and Sistemar's expertise in this area enables the creation of more efficient hull forms to minimise resistance.*

## Shipping Consultancy

*In June 2005, Bilbao Plaza Marítima, S.L., a consultancy company specialising in maritime and port services, entered into a cooperation agreement with Cintranaval-Defcar, S.L. This resulted in the creation of two separate companies, Bilbao Plaza Marítima Shipping and Bilbao Plaza Marítima Puertos, with the former becoming part of the Cintranaval Group.*

*Bilbao Plaza Marítima Shipping offers services in the following areas:*

- *Technical, commercial and legal advice*
- *auditing services*
- *inspections for shipowners during vessel construction*
- *monitoring and settlement of guaranties, not only for the owner but also for the shipyard*
- *feasibility and operation studies*
- *preparation of Regulatory Manuals in Spanish, English and French (SOPEP, SOLAS, Fire protection, cargo securing manual, etc… or any type of manual that may be required by the Spanish Administration , IMO or US Coast Guard).*

## International Project Coordination

*Now that shipbuilding has become almost totally globalised, it is vital to seek cooperation agreements with other countries. However, this is not financially feasible for many companies, due to their structure and the need to meet very short delivery times, along with the necessity to divert staff into external projects. With the objective of overcoming this problem and supporting shipowners and shipyards in international agreements, Siateg, S.L. became part of the Cintranaval Group in June 2005.*

*Siateg has considerable experience of the international market and offers the following services:*

- *Consultancy services on mixed construction of vessels in both Spanish and foreign shipyards*
- *logistics of international projects*
- *technology transfer, training and technical assistance abroad*
- *technical and commercial support to shipowners in other countries.*

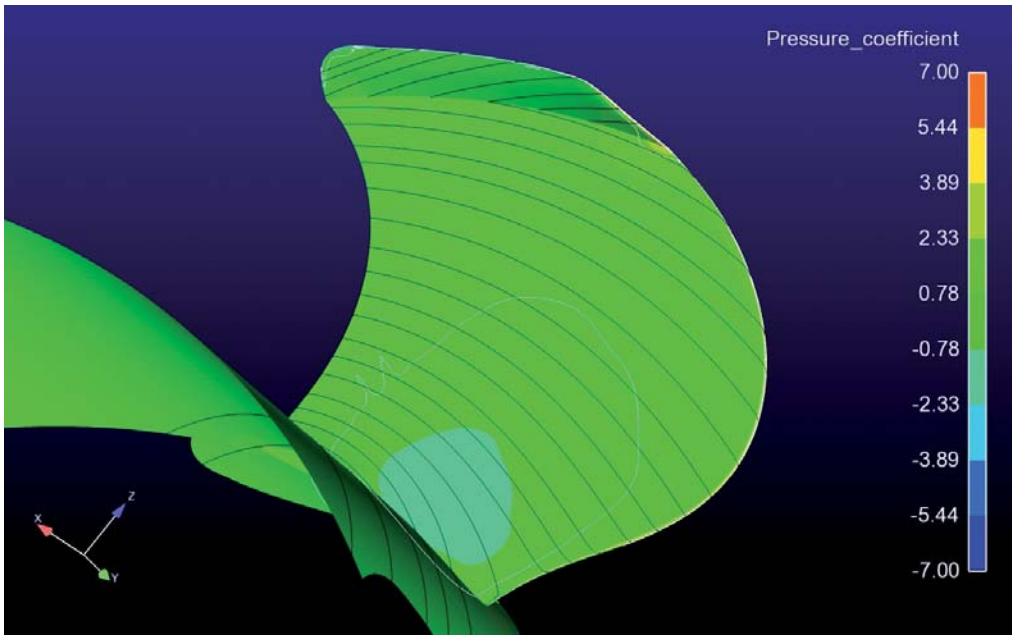
*Siateg, S.L. also coordinates international operations for the Cintranaval Group and enjoys the technical support of all companies belonging to the group.*

### Group References

- *More than 580 innovative projects for shipowners from all over the world*
- *more than 100 CAD/CAM DEFCAR software programs used in 24 different countries*
- *more than 280 high-efficiency CLT propellers installed on all type of vessels*
- *more than 200 operating manuals in several languages*
- *more than 50 technical studies in 9 different countries.*

# CLT Propellers: Numerical Methods and CFD

* **Dott. Ing. Giulio Gennaro,** *CEO of SINM*




*The development of numerical methods appropriate for modelling the peculiar characteristics of CLT propellers has been part of the 'CLT propeller agenda' from the very beginning.*

*However, it was considered of even greater urgency to develop suitable model test procedures, model test extrapolations and to foster not only the installation of CLT propellers but also full scale measurements and experiments.*

*Now that CLT propeller technology is well established and the advantages obtained at full scale over conventional propellers have been demonstrated in a large number of cases, it is necessary to focus on numerical methods in order to refine the design of CLT propellers for the purposes of meeting stringent contract requirements, such as very low pressure pulses, cavitation extension and irradiated noise.*

*For these reasons, Sistemar and SINM have begun to work with a number of organisations with expertise in numerical methods and CFD, in order to check to what extent the results obtained with tools developed for conventional propellers are also valid for CLT propellers, and to devise a roadmap for the creation of computational tools developed ad hoc for CLT propellers.*

*The initial findings showed that programs developed for conventional propellers are not satisfactory. In particular a number of calculations performed at model scale showed rather large deviations from the experimental results (up to 6.5% error on KT and 16.5% error on KQ).*

*Considering the difficulty (if not impossibility) of a complete validation of the results at full scale, it was immediately clear that such large deviations at model scale were a roadblock not easily circumvented.*

*Recently, several calculations have been performed by CEHIPAR, Spain, VTT, Finland, and the University of Genoa, Italy, with different software codes; these calculations have enabled a reproduction of the model test experience with reasonably good accuracy and have also indicated scale effects of similar magnitude to the one measured in the field.*

*Such promising results show that current technology relevant to CFD and numerical methods in general can also be successfully applied to CLT propellers but only after taking account of the phenomena peculiar to this type of propeller.*

*Sistemar and SINM are currently cooperating with CEHIPAR, VTT (CFD) and the University of Genoa for the development of numerical codes capable of predicting the performance of CLT propellers at both model scale and full scale, in both design and off-design conditions.*

*These codes will be validated on the basis of the large body of knowledge accumulated in the past by Sistemar both at model and at full scale.*

*By means of these codes the quality of the design of the CLT propellers will be ameliorated and the already good characteristics of these propellers will be further enhanced.*

(*) Dott. Ing. Giulio Gennaro, CEO of SINM, has many years of experience in ship propulsion and CLT propellers. He is also active in the field of Failure Investigation and Forensic Engineering. He has successfully worked for major shipowners, shipyards and machinery manufacturers and in many complex engineering cases involving propulsion pods, diesel engines, lubricating oil filtering systems, gearboxes, shafting, propellers, turbo chargers, etc. He is member of AIPAM, the Italian Association of Experts in Maritime Casualties. SINM is an Italian engineering consultancy firm and the company is a partner and shareholder of Sistemar.

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