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EDITORIAL

Travel is fatal to prejudice, bigotry, and narrow-mindedness.

- Mark Twain

Mumbai has got its cruise terminal. Built to over 4 lakh sq. ft., the terminal is expected to handle 10000+ passengers in a day. The berths have the breadth for 5 vessels (up to 300m in length). The world class terminal brings cheer to the cruise tourism/heritage tourism/ lighthouse tourism and adds an option to the Indian and foreign travellers. It brings another dimension to the hospitality side of things, certainly.

However, course corrections are crucial. A few Indian cruise experiences in recent past have been found wanting. Passengers herded to locations nearby to the terminal, brought by bus, haul-it-yourself arrangements for luggage (roll or carry along the berth and board the vessel), delayed customs/immigration connects and processes are on record. Such glitches and misadventures must not occur and professionalism experienced in foreign terminals should be the models to adopt and execute.

The aspiring neo-Indian traveller would be wary otherwise. Indians' travelling habit has certainly become global and in fact, a few European destinations are concerned with over tourism (not just from Indian populace). Almost in the same boat, many Indian destinations are besting the regular Indian/foreign tourist hot spots. While all these developments are exciting, the looming gloom is cast by the security aspect. The terror trampling at the J&K tourist space will remain a dampener and a sad scar. Reversibly, it seems prejudice, bigotry and narrow mindedness have made travel fatal in this instance.

In this issue

In this training focussed issue, we have articles by students in stream, research scholars and the regulars.

We start with a study on composites. Polymer composites reinforced with Al_2O_3 have been taken up by young researchers for testing and analyses. After producing the specimens to ASTM standards, these test-samples were subjected to various tests (tensile test, three-point bend test, hardness test, and thermal analysis etc. The Authors have relied on MATLAB for analyses. The study gives an insight into how nano composites are tested and adopted for applications. The article also convey the need for MATLAB exposure at UG levels.

Next, we move on to a paper presented in the WMTC 2024. Dr. Alok Verma takes us through the state of marine engineering training in the USA and discusses the future options for developments. Though not much different from the Indian scenarios, the takeaway is the importance of training in emerging technologies. This is an easily digestible read.

Following this is an article on how ports have been faring on the emission front. Raja Manikanda Kalyan and Dr. Sekar look at six major ports on the eastern coast and try to analyse how they have performed. The analysis goes on the premise that longer the port stay for a ship, more are the emissions, and pegging this vessel turn around etc., as an index of the ports' performance. This is an easily comprehensible read.

Under the Students' Section, we feature another paper from WMTC 2024. Here, the Authors describe how augmented reality can be employed for training on marine components and machines. With products on VR, AR and also extended reality appearing as training solutions, this capturing of knowledge and reflection by students should draw appreciation.

Under the Technical Notes section, we start a series on seafarer stress. Dr. Neha Jain and Yash Jain discuss the nature of job and situational stress and possible occupational therapies for the same. This can be followed with ease.

The MER Archives from May 1985 has an interesting but outdated Transaction on coal bunkers. Old times may relish this paper.

Wishes for May: May the summer showers cool the land and heal the sorrow-scabs of the Pahalgam losses. With a heavy heart, here is the May 2025 issue.

Dr Rajoo Balaji
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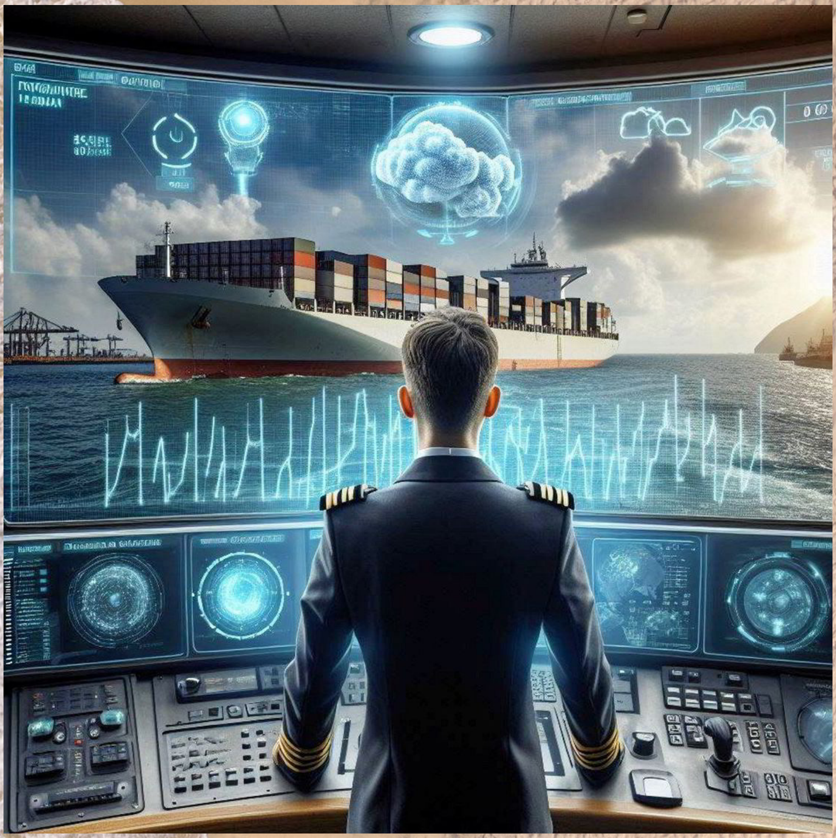

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Marine Materials: MATLAB Application to Forecast Mechanical and Thermal Tests of a Nano-polymer Composite

Maduthuri Venkatesh, V.V.S. Prasad, Gorrela Solomonraju, Duddu Hemanth, Poliparthi Uday Bhaskar

Abstract

Nano polymer composites are finding use in various applications including marine material fields.

This study focuses on creating and analysing polymer composites reinforced with Al_2O_3 fibres using the hand layup process. Investigate the mechanical properties of e-glass (610-gsm) fibre-reinforced polymer composite with epoxy (ly556) and hardener (hy951) as the matrix. The Al_2O_3 powder is produced using high-energy ball milling. the testing samples are made according to astm-d-638, astm-d-790, and astm-d-785 standards by altering volume percentages (0%, 0.5%, 1%, 1.5%, 2%, and 2.5%) with 5 layers of e-glass fibre for all the laminates using the hand layup process. The specimens undergo testing using tensile test, flexural test (three-point bend test), hardness test, and thermal analysis (dsc, dta, and tga tests). The composite specimens are analysed using SEM analysis. The results are compared at different volume percentages (0%, 0.5%, 1%, 1.5%, 2%, and 2.5%) for all the laminates. e-glass fibre-reinforced polymer composites are widely used due to their benefits such as good wear resistance and high strength-to-weight ratio. The composite was tested for tensile strength, flexural strength, hardness, dsc, dta, tga, thermal conductivity, thermal expansion, and fire resistance. Scanning Electron Microscopy (SEM) is utilised to examine the bonding and distribution of filler particles within the matrix. the data is entered into artificial neural networks (ANN) to see if it is enough for predicting future combinations.

Keywords:

ANN, Dsc, Dta, Tga, In Mechanical Tests Lamintas, Epoxy, Eglass Mat

1. Introduction

The development of advanced materials with tailored properties has driven the exploration of novel composite systems, such as those incorporating nano fillers into epoxy matrices reinforced with e-glass fibres. This paper aims to introduce a study that employs artificial intelligence, specifically the application of artificial neural networks (ANN) in MATLAB, to predict and optimise the mechanical and shielding properties of these innovative composites. e-glass fibre reinforced epoxy composites have been widely recognised for their strength, cost-effectiveness, and lightweight properties, making them suitable for various applications, including automotive, aerospace, and construction industries [4]. the integration of nano fillers, such as lead oxide (PbO) nano particles[1] and nylon 6,6 nano fibres[3], has been shown to enhance the mechanical and shielding properties of these composites. The use of ANN models in mat lab offers a powerful tool for predicting the behaviour of these complex systems, as they can handle the nonlinear relationships between variables and provide accurate predictions based on training data. This approach can help to optimise the composition of these composites, reducing the need for extensive experimental testing and accelerating the development of new materials.

The present study will focus on the following aspects:

Investigating the mechanical properties of e-glass fibre reinforced epoxy composites with various nano filler weight fractions, using ANN models to predict the tensile, flexural, and impact strengths.

> *The use of ANN models in mat lab offers a powerful tool for predicting the behaviour of these complex systems, as they can handle the nonlinear relationships between variables and provide accurate predictions based on training data*

- Exploring the shielding properties of these composites, incorporating nano fillers such as lead oxide nano particles, and using ANN models to predict their radiation shielding performance.
- Comparing the predictions of ANN models with experimental data to validate the accuracy and reliability of the models.

The results of this study will provide valuable insights into the behaviour of e-glass fibre reinforced epoxy composites with nano fillers, offering a foundation for the development of advanced materials with tailored properties for various applications. The use of ANN models in MATLAB will also demonstrate the potential of artificial intelligence in accelerating the development of new materials and optimising their properties.

Materials

The Al_2o_3s used in this work were acquired from matrix nano in Uttar Pradesh, India **Al_2O_3** made using the sol-gel process have a diameter of 50 nm and a length ranging from 600 Nm To 1.25 Um. epoxy resin is chosen over other accessible polymers due to its diverse attributes such as strong adherence to fibres, simple processing, and excellent mechanical characteristics. Epoxy Resin Ly556 And Hardener Hy951 are bought from Herenba instruments and engineers in Chennai. The fibre utilised in the laminate composite is woven glass fibre mat supplied from Herenba instruments and engineers.

Methods

Manufacturing Of Al_2O_3 Prepreg Impregnated e-Glass Fibre The Al_2O_3s Synthesised Will Exhibit Varied Aggregates And Will Not Possess a Uniform Size. This disparity in aggregates hinders the homogeneous blending of these elements in epoxy. **Ultra-sonication** at 30 Khz and magnetic stirrers are utilised to achieve a homogeneous mixture of Al_2O_3, epoxy, and hardener. Aluminium Oxide (Al_2O_3) in volume percentages of 0.5, 1, 1.5, and 2.5 is combined with epoxy and hardener.

Table:4.1 ultimate tensile strength

Specimen	Ultimate tensile strength (MPa)
a1	199
a2	207.55
a3	228.37
a4	248.99
a5	237.91
a6	182.96

Table:5.2 Maximum Flexural Strength

Specimen	Ultimate flexural strength (MPa)
a1	176.5
a2	186.2
a3	200.2
a4	205.88
a5	200.81
a6	205.63

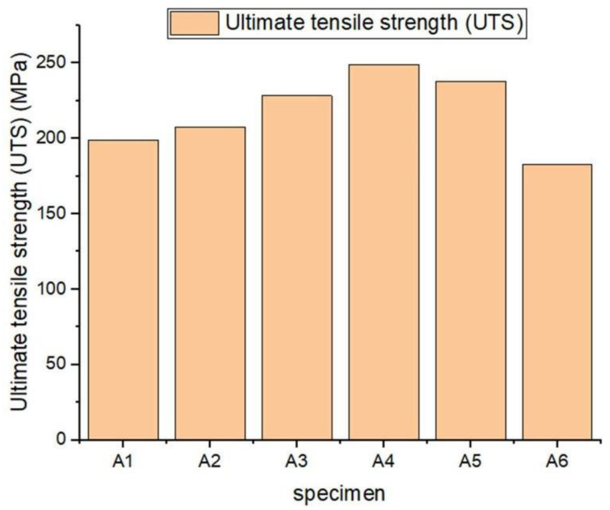

Figure:5.1 variation Of Tensile Strength w.r.t nano- Al_2O_3 content in Composites

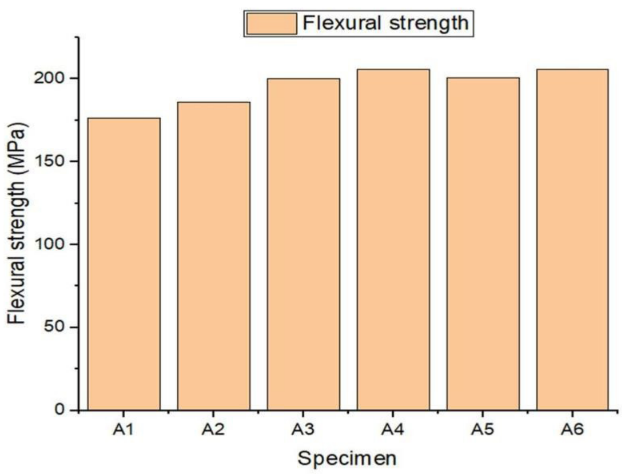

Figure:5.2 variation of flexural strength w.r.t nano - Al_2O_3 content in Composite

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Sonication is performed for 1.5 hours. 2.2.2. preparation of cnt reinforced epoxy composites laminates measuring 300mm by 300mm are produced using hand layup technique with 5 layers of e-glass fibre.

Characterisation sample : 2.3.1. and 2.3.2. scanning electron microscopy SEM is used to identify the morphology and average diameter of mcnts. supra 55 vp 4132 Carl EISS field emission scanning electron microscopy is utilised.

2.4. Edx analysis is performed to characterise and analyse the composition of Al_2O_3 composites. SEM is conducted to analyse the morphology and fracture behaviour of five distinct composites. utilising differential scanning calorimetry (dsc), thermal gravimetric analysis (tga), differential thermal analysis (dta), thermal conductivity, and thermal expansion.

Differential scanning calorimetry (dsc) is used to analyse the thermal stability of polymer nano composites. The tga-dta test provides the temperature at which maximum deterioration occurs. Tests are conducted on a Hitachi sta 7300 at a heating rate of 10°c/min within a temperature range of 25 to 350°c.

Mechanical Properties

Tensile test results

The impact of nano- Al_2O_3 particles on GFRP composites is shown in **Figure 4.1.** due to the strong filler/matrix contact and good particle dispersion, which result in an efficient stress transfer, the addition of nano particles considerably increases the tensile strength of composite materials. According to the results, the composite specimen filled with 1.5%nano- Al_2O_3 particles had the high strength (248.99mpa), and its tensile strength variation was greater than that of other compositions. beginning with a composite specimen filled with 2%nano- Al_2O_3 particles, the ultimate tensile strength begins to decline.

1.1 Flexural test results

The flexural strength of composite samples with various amounts of nano-in comparison to other composite specimens, the specimen with 1.5% nano- Al_2O_3 Particles had the highest flexural strength (205.88mpa), which is a gain attributable to the uniform distribution of Nano-fillers and the strong bond between epoxy and filler materials, which increases energy absorption, its crack initiation and growth. additionally, it can be observed that the flexural strength of composite specimen steadily increases as the fraction of nano-filler rises.

Table:5.3 Micro hardness values

Specimen	Micro Hardness Hv
a1	17.2
a2	18.5
a3	20.1
a4	21.6
a5	22.4
a6	25.3

The micro-hardness of the composite is measured using a digital micro-hardness tester. To leave an impression on the surface, a diamond indenter is pressed into the composite specimen for 10 seconds while being subjected to a stress of 3 N

Hardness test results

The micro-hardness of the composite is measured using a digital micro-hardness tester. To leave an impression on the surface, a diamond indenter is pressed into the composite specimen for 10 seconds while being subjected to a stress of 3 N. In **Table 2,** the typical Vickers hardness is listed. The hardness of composites is seen to be gradually rising, with 25.3Hv being the maximum value. However, the hardness values show that there isn't much of a hardness difference between compositions

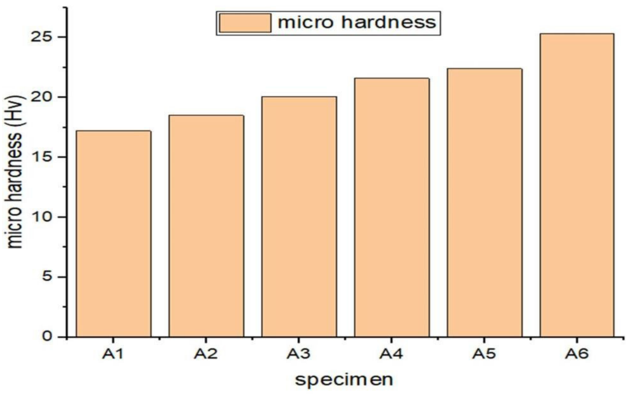

Figure:5.3 Variation of Hardness value w.r.t nano- Al_2O_3 Content in composites.

Table:5.4 Glass transition temperature

Specimen	Glass transition temperature (°c)
a1	60.8
a2	61.6
a3	62.4
a4	63.6
a5	66.0
a6	67.5

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> *MATLAB is used to use Artificial Neural Networks (ANNs) to examine the correlation between the mechanical and thermal characteristics of epoxy-based nano composites that include multi-walled carbon nano tubes (MWCNTs) and nano bagasse*

Thermal Analysis

DSC test results

The effects of micro particles on the glass transition temperature of the composite are analysed for A1, A2, A3, A4, A5, and A6 types of compositions. The glass transition temperature with different modifiers is reported in **Table 4.4.** There is no significant change in the tg values.

DTA Test Results

Figure 4.5 show DTA graphs of nano Al2O3 filler material composite in an oxygen atmosphere. In this Figure 4.5, the DTA peak signifies the oxidation temperature of Al_2O_3nano composites. At 474°C larges Spike appeared. This is due to the sudden loss of mass of nano Al_2O_3. In addition, there is a great weight loss between 400°C and 500° C which is related to pyrolysis of the polymer materials, and between 600°C and 700°C another weight loss occurs smaller than the other one.

Table: Peak value temperature

Specimen	Peak value temperature (°c)
a1	269
a2	423
a3	457
a4	464
a5	471
a6	474

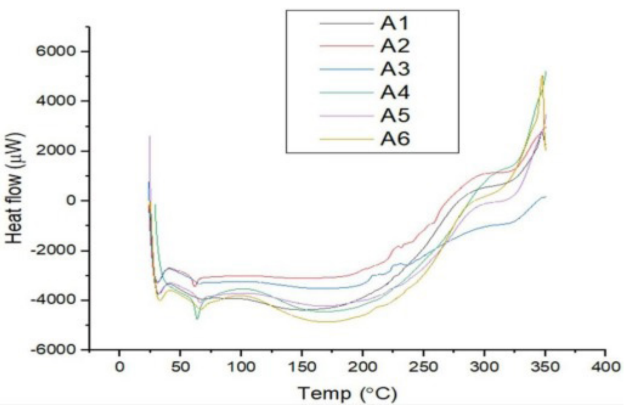


Figure: 5.4 Temperature vs Heat flow graph

TGA test results

Table 4.6 presents the initial and final degradation of temperatures of the various percentages of nano Al_2O_3 filled composites. The addition of nano fillers in the polymer matrix improves the thermal stability of the prepared composites. Thermal degradation proceeds in two stages. The first stage starts with an initial degradation of the composites by the evaporation of water molecules that are present as moisture in the inter-layer zone. This stage accounted for 10% of the total degradation of the composite. The nano Al_2O_3 filled composite shows an initial degradation temperature range of 233°C to257°C. In the second stage, the thermal degradation of the composite is related to the type of filler loading, bonding strength, and compatibility of the filler with the matrix. The weight loss % is high for the A3 specimen and low for the A4 specimen. Therefore 1.5% nano Al_2O_3 composite becomes thermally stable than all other nano- filled Al_2O_3 composites. This is due to ceramic nano Al_2O_3 filler being more stable and harder than the epoxy matrix as shown in **Figure 4.6.** Nano Al_2O_3

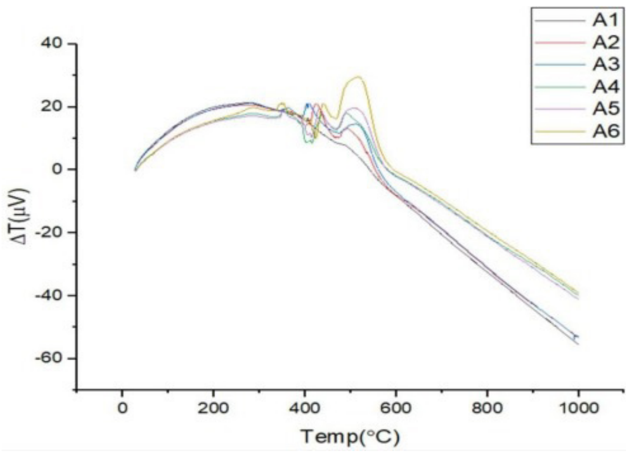


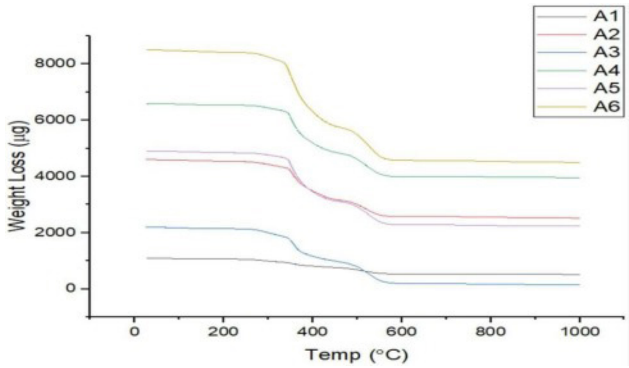
Figure:5.5 Temperature vs Difference in temperature(T) Graph

Table : Weight and degradation temperature

specimen	Initial weight (mg)	Final weight (mg)	Initial degradation temperature (°c)	Final degradation temperature (°c)
a1	1.100	0.542	233	573
a2	4.600	2.590	260	568
a3	2.200	0.209	265	582
a4	6.500	4.006	271	576
a5	4.900	2.336	280	562
a6	8.500	4.594	257	575

materials are capable of withstanding high temperatures. Hence there is scope for improvement in the thermal stability of the composite incorporating the nano Al_2O_3 filler. The abrupt degradation temperatures were steadily decreasing with an increasing nano Al_2O_3. This reports that ceramic filler (nano Al_2O_3) enhances the thermal stability of polymer composites.

TGA test results



Thermal conductivity

The graph show the thermal conductivity is decreases gradually with increase in content of the specimen.

Thermal expansion

Upon conducting thermal conductivity and thermal expansion analyses, it was observed that as the percentage of nano Al_2o_3 increases, the thermal conductivity tends to decrease, while the thermal expansion rate decreases with a higher percentage of nano Al_2o_3. the results are plotted in the **Figure 5.9, 5.10.**

MATLAB network training

MATLAB is used to use Artificial Neural Networks (ANNs) to examine the correlation between the mechanical and thermal characteristics of epoxy-based nano composites that include multi-walled carbon nano tubes (MWCNTs) and nano bagasse. The subsequent aspects delineate the use of artificial neural networks in this setting:

Features provided as input

Tensile Strength - Flexural Strength - Differential Scanning Calorimetry (DSC)

Thermo gravimetric Analysis (TGA) Information

Differential Thermal Analysis (DTA) Data

Network Architecture:

The input layer comprises all five specified features.

There are four secret layers.

The output layer consists of three neurons that indicate the projected reflectivity loss (RL) values.

Training Parameters:

Training Iterations: Maximum of 1000 iterations

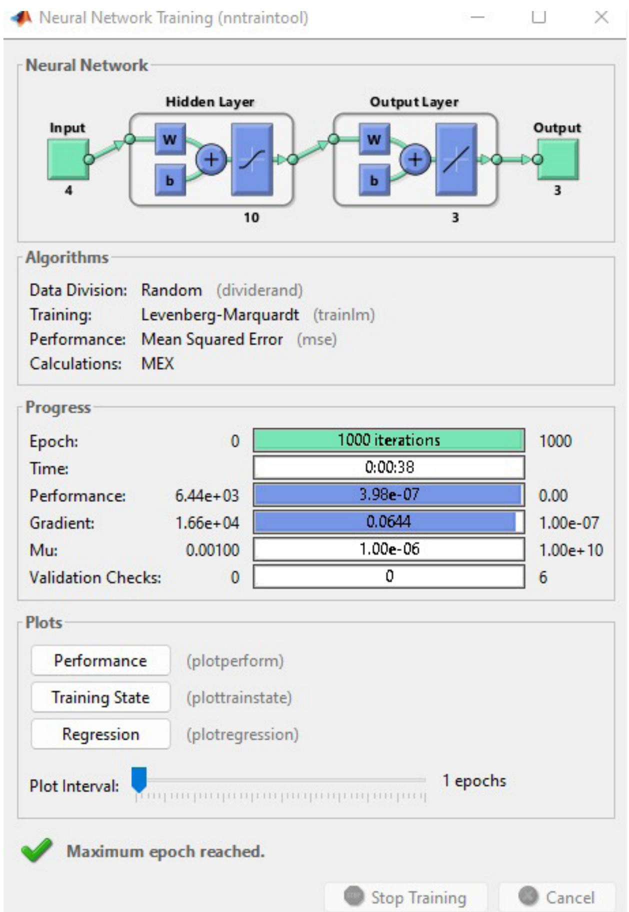
Learning Rate: Unspecified - Activation Function:

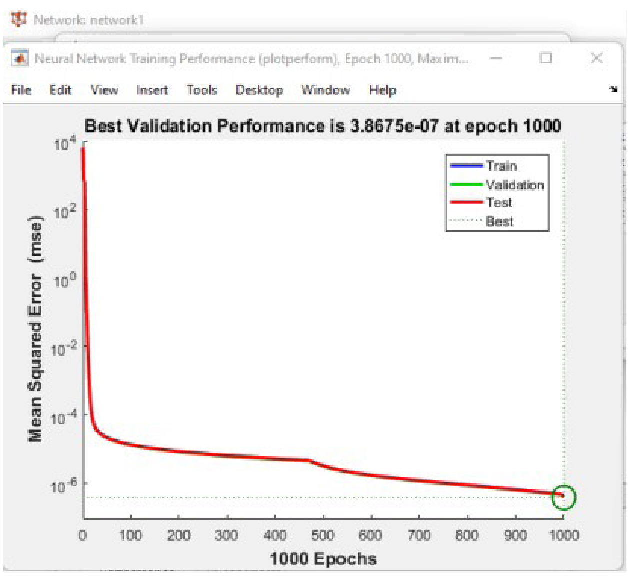
Rectified Linear Unit (ReLU)

The loss function used is Mean Squared Error (MSE).

Outcome:

The overlap of the Test Validation and Trained Mean Squared Error curves suggests strong generalisation abilities of the Artificial Neural Network.





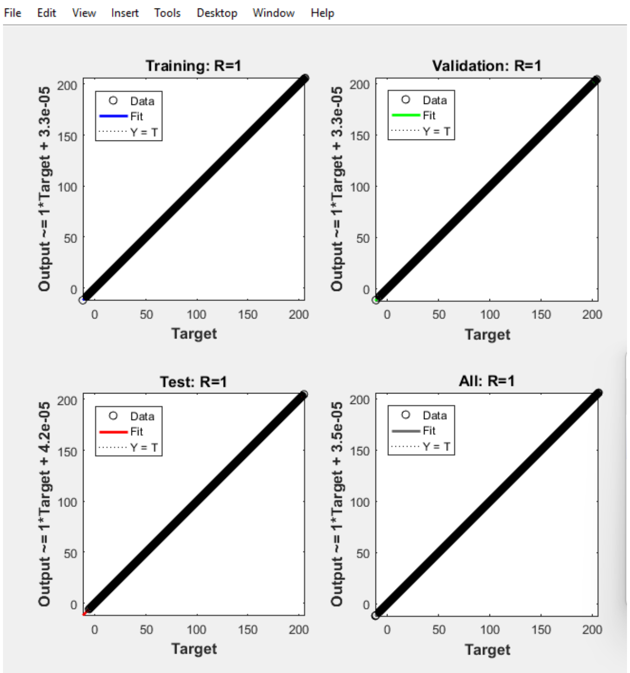
- The Gradient vs Epoch plot illustrates the learning progress in training. - The Mu vs Epoch plot shows the average weight change over time. - The ValFail vs Epoch curve indicates the quantity of failed validations throughout training.

Graphics:

Training vs Target Plots: Illustrate the relationship between actual and 2predicted values in the training phase. - Validation vs Target Plots: Display the relationship between actual and predicted values in the validation phase. Test versus Target Plots show the relationship between observed and forecasted values in the testing phase.

Metrics for evaluating performance:

The Coefficient of Determination (R) measures the goodness of fit, with R = 1 indicating flawless prediction.



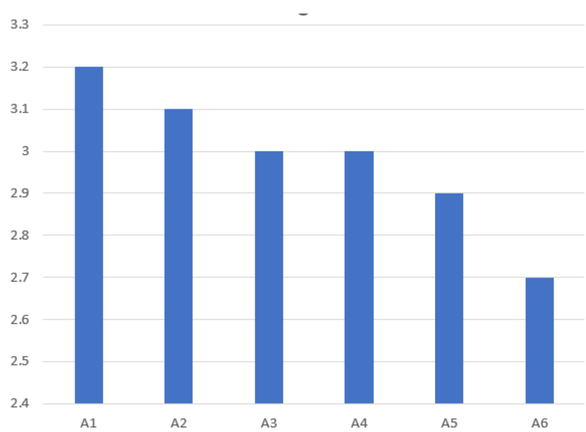


Figure: specimen vs thermal conductivity(w/m⁰C)

Conclusion

The tensile test under ASTM D638 standard results obtained for laminates with different vol.% of nano Al_2O_3 (0 vol.%, 0.5 vol.%, 1 vol.%, 1.5 vol.%, 2 vol.% and 2.5 vol.%) are 199MPa, 207.55MPa, 228.37MPa, 248.99MPa, 237.91MPa and 182.96MPa respectively.

From the tensile test results of the nano Al_2O_3 epoxy samples, the 1.5 vol.% nano Al_2O_3 sample was the highest among all the compositions with the largest tensile strength value of 248.99MPa.

2% of the nano Al_2O_3 sample showed a drop in the tensile strength with the value of 237.91MPa and 2.5% of nano Al_2O_3 tensile strength gradually decreased with the value of 182.96MPa. This might be attributed possible aggregation of nano Al_2O_3 at some sites

The flexural test under ASTM D790 standard results obtained for laminates with different vol.% of nano Al_2O_3 (0 vol.%, 0.5 vol.%, 1 vol.%, 1.5vol.% and 2 vol.%) are 176.5MPa,186.2 MPa, 200.2MPa, 205.88MPa, 200.81MPa and 205.63MPa respectively.

From flexural test results of the nano Al_2O_3 epoxy samples, the 1.5 vol.% nano Al_2O_3 sample was the highest among all the compositions with the largest flexural strength value of 205.88 MPa.

2 vol.% nano Al_2O_3 sample showed a drop in the flexural modulus with a value of flexural strength 200.81MPa and 2.5 vol.% nano Al_2O_3 showed a slight increase in flexural strength with a value of 205.63MPa. This might be attributed possible aggregation of sugarcane bagasse at some sites.

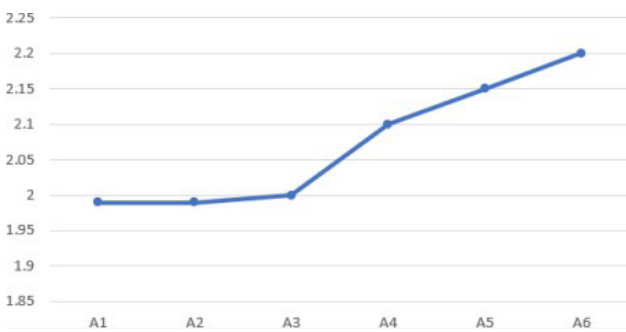


Figure 5.10 specimen vs thermal expansion×10^{-5} ($^0C^{-1}$)Upon

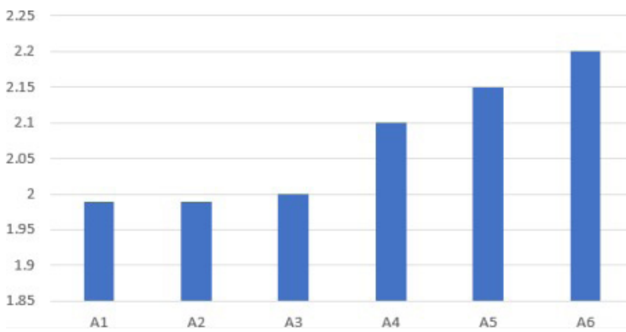


Figure: specimen vs thermal expansion×10-5(0C-1)

The Vickers Hardness test under ASTM D785 standard results obtained for laminates with different vol.% of nano Al_2O_3 (0 vol.%,0.5 vol.%, 1 vol.%,1.5 vol.%, 2 vol.% and 2.5 vol.%) are 17.2Hv, 18.5Hv, 20.1Hv, 21.6Hv, 22.4Hv and 25.3Hv respectively.

From Vickers hardness test results of the nano Al_2O_3 epoxy samples, the 2.5wt % Al_2O_3 Composite sample was the highest among all the compositions with the largest Hardness value of 25.3Hv.

Hardness value increases by increasing the vol.% of nano Al_2O_3 because the brittle nature increases. Hence flexural strength and tensile strength decrease beyond 1.5vol.% of nano Al_2O_3 but hardness increases.

We discovered via the DSC analysis that the tg values had not significantly changed.

From the TGA analysis, the weight loss percentages of nano Al_2O_3 epoxy samples (0 vol.%, 0.5 vol.%, 1 vol.%, 1.5 vol.%, 2 vol.% and 2.5 vol.%) are 50.72%, 43.69%, 90.5%, 38.36%, 52.32% and 45.95% respectively. Therefore, A3 has more percentage in weight loss i.e., 90.5%, and less weight loss in A4 i.e., 38.36%.

From the DTA analysis, it shows that as a percentage of nano Al_2O_3 increases the peak value also increases.

The ANN architecture demonstrates good performance since the Mean Squared Error (MSE) curves completely overlap in the training, validation, and testing phases. The high coefficient of determination (R = 1) indicates that the data given to the ANN is completely adequate for properly forecasting future reflectivity losses. Providing more information on activation functions, learning rate, and optimisation algorithms would improve the comprehension of the artificial neural network's behaviour.

[This paper was presented at the GLOMARS Conference, 8-9 March 2024]

Citations

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Marine Engineering & Technology Training Programs in the US – Opportunities and Challenges

A.K. Verma, D. Pinisetty,
D. L. Satterwhite

Abstract - Maritime industry is crucial for global trade and economic development. Ninety percent of all goods are traded through oceans globally. Over the past few decades, electrical and electronics systems on seagoing ships have become highly sophisticated. The efficient operation of modern vessels depends upon the crew trained in these modern technologies and intelligent systems. New training programs must be developed to address the changing workforce skill requirements [1] [2]. Seven Maritime Academies in the US offer US Coast Guard-approved programs in Marine Engineering and Marine Engineering Technology.

The country's Marine Engineering and Technology programs must prepare for the shift towards ship automation, cybersecurity of marine systems, and the use of alternative fuels. This article is a collaboration between Texas A&M Maritime Academy and California State University Maritime Academy to present the ongoing efforts at these Academies to improve the workforce by developing new curricula to address future workforce needs. The article discusses the development and implementation of new courses, minors, and programs, including the development of laboratory facilities in support of the new curriculum.

Keywords: Training programs; Curriculum, Minors, Lab development; Workforce development.

Introduction

The global blue economy is expected to double in size to $3 trillion by 2030, according to an analysis by the Organization for Economic Co-operation and Development (OECD). This economy is defined by the World Bank as "the sustainable use of ocean resources for economic growth, enhanced livelihoods, jobs, and the health of ocean ecosystems"[4]. This growth will be driven by strong expansion in new industries like alternative energy, the digitalisation and automation of port and transportation operations, food security, and coastal resilience.

Over the last few years, electrical systems on seagoing ships have undergone significant development and change. In addition, the complexity and number of electrical and electronic equipment have greatly expanded [3]. With the increasingly complex electromechanical systems, and the impact of global warming, the demand for marine engineers is expected to grow since the existing vessels must be retrofitted to comply with new pollution and emission standards regulations.

In light of these developments, The International Maritime Organization (IMO) amended STCW 95 (also known as the Manila Amendment) on June 25, 2010, to introduce the certified position of Electro-Technical Officer in place of Electrical Officers. This was enacted to make modern electrical engineers competent to understand the emerging more complex and sophisticated electrical systems [7]. An Electro-Technical Officer (ETO) is defined as a licensed member of the engine department of a merchant or passenger ship and is a key position in the technical hierarchy of modern ships with automated and conventional electrical and electronic systems [8]. Under the direction of the Chief Engineer, Electro-Technical Officers are responsible for monitoring and repairing the ship's electrical and electronic equipment to ensure that it is operating as safely and efficiently as possible [8].

Over the last few years, electrical systems on seagoing ships have undergone significant development and change

To prepare the future workforce for Blue Economy, the Marine Engineering Technology Department at Texas A&M University has decided to develop two minors and a state-of-the-art engine room simulator laboratory. ETO program to address industry needs. The first minor in Marine Engineering Technology is designed to increase awareness about marine engineering careers, and the second minor in Marine Electro-Technology is designed to provide foundational courses so students can obtain an ETR rating upon graduation.

FUTURE INDUSTRY NEEDS

The workforce will need to grow in tandem with the growth of the U.S. blue economy to satisfy the demands of new technologies and disciplines. With the rising use of automation on ships and shipping terminals, it is projected that skilled people would be required to support this expansion. The following five technological advancements play a key role in global trade growth and climate change's escalating effects: 1. Artificial intelligence 2. Sensor technology 3. Robotics and 3D printing 4. Big data and IoT 5. Autonomous control 6. Augmented reality 7. Ship propulsion systems 8. Advanced materials [9][10].

The advancements in intelligent, highly automated, and autonomous ships stand out among the eight growth areas. The rising usage of intelligent systems for ship management, operation, and propulsion is an example of this trend. **The U.S. Coast Guard is expected to adopt this approach soon and mandate that an ETO man all ships in U.S. waters.** No higher education institutions, not even the seven maritime academies in the U.S., currently provide a degree or a training course for ETOs.

In the future, the Marine Engineering Technology department at the Galveston campus of Texas A&M University plans to develop a new program in collaboration with the Multidisciplinary Engineering Technology Program from the main campus in College Station.

COLLABORATING INSTITUTIONS

Texas A&M University at Galveston, an ocean-focused branch campus of Texas A&M University, educates early 2,300 undergraduate and graduate students in a diverse range of marine and maritime programs, including majors in science, business, engineering, liberal arts, and transportation. With almost $10 million in research expenditures, it is an essential part of Texas A&M's unusual land-, sea-, and space-grant mission and is promoting the growth of the blue economy in the Gulf Coast Region.

The Texas A&M Marine Academy, one of seven in the nation and the only academy incorporated into a Tier 1 academic institution, is located at Texas A&M-Galveston and prepares more than 400 cadets yearly for maritime duty and employment worldwide. Texas A&M-Galveston is perfectly situated in Galveston, Texas, on the Gulf Coast, surrounded by the industry, environment, and programs necessary to carry out its unique mission.

Located on a scenic waterfront campus in Vallejo, CA, Cal Maritime is one of seven degree-granting maritime academies in the United States and the only one on the West Coast. The School of Engineering offers ABET-accredited programs in Mechanical Engineering, Facilities Engineering Technology, and Marine Engineering Technology. The mission of the School of Engineering is to provide each cadet with a world-class education and experiential training in engineering and applied technology. The School of Engineering prepares cadets for a lifetime of learning and successful careers in engineering and maritime-related fields while instilling the values, vision, and skills to enable them to become future leaders and problem solvers to advance the engineering profession's science and technology.

Table 1. Marine Engineering Technology Minor Courses

Marine Engineering Technology Minor Courses	Cr. Hrs
MARE 100: Marine Engineering Fundamentals	3
MARE 103: Basic Safety and Lifeboatman Training	3
MARE 200: Basic Operations	4
MARE 401: Marine Auxiliary Systems	3
MARE 377: Engineering Risk Management in Maritime Construction and Shipbuilding -or- MARE 441: Engineering Economics and Project Management	3
Total Credit Hours	16

Table 2. Marine Electro-Technology Minor Courses

Marine Electro-Technology Minor Courses	Cr. Hrs.
MARE 235: Digital Fundamentals for Marine Engineers	3
MARE 325: Shipboard Networking Systems	3
MARE 335: Power Electronics for Shipboard Applications	3
MARE 345: High Voltage Technology for Marine Engineers	3
MARE 445: Marine Navigation Systems	3
Total Credit Hours	15

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> *The first minor in Marine Engineering Technology is designed to increase awareness about marine engineering careers, and the second minor in Marine Electro-Technology is designed to provide foundational courses so students can obtain an ETR rating upon graduation.*

EFFORTS AT TEXAS A&M UNIVERSITY AT GALVESTON

A. Development of Minors

1) Minor in Marine Engineering Technology

The growth of autonomous vessels and increased global trade have transformed the Merchant Marine's workforce needs. To meet this demand, the MARE department has begun two separate minors: a minor in Marine Engineering Technology and a minor in Marine Electro-Technology.

The first minor introduces maritime business and other engineering majors to marine engineering, ship's propulsion, and auxiliary systems. This minor program, once USCG approves it, will allow the student to test for their Designated Duty Engineer Coast Guard Certification, allowing them to work on smaller vessels such as tugboats and river barges. This curriculum includes the MARE 200 course, where the student will spend 60-75 days as a cadet on the training vessel, participating in class, standing watch, and performing maintenance. The classes for the MARE minor are listed below in **Table 1.**

2) Minor in Marine Electro- Technology

The Marine Electro-Technology minor will introduce students to the cutting-edge technology now on vessels. Digital electronics will be covered with advanced topics in High Voltage operations, Battery Power supply management, and shipboard automation. Upon USCG approval, the student will graduate with an Electro-Technical Rating (ETR) and, with additional sea-time, will be allowed to test for their Electro-Technical Officer Endorsement. As ships become more automated and move to alternative propulsion to decarbonise, electrical expertise will be critical onboard vessels. This minor will allow our students to fill the need in the modern merchant marine. This minor is not limited to our License Option students; we are encouraging all of our students to enrol, as the knowledge can be applicable in Port Engineer or Maintenance Mange positions. The Marine Electro-technology courses are listed below in **Table 2.**

B. Development of Simulator Laboratory

Department of Marine Engineering Technology (MARE) has recognised the need for simulation-based training and paired with Wärtsilä Simulation and Training Solutions to update their traditional ERS I lab to a fifteen-person multipurpose propulsion simulation and full mission simulator with virtual and 3D capabilities. This new facility can supplement workshops on the training ship and existing labs with fully rendered high-fidelity experiences on six different propulsion types.

- Dual Fuel Diesel Electric
- Dual Fuel Slow Speed
- Slow Speed Diesel
- Medium Speed RoPax
- Dual Fuel Steam
- Gas Turbine

Wärtsilä has continued to lead the simulation industry with new High Voltage training aids and multiple simulators in alternative fuel sources. MARE has implemented more electro-technical training and alternative fuel source training, research, and education into their programs. This has led to new classes, minors, and exercises utilising the upgraded full mission simulator with its high voltage breaker and the collection of four LNG models.

Figure 1. Tamug Mare Ers 1 Classroom

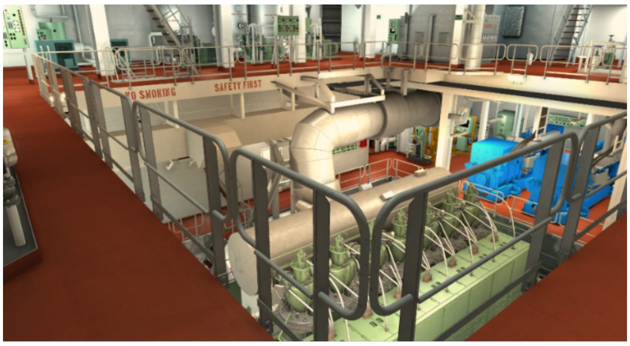

Figure 2. Tamug Mare Vr Machinery Space

Beyond the use of the updated fifteen-person and full mission simulator, MARE plans to use modern virtual and augmented reality (AVR) exercises in high voltage and LNG propulsion as shown in **Figure 2.** This will allow students to gain a sense of scale and layout for the operation and design of these modern vessels. With AVR, the entire vessel can be simulated in the confines of a twenty-five-square-foot space.

> *This curriculum includes the MARE 200 course, where the student will spend 60-75 days as a cadet on the training vessel, participating in class, standing watch, and performing maintenance*

C. Development of New Courses

MARE is developing four new courses to meet the challenges of a changing marine industry.

1) Marine Cyber Security
2) LNG as Marine Fuel
3) Shipboard Networking System
4) Nuclear Engineering

EFFORTS AT CALIFORNIA STATE UNIVERSITY MARITIME ACADEMY

A. Development of Automation Engineering Major and Data Science Minor

1) Major in Automation Engineering

Automation technology is rapidly transforming the global marine industry, creating a growing demand for professionals equipped with specialised knowledge and skills in this field. As the shipping industry increasingly relies on automation to enhance efficiency, reduce costs, and improve processes, the need for a workforce proficient in automation systems, control engineering, and data analysis becomes more pressing. This proposed major aims to meet this demand by equipping students with the skills necessary for roles related to automation, autonomous vehicles, and robotics within the maritime sector.

The curriculum is being developed to emphasise emerging technologies in industrial automation and artificial intelligence, among others. There is also potential

Figure 3. Cal Maritime's (a) Part-Task steam simulator; (b) Full-Mission steam simulator; (c) Part-Task diesel simulator; (d) Full-Mission diesel simulator.

> *As ships become more automated and move to alternative propulsion to decarbonise, electrical expertise will be critical onboard vessels*

to incorporate an automation engineering technology program that includes a Merchant Marine license.

2) Minor in Data Science

Autonomous ships are expected to include a range of advanced technologies such as artificial intelligence, sensors, communication systems, navigation systems etc. Such technologies generate a vast amount of data that must be analysed to improve decision-making, enhance safety, optimise vessel operations, and reduce human errors.

The Data Science minor will introduce critical concepts in computer programming, statistical inference, algorithms for machine learning methods, data visualisations, data processing, statistical concepts for error measurement.

B. Remote Trouble Shooting in Marine Engineering Technology (MET) Curriculum

The rapid evolution of shipboard technology presents significant challenges in troubleshooting, especially concerning innovative electronic and automation systems on new or upgraded vessels. This issue is particularly relevant in sectors such as offshore wind turbine installation, vessels associated with the oil and gas industry, and offshore drilling rigs. Failures due to new equipment, improper installation, or incorrect use and maintenance often exacerbate the problems they were meant to solve. Therefore, the ability to perform remote troubleshooting is essential for the industry.

In the Marine Engineering Technology (MET) curriculum, students are trained to collaborate with shoreside support from vendors and engineers, gaining an understanding of the shoreside perspective. In this training, students act as port engineers tasked with troubleshooting shipboard technical problems remotely. They must resolve issues with limited information and poor-quality system drawings provided by onboard engineers, developing critical thinking skills essential for workforce development in shore-based control centres. These skills are crucial for controlling and troubleshooting autonomous ship equipment using real-time data and communication systems.

C. Simulator Training in MET Curriculum

Simulators create an interactive environment where students can collaboratively diagnose system and machinery faults, akin to real-world operations of steam and diesel plants. This training allows students to build a mental model of real-world scenarios and safely test solutions without risk of injury or equipment damage. The workforce development with these skills is paramount for the success of maritime industry with modern ships. Cal Maritime boasts four engine room simulators, including full-mission and part-task diesel and steam simulators as shown in **Figure 3.**

Currently, Cal Maritime is upgrading its engine simulators with Wärtsilä to provide students with training on modern ship control and a plethora of virtual engine rooms and propulsion types. Additionally, high-voltage training modules will be acquired to prepare students for electrical plants both ashore and sea.

CONCLUSIONS

The growing maritime trade and an increasing number of highly automated ships require the presence of a skilled Electro Technical officer on board each vessel to manage and maintain these systems. The Marine Engineering Technology department at Texas A&M University's Galveston campus has developed an Electro Technology minor so that existing students in Marine Engineering Technology can obtain the required technical background for the USCG endorsement as ETO. Four new courses are under development for the minor in Electro Technology, and one, the Marine Power Electronics for Shipboard Applications course, has been developed and offered. Another minor in Marine Engineering Technology was developed to increase awareness about the discipline among other majors. The ETO minor creates a pathway to highly sought-after and lucrative jobs in the marine sector.

> *In the Marine Engineering Technology (MET) curriculum, students are trained to collaborate with shoreside support from vendors and engineers, gaining an understanding of the shoreside perspective*

The Automation Engineering major and Data Science minor at Cal Maritime are designed to educate the next generation of engineers for the maritime industry. With the rise of autonomous boats and the preparation for autonomous shipping [13], including the regulatory framework development by the International Maritime Organization, the need for such education is critical. Remote troubleshooting training in the MET curriculum is a key component of workforce development for modern ships equipped with advanced technologies. The planned simulator upgrades at Cal Maritime will incorporate high-voltage training, essential for modern shore side facilities and vessels. Additionally, like Texas A&M University's Galveston campus, Cal Maritime will consider developing an Electro-Technical Officer program and seek approval from the USCG.

[This Paper was presented in the WMTC 2024; 4-6 Dec 2024, Chennai]

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Empirical Analysis of Carbon Emission Trends of Major Ports in Eastern India - Challenges in Decarbonisation

Raja Manikanda Kalyan, M.Sekar

Around 80% of the global trade by volume is carried out through sea which makes it a crucial sector for economic growth of a nation. In India there are 11 major ports under the Major Port Authorities Act, and 1 Major Port under Companies Act 1956 and around 200 non major ports which includes ports owned by the state as well as privately owned ports.

Ports have a significant impact on the environment. The shipping industry accounts for around 3% of total carbon emissions in the world. One of the major factors contributing to the burning of fossil fuel in the port is largely due to carbon emission from the ships.

The scope of the study is limited to six major ports in the Eastern India, that is Syama Prasad Mookerjee Port, Kolkata, Paradip Port, Visakhapatnam Port, Chennai Port, Kamarajar Port Limited and V O Chidambaranar Port.

The objectives of the study are to compare and analyse the carbon emitting from the ship which is in the berth for operation and how to reduce the carbon emission from the ship. The researcher has planned to use indices like Average Pre-Berthing Detention Time, Average Turn Round Time of the vessel and Average Output per Ship-berth-day. Both primary and secondary data shall be used for the study. The researcher has planned to use multivariate analysis or rank correlation and Data Envelopment Analysis for the study

One of the controlling measures to reduce the fossil fuel emanating from the ship inside the port is to reduce the idle time of ship berthed at port, to find out the ship idling at the port the following indices needs consideration, reduction in Average Pre-Berthing detention time, meaning the vessel can be directly berthed without waiting in the outer anchorage. Waiting in an outer anchorage shall consume more fuel oil, producing more fossil fuel from the vessels. Lesser pre-berthing detention can help to reduce carbon footprint. Minimizing the average turnaround time will burn less fuel oil resulting in a reduction in carbon gas house emission. Similarly, when Average Output per Ship-berth-day is higher, the vessels can be serviced faster, resulting in low fuel oil consumption. The scope of the study is limited to the above indices.

Key Words: Average Pre-Berthing Detention Time, Average Turn Round Time, Average Output per Ship-Berth Day.

Introduction

The release of Carbon dioxide into the atmosphere is the leading cause for Global Warming and Climate Change. The transport sector is responsible for around 25% of all carbon emissions out of which the shipping industry accounts for around 3%. The trade through sea is expected to increase by 7% each year till 2030. Hence it is crucial to accelerate decarbonization of the shipping sector in order to achieve the target of keeping the global average temperature below 2° C above the pre-industrial level.

This study aims to empirically analyse the emission trends of major ports in the eastern coast of India. The Average Pre-berthing detention time (X), Average Turn Round time(Y), and Average Output per ship-berth-day(Z) were considered for the study. In order to accelerate decarbonisation of ports it is necessary to reduce the values of X & Y and increase Z. The study shows that the trends of X & Y is decreasing and Z is increasing for the past decade. This implies that the overall efficiency of the selected ports shows an increasing trend resulting in decreasing trend of carbon emissions in the past decade. Hence, ports may focus on further reducing the Pre-berthing Detention Time and Turn Round Time while at the same time increasing the Output per ship-berth-day in order to reduce the carbon emissions.

Literature Review:

The carbon emissions reduction and control is possible on increasing the operational efficiency.(Winnes et al., 2015). Another study indicates that by decreasing the speed of the ship and by providing onshore power supply the Co_2 emissions have reduced. (Tai & Chang, 2022) Keelung, Taichung, Taipei, Hualien, Anping, and Suao.

Further there exists a correlation between carbon emissions and the infrastructure of the ports and timely upgrade of infrastructure would mitigate the emissions. (Barberi et al., 2021).

In a different study a standardized method calculate the emission pollutions from the ports was proposed to help create a benchmark for analysing and comparing the pollution caused by each port.(Azarkamand et al., 2020). The alternative fuels such as biodiesel and retrofitting the electrical equipment can reduce the carbon footprint. (Misra et al., 2017). It is observed that large vessels are responsible for 92% of GHG emissions. Moreover 84% of the emissions are at cruise mode of the ship, which is highest.

The study estimates the environmental cost of ports at 6$ per ship.(TOKUŞLU, 2022). In one study it is concluded that 69% of the emissions were during berthing, which is highest. (Budiyanto et al., 2022). The multi layered bottom-up methodology is proposed to estimate the emissions.(Bojić et al., 2022). The emissions from the port of Valencia were studied and it is concluded that the container and cruise ship traffic contribute highest around 40% of the GHG emissions of the port. The electricity consumed in lighting of the port buildings are next to follow.(Ballester et al., 2020). Another study concludes that the large bulk carriers are the most energy efficient than other types of ships when life-cycle carbon footprint is considered(Zhang et al., 2022)

Methodology

4. Data Analysis & Interpretation:

For the purpose of analysis, secondary data from the website of Ministry of Ports, Shipping & Waterways was used.

Average Pre-Berthing Detention Time:

Average Pre-Berthing detention time is an important index to measure the efficiency of a port. When a vessel spends significant time in the outer anchorage one can infer that the efficiency of the port alone is not jeopardized but also the vessel is burning the fossil fuel. A vessel which is directly berthed in the port without detaining in the outer anchorage can be construed as less carbon emitting vessel operation. The following graphs shows the decreasing trend of Average Pre-Berthing Detention Time of all 6 Major Ports in the Eastern Coast of India over the last decade.

Table 4.1 Average Pre-Berthing Detention time (in Days)

	KPL	Chennai Port	VoC Port	Kolkata Port	Paradip Port	Vizag Port	Average Pre-Berthing Detention Time of all ports
2011-12	0.76	1.16	1.91	3.31	3.69	2.84	2.28
2012-13	1.33	0.8	1.31	2.9	1.65	2.5	1.75
2013-14	2.38	0.41	1.19	2.77	1.94	1.84	1.76
2014-15	2.51	0.41	1.07	2.14	4.11	2.59	2.14
2015-16	4.73	0.44	1.33	1.16	2.05	1.47	1.86
2016-17	0.96	0.38	1.8	3.06	2.47	1.22	1.65
2017-18	0.57	0.86	1.13	3.77	0.87	2.37	1.60
2018-19	0.18	0.15	0.68	3.18	0.3	1.29	0.96
2019-20	0.12	0	0.65	3.66	0.64	0.05	0.85
2020-21	0.08	0	0.5	3.22	0.26	0.05	0.69
10-Year Average Pre-Berthing Detention Time	1.362	0.461	1.157	2.917	1.798	1.622	**1.55**
Rank	3	1	2	6	5	4	

Source: Basic Port Statistics, MoPSW, GoI

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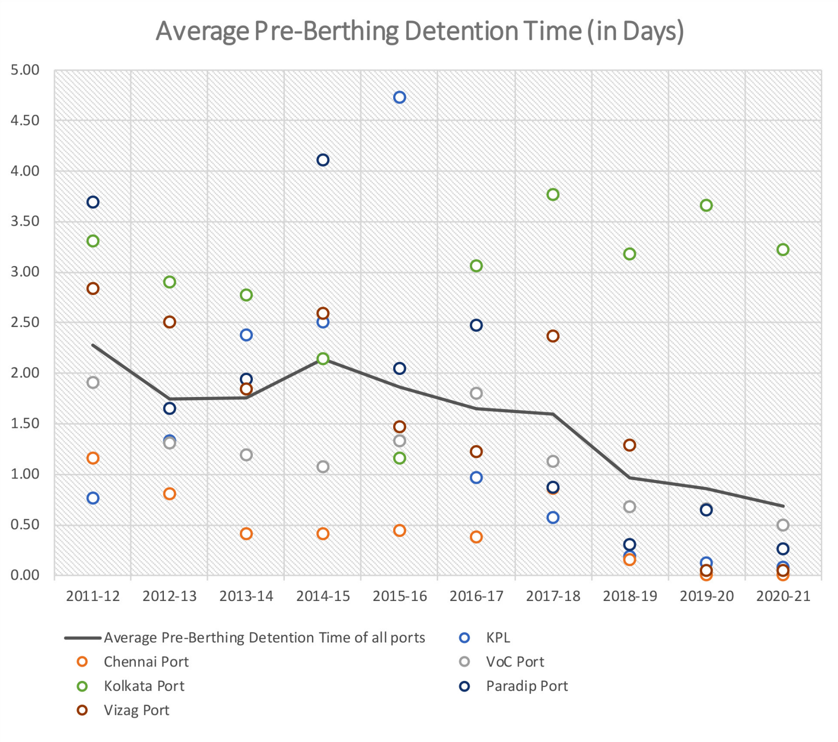
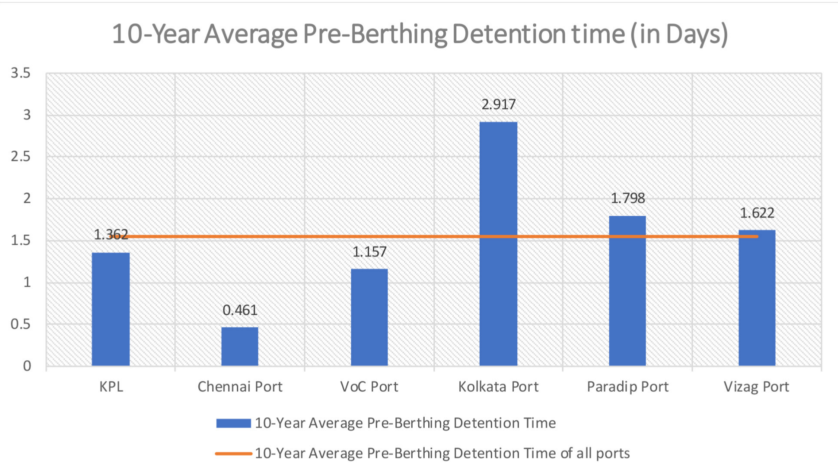




While it is encouraging to know that there is a decreasing trend of Average Pre-Berthing Time over the last decade, it also shows that some of the ports are lagging far behind this average and hence need to reduce their pre-berthing detention time.

The following graph indicates which ports are performing better than the average and which ports need course correction.

"While it is encouraging to know that there is a decreasing trend of Average Pre-Berthing Time over the last decade, it also shows that some of the ports are lagging far behind this average and hence need to reduce their pre-berthing detention time"

The 10-Year Average Pre-berthing Detention Time of all the ports combined is 1.55 Days. However, from the above table it is clear that some of the ports are performing way better than the average while others are lagging behind. The Chennai port has the least 10-year average pre-berthing detention time. In fact, it has been 0 days for the years 2019-20 & 2020-21. On the other hand, Kolkata port has the highest 10-year average pre-berthing detention time, which is nearly double the combined average of all ports.

Average Turn Round Time:

The average Turn Round Time is an important parameter to measure, how fast the vessel is getting serviced in the port, in other words the time the vessel reaching the outer anchorage towed into the berth getting serviced and then returned time to the outer anchorage is termed as Turn Round Time. When the average turn round time is less it means the efficiency of the port is better and the vessel emits less Co_2 The Kolkata port had the highest Average TRT of 9.9 days in the financial year 2016 while the VoC port had the beast Average TRT of 1.67 days in the year 2019-20.

The following graph shows the gradual decreasing trend of Average Turn Round Time of the Major ports on the eastern coast of India.

Overall trend of Average TRT is decreasing over the past decade. In the beginning of the last decade the Average TRT of all the Major Ports on the eastern coast is 5.35 days. This has reduced by half to 2.64 days by the financial year 2020-21.

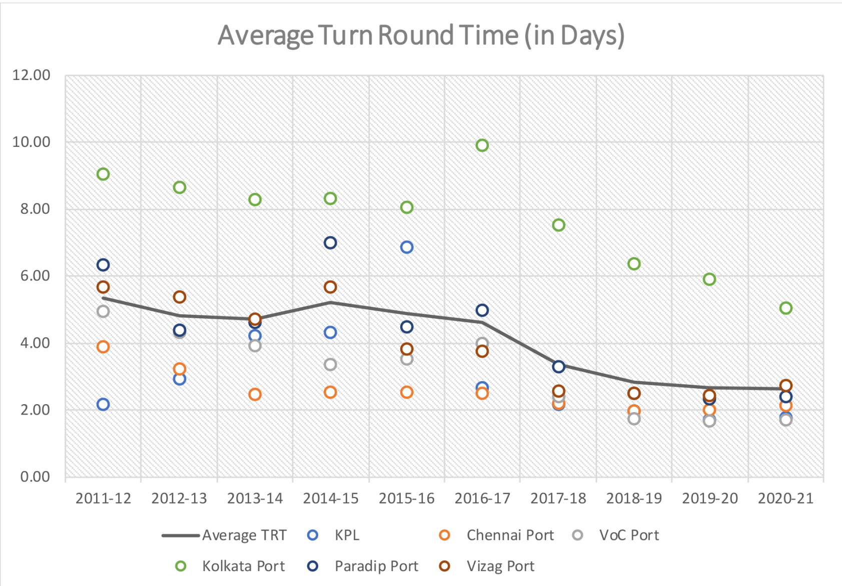
The following graph shows best and worst performers in terms of Average TRT in the last decade.

Referring the above table, the 10-Year Average TRT of all ports combined is 4.12 days. During the last decade Chennai Port has the least 10-Year Average TRT of just 2.55 days followed by KPL having Average TRT of 3.09 days. While Kolkata port and Paradip Port has been the poor

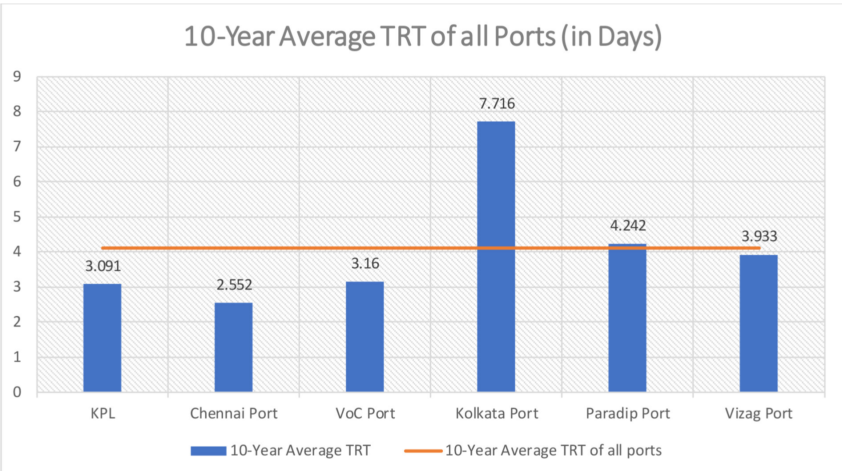
Table 4.2. Average Turn Round Time (in Days)

	KPL	Chennai Port	VoC Port	Kolkata Port	Paradip Port	Vizag Port	Average TRT of all ports
2011-12	2.17	3.91	4.94	9.07	6.33	5.68	5.35
2012-13	2.95	3.24	4.31	8.67	4.39	5.39	4.83
2013-14	4.24	2.46	3.92	8.28	4.62	4.73	4.71
2014-15	4.32	2.54	3.37	8.33	7.01	5.67	5.21
2015-16	6.87	2.53	3.53	8.05	4.5	3.84	4.89
2016-17	2.68	2.51	4	9.9	4.99	3.75	4.64
2017-18	2.19	2.21	2.4	7.52	3.31	2.58	3.37
2018-19	1.97	1.98	1.76	6.38	2.51	2.51	2.85
2019-20	1.73	2	1.67	5.92	2.34	2.43	2.68
2020-21	1.79	2.14	1.7	5.04	2.42	2.75	2.64
10-Years Average TRT	3.091	2.552	3.16	7.716	4.242	3.933	**4.12**
Rank	2	1	3	6	5	4	

Source: Basic Port Statistics, MoPSW, GoI



When the average turn round time is less it means the efficiency of the port is better and the vessel emits less Co_2



performers having 7.72 days and 4.24 days as 10-Year Average TRT.

Average Output per Ship Berth Day:

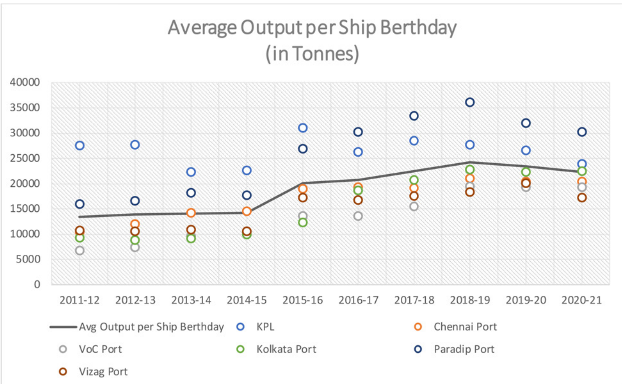
Source: Basic Port Statistics, MoPSW, GoI

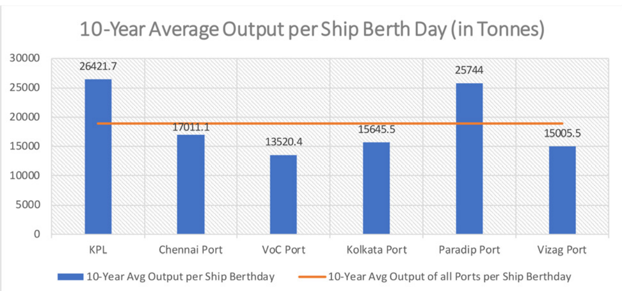
The average output per ship-berth day is an amount of goods transacted per ship berthed per day which is a significant measure to study the efficiency of the port operations. **When the average output per ship berth day is higher the efficiency of the port operations is greater.** The port with greater operational efficiency emits less carbon which makes the port eco-friendly. The data in the **Table 4.3** shows KPL has

Table 4.3 Average Output per Ship-berth-day (in Tonnes)

	KPL	Chennai Port	VoC Port	Kolkata Port	Paradip Port	Vizag Port	Avg Output per Ship Berth Day of all ports
2011-12	27505	10352	6733	9231	15995	10704	13420
2012-13	27741	12046	7452	8840	16625	10641	13891
2013-14	22357	14268	9633	9093	18179	10925	14076
2014-15	22613	14464	10468	9886	17736	10640	14301
2015-16	31106	18976	13619	12327	26965	17179	20029
2016-17	26235	19220	13612	18617	30245	16823	20792
2017-18	28456	19113	15557	20794	33440	17592	22492
2018-19	27678	21001	19494	22848	36030	18281	24222
2019-20	26581	20340	19334	22366	32001	20032	23442
2020-21	23945	20331	19302	22453	30224	17238	22249
10-Year Avg Output per Ship-Berth Day	26421.7	17011.1	13520.4	15645.5	25744	15005.5	**18891**
Rank	1	3	6	4	2	5	

Source: Basic Port Statistics, MoPSW, GoI





been consistently performing in terms of Average Output per Ship Berth Day followed by Paradip Port in the last decade.

The following graph shows an increasing trend of Average Output per Ship Berth Day for all Major ports in the eastern coast of India.

It is evident from the graph that the Average Output per Ship Berth Day has been increasing in the past decade. The value peaked in the year 2018-19 with 24,222 tonnes. However, it fell consecutively for the next couple of years.

The following graph indicates the performance of all the ports in terms of Average Output per Ship Berth Day for the decade.

The 10-Year Average Output per Ship Berth Day for all the ports combined is 18891 tonnes. The above graph shows that KPL is the best performing port in terms of average output per ship berth day transacting on an average 26,421.7 tonnes of cargo per ship berth day followed closely by Paradip port with 25,744 tonnes of cargo transactions per ship berth day. The cargo transaction of the rest of the ports are below the overall average output per ship berth day.

Rank Correlation:

The formula applied:

$$r = 1 - \frac{6\sum Di^2}{N(N^2 - 1)}$$

where $D_1^2 = (R_1 - R_2)^{2;}$ $D_2^2 = (R_3 - R_1)^2$

N = No., of Ports

$$r_1 = 1 - \frac{6\sum D1^2}{N\left(N^2 - 1\right)}$$

$$= 1 - \frac{6 * 2}{6(6^2 - 1)}$$

$$r_1 = 0.94$$

Similarly, $r_2 = -0.09$

The ten years Average of Pre-Berthing Detention Time, Turn Round Time, Output per Ship Berth Day were rank for each port and spearman's rank correlation formula is

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Table 4.5. Rank Correlation

	Average Pre-Berthing Detention time (in Days) (R1)	Average Turn Round Time (in Days) (R2)	Average Output per Ship-berth-day (in Tonnes) (R3)
KPL	3	2	1
Chennai Port	1	1	3
VOC Port	2	3	6
Kolkata Port	6	6	4
Paradip port	5	5	2
Vizag Port	4	4	5

applied to check the relation between the above variables. The result shows that the Average Pre-Berthing Detention Time and Average Turn Round Time have a strong positive correlation and Average Output per Ship Berth Day and Average Pre-Berthing Detention time have a weak negative correlation.

Conclusion:

Decarbonisation of ports is significant step forward in limiting the average global temperature below 2° C above the pre-industrial levels. Burning of fossil fuels in the ship contributes the most for carbon emissions from the ports. The author assumes that the Average Pre-Berthing Detention Time, Average Turn Round Time and Average Output per Ship Berthing not only shows the operational efficiency but also indicates the level of carbon emissions from the ports. The analysis show that the Average Pre-Berthing Detention time and Average Turn Round Time are decreasing over the past decade while the Average Output per ship Berth Day has seen an increasing trend in the same period. Hence, there is an overall decline in the carbon emissions from the ports in the last decade. However, the major ports are required to implement various measures to achieve the carbon emission reduction targets of the Indian government. Shore based electricity is one such measure which can result in significant reduction in carbon emissions from the ports as well as ships. The ports can also generate electricity from renewable sources like the solar energy, wind energy or tidal energy.

[This paper was presented at the CC Marpol Conference, February 2024]

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TECHNICAL NOTES

Navigating the High Seas: Occupational Therapy Strategies for Managing Stress and Improving Well-being among Marine Seafarers – Part 1

(Supporting Seafarers' Mental Health in the Demanding World of Maritime Work)

Neha Jain, Yash Jain

Introduction

Overview of Maritime Industry

The maritime industry is one of the oldest and most important industries in the world. It plays a crucial role in the global economy by facilitating the transportation of goods and people across the world's oceans. The industry encompasses a broad range of activities, including shipping, fishing, offshore oil and gas exploration and marine tourism.

Shipping is the backbone of the maritime industry and is responsible for the vast majority of its economic activity. Ships are used to transport a wide variety of goods, including raw materials, finished products, and consumer goods. The industry is also a major employer, with millions of people working in various maritime occupations, including seafarers, engineers, port workers, and shipping agents.

The importance of the maritime industry is reflected in its global reach and the large number of countries that rely on it for their economic well-being. Many countries, particularly those that are geographically isolated, rely heavily on shipping to import and export goods. In addition, the industry is a vital source of foreign exchange earnings for many developing countries.

Despite its importance, the maritime industry faces a number of challenges. These include changing market conditions, environmental concerns, and increasing competition from other forms of transportation, such as air and rail. In addition, the industry is facing a growing shortage of skilled workers, particularly in technical and engineering roles.

Given the complex nature of the maritime industry and the challenges it faces, it is important to have effective strategies in place to support the well-being of its workforce. Occupational therapy is one such strategy that can help to mitigate the challenges faced by seafarers and other maritime workers. By providing targeted interventions and support, occupational therapists can help to promote the mental and physical health of seafarers and ensure that they are able to perform their jobs safely and effectively.

These challenges include extended periods of isolation, physical and mental fatigue, separation from family and loved ones, and limited access to mental health resources while at sea

Importance of Seafarers' Well-Being

The maritime industry plays a critical role in global trade, with over 80% of the world's goods transported by sea. Marine seafarers are the backbone of this industry, working long hours in demanding and often dangerous conditions to keep goods moving across the world's oceans.

Despite the essential role they play, seafarers often face significant challenges that can impact their mental health and well-being. These challenges include extended periods of isolation, physical and mental fatigue, separation from family and loved ones, and limited access to mental health resources while at sea.

The well-being of seafarers is therefore of paramount importance. It not only affects their personal health and happiness but also has a direct impact on the safety and productivity of the ships they work on. Seafarers who are struggling with mental health issues or stress are more likely to make mistakes or have accidents, which can be dangerous for themselves and others on board.

Furthermore, the COVID-19 pandemic has highlighted the importance of seafarers' well-being, with thousands of seafarers stranded on board ships due to travel restrictions and border closures. Many seafarers have been unable to return home to their families for months on end, leading to increased stress, anxiety, and depression.

Given the crucial role that seafarers play in the global economy, it is essential to prioritise their well-being and ensure that they have access to the resources they need to maintain good mental health while at sea. This is where occupational therapy comes in. Occupational therapists can play a vital role in supporting seafarers' mental health and well-being, by providing interventions, strategies, and resources that can help them manage stress and maintain good mental health.

The following chapters will explore the challenges faced by seafarers, the role of occupational therapy in the maritime industry, and the interventions and strategies that can be used to support seafarers' mental health and well-being. By prioritising seafarers' well-being, we can ensure that they continue to play a crucial role in global trade while maintaining their physical and mental health. [1][2][3][4][5]

Introduction to the Role of Occupational Therapy in the Maritime Industry

The maritime industry is an essential part of global trade, transportation and commerce. It is also a unique industry that poses distinct challenges to the mental health and well-being of its workers, particularly seafarers who spend long periods away from their families and loved ones. In recent years, there has been increasing recognition of the importance of seafarers' mental health and the need to provide them with adequate support and resources. Occupational therapy is one profession that has an important role to play in promoting the well-being of seafarers.

Occupational therapy is a healthcare profession that focuses on helping people to engage in meaningful activities, or occupations, which are important to

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> *Occupational therapy interventions may include counselling, activity analysis and modification and environmental modifications, among others*

them. The goal of occupational therapy is to help people achieve their highest level of independence and quality of life. Occupational therapists work with individuals to identify their strengths and challenges and to develop strategies to overcome barriers and achieve their goals. Occupational therapy interventions may include counselling, activity analysis and modification and environmental modifications, among others.

In the maritime industry, occupational therapy can play a critical role in supporting seafarers' mental health and well-being. Seafarers face a range of challenges that can impact their mental health, including long periods of isolation and loneliness, exposure to harsh weather conditions and high-stress work environments. Occupational therapists can work with seafarers to develop strategies to manage these challenges, such as providing education on stress management techniques, creating opportunities for social interaction and recreation and advocating for improvements in working conditions.

Occupational therapy can also be instrumental in helping seafarers to transition back to life onshore after extended periods at sea. This can be a challenging and stressful process, as seafarers may have difficulty adjusting to changes in their environment, relationships and daily routines. Occupational therapists can work with seafarers to develop coping strategies and provide support during this transition.

Overall, the role of occupational therapy in the maritime industry is an important and growing area of focus. As awareness of seafarers' mental health and well-being continues to grow, occupational therapy can be an effective and valuable resource for promoting the health and safety of seafarers and supporting the continued success of the maritime industry.

Introduction to Occupational Therapy and the Maritime Industry

Some key occupational therapy interventions used in the maritime industry include:

Cognitive-behavioural therapy (CBT) - a type of therapy that helps individuals to identify and change negative thought patterns and behaviours that contribute to mental health issues

Mindfulness-based interventions - these interventions involve practices such as meditation and breathing exercises to promote relaxation and reduce stress

Psychoeducation - this involves providing information and resources to seafarers about mental health and well-being, as well as strategies for managing stress and other mental health concerns. [6][7]

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Augmented Reality in Marine Machine Training

Dheeraj Kumar Devaraj,
Jayesh Chandrapurakkal Sasi,
Sharon Mathew George

ABSTRACT: Due to lack of knowledge and development, seafarers often cause operation faults and equipment damage while on sail which causes cargo delay and financial loss. The high dependence on machine manual for the operation and maintenance has caused confusion and bypass of right procedure. Augmented Reality is one of the modern solutions for this case as it is used to substitute paper manuals with digital instructions which are overlaid on the manufacturing operator's field of view. Virtual manuals help manufacturers adapt to rapidly changing product designs, as digital instructions are more easily edited and distributed compared to physical manuals.

KEYWORDS: Maintenance, Operation, Safety, Manual

1. INTRODUCTION

Machine operation and maintenance has seen a drastic change in the following years. However, we see that due to lack of knowledge and development, seafarers often cause operation faults and equipment damage while on sail which causes cargo delay and financial loss. The long tradition of highly dependence on machine manual for the operation and maintenance has caused confusion and bypass of right procedure by seafarers. As autonomous ships are slowly being introduced into the industry, number of manning individuals are reduced in those ships. Companies feel reluctant to spend their resources for training purpose. Also, seafarers find its time consuming and frustrating to train new cadets. So, introduction of new technologies is highly demandable in this scenario.

Augmented Reality (AR) is one of the effective solutions for this case as it provides a wide variety of problem solving. Using AR an engineer can get accurate information about a marine equipment and a clear understanding of its operation, components, maintenance through a 3-Dimensional portrayal of the component in an Augmented Space through an AR device (smartphone, AR glasses, tablets). This 3D projection can either be static or an interactive 3D projection. It's a very user friendly, error proof, exciting and valuable innovation that can be bought into the marine field.

AR is used to substitute paper manuals with digital instructions which are overlaid on the manufacturing operator's field of view, reducing mental effort required to operate. AR makes machine maintenance efficient because it gives operators direct access to a machine's maintenance history. Virtual manuals help manufacturers adapt to rapidly changing product designs, as digital instructions are more easily edited and distributed compared to physical manuals. Digital instructions increase operator safety by removing the need for operators to look at a screen or manual away from the working area, which can be hazardous. Instead, the instructions are overlaid on the working area. The use of

Companies feel reluctant to spend their resources for training purpose. Also, seafarers find its time consuming and frustrating to train new cadets

> ***AR is used to substitute paper manuals with digital instructions which are overlaid on the manufacturing operator's field of view, reducing mental effort required to operate***

AR can increase operators' feeling of safety when working near high-load industrial machinery by giving operators additional information on a machine's status and safety functions, as well as hazardous areas of the workspace.

AR can be programmed to project the machinery or component by the manufacturer as per the model used in the ship. The manufacturer can input the details and correct procedures into the AR platform as per the requirement. Each machinery or component can be provided with an AR facility to understand it in a better way. The engineer can use the AR projection to carry out maintenance and operation with ease. AR can be easily used through the engineer's phone or the owner provided AR smart device.

2. MAIN WORK

2.1 APPROACH TO THE ISSUE

According to the Maritime Transportation Research Board of the USA, human error in the maritime domain is "the commission or omission of acts by maritime personnel that cause or contribute to merchant marine casualties or near-casualties" (NAS, 1976). In addition, Lu (20012) remind us that "shipping is one of the riskiest service industries. Although shipping companies attempt to assure work safety, they are not completely successful in eliminating human failures". All crews and shipping companies in the world are aware of the influence of the human element in accidents. In 1976, a research board in the U.K. concluded that human error was the cause of 80% of accidents (Guglielmo's, 1997). Ever since, most of the published studies on maritime accidents have found that maritime accidents are caused mainly by human errors (Berg et al., 2013a).

In marine accidents, society tends to make an assessment quickly in order to find a scapegoat. In many cases, the Master and the crew are the target of criticism before the investigation starts (Sánchez-Beaskoetxea and Coca, 2015). Human factors are involved in many cases, but the crew is not always to blame. In recent decades, many researchers have published papers on the causes of maritime accidents, focusing both on technical failures and on the errors of the people working on board ships (crew, pilots, on-shore personnel, inspectors, etc.).

Several of these studies found that in many accidents human error was the main cause or an important factor. We can highlight some of them as an example: "Of a total of 880 accidents analysed during the investigations between 2011 and 2015, 62% were attributed to erroneous human action" (EMSA 2016), "Over 80% of marine accidents are caused or influenced by human and organization factors" The high dependence on machine manual for the operation and maintenance has caused confusion and bypassing of correct procedures. From many case studies it can be found that cadets as well as other seafarers find it confusing or difficult to understand a machine manual properly which leads to at times a lot of confusion and wrong working space. A case study of this can be seen below.

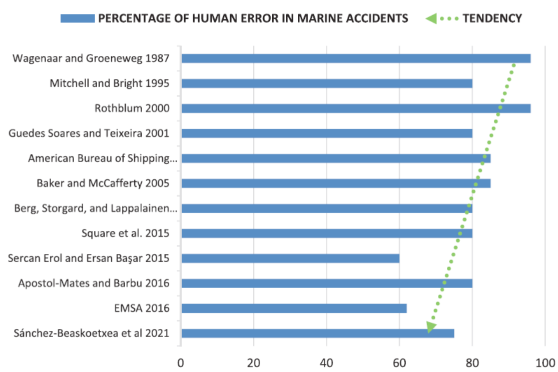

Fig. 1. Percentage of human error in marine accidents according to several authors.

Figure.1. Percentage of Human Error in Marine Accidents
Source: https://www.sciencedirect.com/science/article/pii/S2666822X21000083

Types of human errors among the crew on cargo and passenger ships.

TYPES OF HUMAN ERROR AMONG THE CREW ON CARGO & PASSENGER SHIPS (44 ships)

GROUP	*N°*	*ERROR*	*Q*	*% cases*
A (Physical problems)	1	Physical problems due to marine environment (storms, cold, etc.)	1	50.00%
	2	Fatigue due to lack of sleep / Physical problems	1	50.00%
	3	Fatigue due to excessive workload	0	0.00%
		TOTAL GROUP A:	2	4.55%
B (Damaging substances)	4	Adverse reaction to medication	1	50.00%
	5	Alcohol	0	0.00%
	6	Drugs	1	50.00%
		TOTAL GROUP B:	2	4.55%
C (Communication error)	7	Failure to communicate among crew members (misunderstanding, inappropriately expressed orders, language. ...)	4	19.05%
	8	Failure to communicate with the pilot (language, etc.)	10	47.62%
	9	Communication error among crew members due to personal problems	0	0.00%
	10	Communication error with other ships	6	28.57%
	11	Communication error with ground personnel	1	4.76%
		TOTAL GROUP C:	21	47.73%
D (Distractions)	12	Distraction during the watch caused by performing several tasks at the same time	1	16.67%
	13	Distraction during the watch caused by non-work tasks (telephone, etc.)	2	33.33%
	14	Lack of proper monitoring of navigation	3	50.00%
		TOTAL GROUP D:	6	13.64%
E (Navigation error)	15	Navigation error due to misjudgement	12	30.77%
	16	Navigation error due to poor technical training or inexperience	7	17.95%
	17	Navigation error due to overconfidence	10	25.64%
	18	Navigation error due to misuse of vessel equipment	10	25.64%
		TOTAL GROUP E:	39	88.64%
F (Inadequate planning)	19	Lack of trip planning or maneuver planning	12	70.59%
	20	Failure to follow trip plan or maneuver plan	0	0.00%
	21	Not following the procedures	5	29.41%
		TOTAL GROUP F:	17	36.96%
G (Lack of training)	22	Ignorance of the procedures	2	40.00%
	23	Ignorance of the use of ship equipment	1	20.00%
	24	Ignorance of regulations	2	40.00%
	25	Ignorance of working language	0	0.00%
		TOTAL GROUP G:	5	11.36%
H (Lack of leadership)	26	Error in the exercise of command	3	100.00%
		TOTAL GROUP H:	3	6.52%
I (Maintenance)	27	Poor maintenance of the ship known by crew	3	100.00%
	28	Failure to take adequate corrective measures against a known mechanical failure	0	0.00%
		TOTAL GROUP I:	3	6.82%
J (Fear)	29	Fear	0	0.00%
		TOTAL GROUP J:	0	0.00%

Figure.2. Types of Human Errors on Board
Source: https://www.sciencedirect.com/science/article/pii/S2666822X21000083

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According to the Maritime Transportation Research Board of the USA, human error in the maritime domain is "the commission or omission of acts by maritime personnel that cause or contribute to merchant marine casualties or near-casualties" (NAS, 1976)

2.2 AUGMENTED REALITY

Augmented reality (AR) is an emerging Human Computer Interaction (HCI) technology that renders virtual information on a real scene. **An AR system is formally defined as an application that fulfils the following three properties, namely, (a) able to blend real and virtual content in a real environment, (b) is real time and interactive, and (c) can register virtual content in 3D environment.** Typical AR application consists of five modules, namely, registration, tracking, rendering, interaction, and content generation. In short, computer-generated information, such as annotations, graphics and 3D models, should be rendered and registered on the real scene with accurate tracking and alignment, followed by user-friendly interaction modes, such as gesture-based input, speech input or with the help of external input devices, such as data gloves, ray casting using mouse, etc. Lastly, relevant content in response to specific request or task should be generated and displayed to the users.

2.3 RELATED AR APPLICATIONS

In the modern world AR is already in use in many industries even in transportation & logistics such as on land and air. Transportation systems and fleets are becoming more complex, and the need for longer service life is increasing, making transportation planning challenging. But experts with the required skills to maintain vehicles are becoming scare due to an aging workforce. When experts retire, their expertise is lost forever. Manifest helps capture this knowledge, before it is too late, to standardise and digitise even the most complex procedures. Knowledge is transferred seamlessly providing the needed competency, consistency and agility to address the growing workforce skills gap and the increasing complexity and diversity of fleets and transportation services.

2.4 AR GUIDANCE

AR applications involve different kinds of augmentation including visual augmentation, audio and haptic feedback, etc. In the proposed framework, visual augmentation is applied. Generally, there are two types of visual information, namely, static information (general and prompts) and dynamic information (guiding scene and instructions). Particularly, static information can be pre-defined beforehand while dynamic information requires constant update during the disassembly process according to the disassembly sequence generated earlier. Given the disassembly sequence and product information,

Machine Manual	AR Interface
Misinterpretation of procedure due to less visualisation	Proper Maintenance and Operation process and machine data is shown to the user leaving no space for misinterpretation
Difficult way of identifying new and complicated machine data	The data can be made easy for understanding for any machine irrelevant of its complicity or newness
Cannot be updated	Can be updated as needed for renewal or upgradation
Requires a senior operative to explain the manual to a cadet	The ease of understanding can help the cadet to understand all the required info without any external help
Complicated machineries are hard to operate or maintain using the manual only	Most part of the data is easy to interpret but in case there is any doubt the user can get more detailed explanation or view through the AR software itself
Understanding the process through words and diagrams are very traditional and not innovative	A virtual elaboration is very innovative and interesting and instigates curiosity and deep learning
Time required is more for the understanding the whole manual	Proper Time Management due to ease of understanding
Each machinery requires a separate manual	All data, visuals, procedures, projections can be accessed from a single AR smart device
To find a about a part of the machine the user has to go through most of the manual	Any section that is required can be easily selected out from the AR depiction

Figure.3. Machine manual vs AR Interface


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'THE GOD CONCEPT'
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> *From many case studies it can be found that cadets as well as other seafarers find it confusing or difficult to understand a machine manual properly which leads to at times a lot of confusion and wrong working space*

a series of disassembly tasks can be identified, which consists of an action and direction, and linked to the corresponding visual cues, such as arrows or 3D models for AR visualisation and guidance. Augmented work instructions and 3D models are used to virtually train, increasing safety and eliminating the need to schedule equipment downtime, improving maintenance and operations for transportation companies

2.5 IMPROVEMENTS

2.6 METHODOLOGY

Problem Statement:

From the study carried out we found that due to emerging technologies, requirement of less operating personals and reliability on traditional manuals the training process onboard has become rushed and not taken into serious consideration, hence there is a huge number of accidents that follows with it. It has become a situation where new means for training should be sought out. AR is a wonderful solution to it.

Designing a 3D model:

For the trail we chose the design of a Gate Valve. It is a common type of valve found aboard on all types of ships. It is used to connect many machineries aboard. Gate valves are made of several parts: Body, Wedge, Cover, Seats, Stem, Gland Flange, Stuffing Box, Hand wheel, Gear box & Square drive nut.

The design was made in AutoCAD Fusion 360.

Selecting AR Platform:

One of the best applications we found free to use here is UniteAR, which can be used in many smart devices. UniteAR is a cutting-edge no-code AR SaaS platform that enables users to effortlessly build WebAR plugins, branded AR apps, and immersive experiences without any coding expertise. It empowers businesses to elevate their brands. No commercial licensing is required. Completely online and DIY platform, with 100% design friendly AR

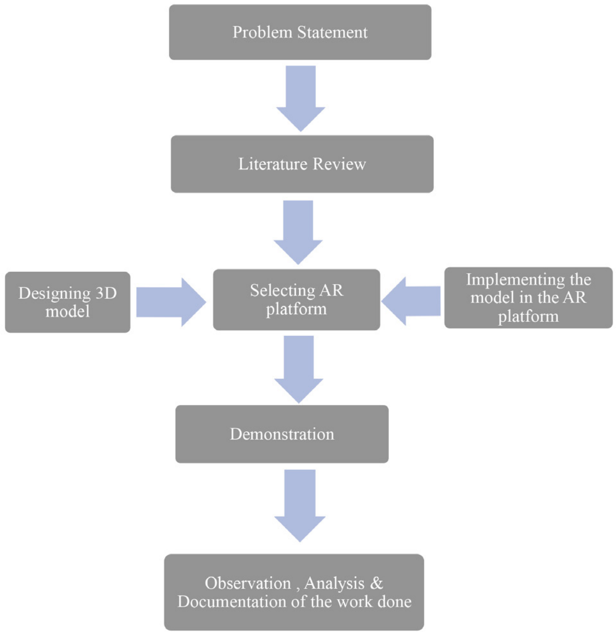

Figure.4. Gate Valve
Source: Great Eastern Institute of Maritime Studies, Lonavala

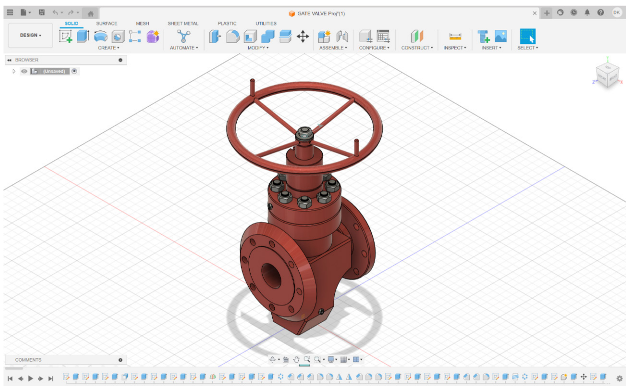

Figure.5. Design of Gate Valve

> *Typical AR application consists of five modules, namely, registration, tracking, rendering, interaction, and content generation*

creator. You can create white labelled AR Apps, WebAR scanners and AR experiences.

UniteAR's features include:

- Image detection and tracking: Create image-based AR experience by uploading your 2D images to the editor, and upload any types of digital contents like 3D models, Video, 360-degree contents, GIF, Call to action buttons, and Audio.
- Image detection with QR: Allows the user to create AR experiences without regarding the quality of the image, an auto-generated QR code will be placed on the tracker image and then you can follow the process similar to image detection.
- WebAR with image detection: It allows the user to experience augmented reality with just a weblink. You can either load the link directly into your mobile web browser or scan the QR code to load the web link, and then the WebAR based scanner will be opened and scan the images which you have already created with the image-based editor.
- Ground plane tracking WebAR: It enables detection of the surface or ground plane such as floor, table top and similar surfaces to place the digital contents. (Supports only 3D model and Video, does not support multiple contents)

Implementing the model in the AR platform:

After the model of the Gate valve is designed it is uploaded into UniteAR Along with its information, maintenance and operation sequence. Then the correct project out sequence is programmed into the AR software. After all the information is set, we give an accurate target image for the app to project out the information.

2.7 DEMONSTRATION

2.8 IMPLEMENTING AR ONBOARD

The machine manufacturer provides an AR software and if required an AR Smart Device to the shipping company which is delivered to the crew. In case the AR Smart Device is not provided by the manufacturer the operator can install the AR software into their smartphone and use it as an input/output AR device. All the data of maintenance and operation of the machinery is programmed into the AR software by the manufacturer. The crew can easily

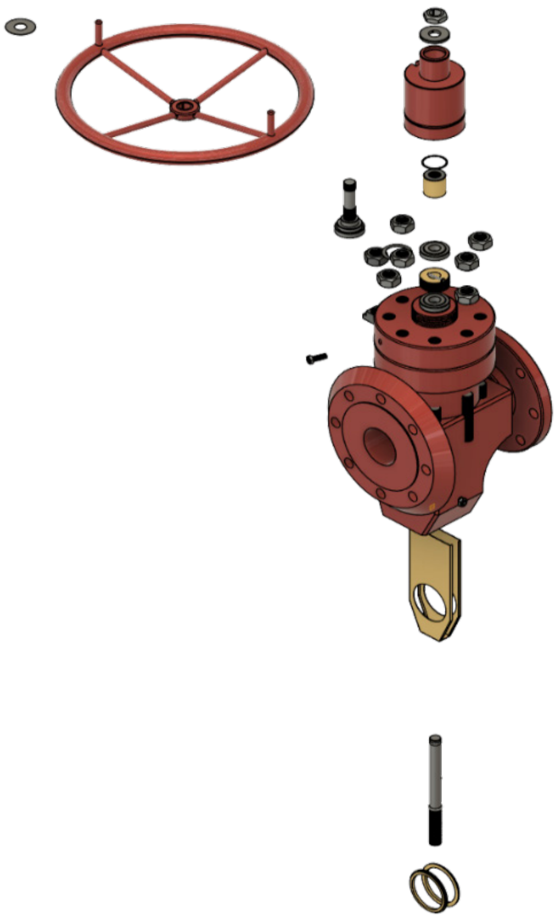

Figure.6. Disassembled view of Gate Valve

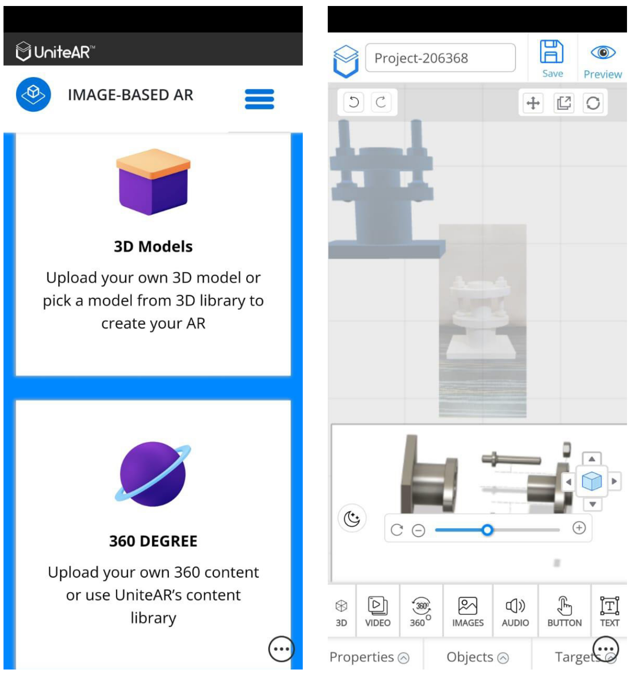

Figure.7. Implementing the model in the Unite AR

> *Given the disassembly sequence and product information, a series of disassembly tasks can be identified, which consists of an action and direction, and linked to the corresponding visual cues, such as arrows or 3D models for AR visualisation and guidance*

open the AR software in the AR device and afterwards scan the machinery or its component and get the visual data required through the AR projection inside the device with ease. Whether the seafarer needs a part of the machine knowledge or it as a whole, both can be provided as needed in the AR space.

The operator can further zoom into the details if any doubt arises in the AR space and understand what he/she requires. If at all the operator feels any change should be done to the AR visuals they can request to the manufacturer as required and the manufacturer can get it updated or fixed through a program update with ease.

3. CONCLUSION

An AR-guided operation & maintenance framework has been described in this paper. The main contribution of proposed framework is automatic content generation that translates a maintenance sequence into AR based instructions for the human operators. An efficient and error-free maintenance process will greatly benefit both the marine industry and the operators considering that it is an efficient tool in an operation cycle. Overall, the proposed framework is useful for this age of marine development in the field of operation & maintenance.

FUTURE SCOPE:

The next stage of marine machine training can be achieved through Mixed Reality (MR). Which is like an advance phase of AR which involves the same working but with a good interactive interface.

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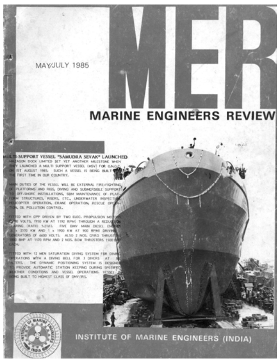
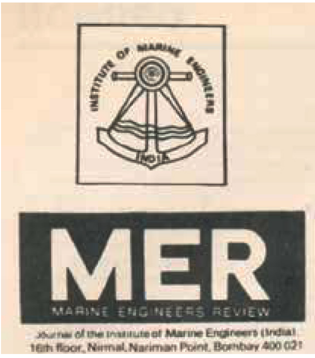
Going Astern into MER Archives…





We start with the Editorial penned by Shri. H.K. Taneja on robots. The premise is that robots are being fashioned emulating the humans which is not in consonance with requirements one may have for manufacturing. True. Robots have to be purpose based especially when it comes to manufacturing.

Basing the robots on humans should be seen from the perspective of nominal tasks performed by humans in normal everyday life. And we have reached frontiers in robotics, mirroring and mimicking humans. Shri. HKT is not amongst us now but MER Archives will feature our reflections on his Editorials.

The May 1985 issue has about 6 to 7 short articles/write-ups on fuels. Two of them are interesting, one on why Aluminium is not a reliable measure of abrasives and another article on how to optimise fuel consumption.

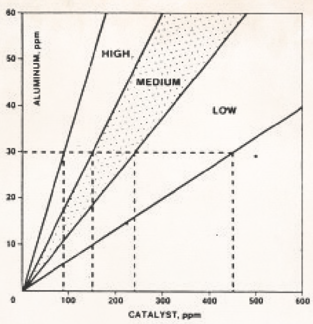
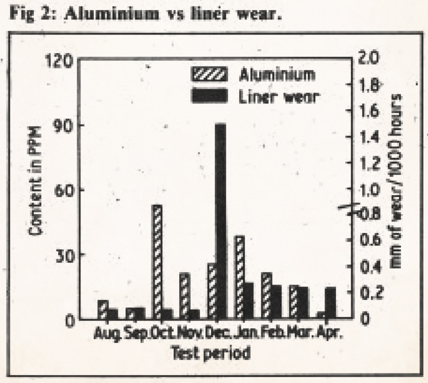


Fig 1: Aluminium vs catalyst ppM in fluid cracking catalyst.

Fig 2: Aluminium vs liner wear.



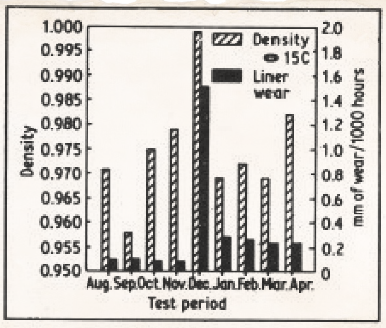


Fig 3: Fuel density vs liner wear.

The next one catching the attention is on the monitoring/assessing the underwater hull roughness. It would be interesting if any of the readers have done such measurements and planned the blasting/painting scheme for underwater hull areas.

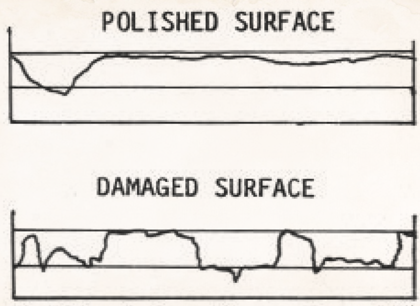
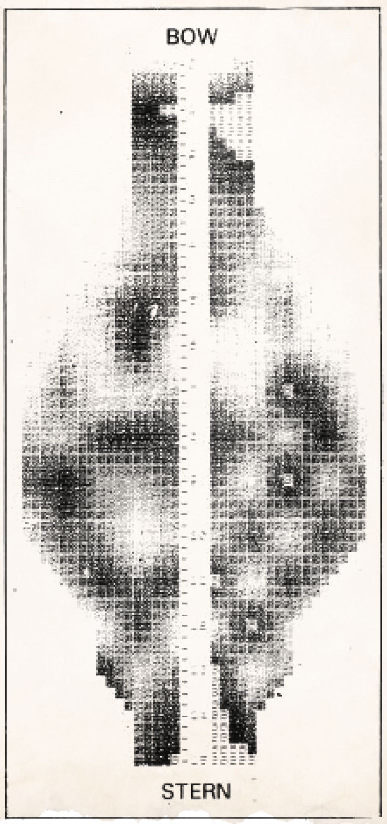


Fig 1: Example of two different surface profiles.

Fig 4: Variation in hull roughness on bottom port and starboard.



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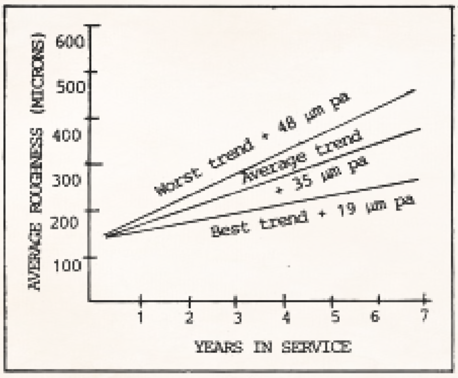


Fig 5: Hull roughness trends.

Year	No.	Gross tonnage
1970	1,037	10,099,965
1971	992	11,132,359
1972	885	12,857,119
1973	1,080	14,750,831
1974	1,045	16,894,017
1975	930	16,991,230
1976	912	15,867,828
1977	1,107	11,707,635
1978	1,046	6,307,155
1979	993	4,696,996
1980	943	6,094,142
1981	839	8,399,831
1982	800	8,162,915
1983	755	6,670,317
1984	902	9,711,381

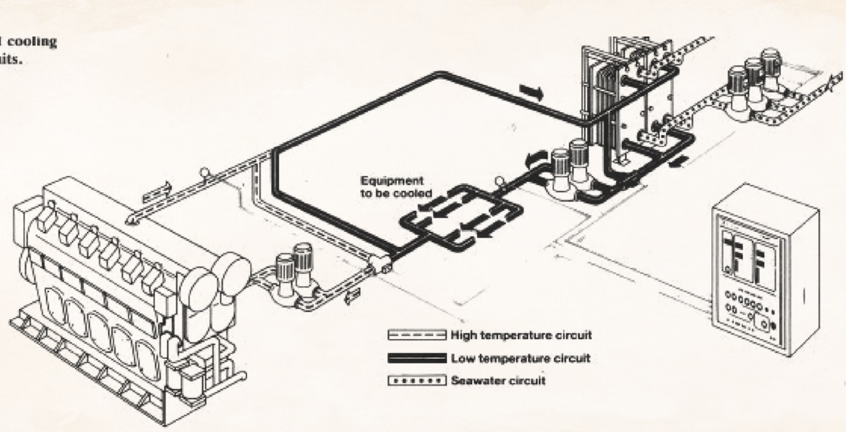
Table 1: Painting strategy—financial comparison*

	Self-Polishing Coating				*Conventional Paint*			
Month	*Microns*	*TPD*	*Miles*	*Fin Status*	*Microns*	*TPD*	*Miles*	*Fin Status*
0	130	28·71	0	– 115 735	130	28·71	0	– 96 813
6	127	28·63	39 600	– 48 296	137	28·87	39 600	– 31 493
12	125	28·57	79 200	15 264	145	29·04	79 200	28 876
18	122	28·50	118 800	76 939	152	29·21	118 800	84 677
24	120	28·44	158 400	136 198	160	29·37	158 400	136 259
Dry Docking								
30	127	28·63	198 000	154 793	190	29·97	198 000	147 431
36	125	28·57	237 600	207 391	200	30·16	237 600	187 643
42	122	28·50	277 200	257 928	210	30·34	277 200	224 447
48	120	28·44	316 800	306 486	220	30·51	316 800	258 123
Dry Docking								
54	127	28·63	356 400	315 194	252	31·05	356 400	253 629
60	125	28·57	396 000	358 293	265	31·25	396 000	279 166
66	122	28·50	435 600	399 704	277	31·44	435 600	302 217
72	120	28·44	475 200	430 492	290	31·62	475 200	322 998
Dry Docking								
78	127	28·63	514 800	457 888	322	32·08	514 800	307 306
84	125	28·57	554 400	493 204	335	32·24	554 400	322 590
90	122	28·50	594 000	527 136	347	32·41	594 000	336 251
96	120	28·44	633 600	559 739	360	32·57	633 600	348 429

*30 000 t disp tanker. Pre-gritblasting 575 µm, after gritblasting 130 µm, pre-gritblasting operating cost used as datum.

This is followed by another interesting write-up on electronic control of cooling water systems. The LT-HT circuits and optimising the flow through them helps. More experiences are welcome.

system and cooling water circuits.



There is more on the antifouling paints, and a very absorbing one page article on shipbuilding by Japan Foundation for Shipbuilding Advancement. POSTBAG has a couple of relatable-connectable problems (water filling in the cargo hold through topside tank overboard discharges which were left open; stern bush failure). There is one Transaction on ‘Storage and Handling of Coal for Coal-fired Ships’ for those with some academic interest in coal firing.

Close those discharges

Sir,
I would like to bring to the attention of those concerned with ships' safety the following incident.

A bulk carrier of 6000 t, with two holds, built only four years ago, had finished loading grain cargo at about midnight of a certain day last year.

The crew closed the hatches and went to bed, with the intention of sailing next morning. At about 05.00 h they were woken by shouts that the vessel was sinking. The hatches were quickly opened, the silos started unloading cargo and the bilge pumps were put into full operation.

An investigation revealed that there was nothing structurally abnormal, although the holds' sounding pipes showed presence of water.

It was later realised that the topside tank overboard discharges had been left open on arrival and in the loaded condition water started getting into these tanks (the valves were situated in line with the loaded waterline and were operable individually by hand from the weather deck).

The trimming holes at the bottom of the topside tanks were also left open, to facilitate the loading of grain.

The result obviously was progressive flooding of the holds, which fortunately, in this case, had no catastrophic results.

It is suggested that arrangements be devised by IMO and other authorities by which such an incident may never again occur in the future.

C Philippou

Piraeus

Naval Architects at sea

Sir,
Your opinion 'Must users study design?' yet again raises issues which seem to defy sensible resolution. Mr Protopapadakis, in his letter on Matrix Management in the December issue, made much the same point.

Seagoing training for naval architects is arguably essential rather than desirable. It is a necessary part of the naval architect's training, but what exactly would his function be aboard ship? Who pays him? It seems doubtful that vacation sea training, except in the home trade, is a practical proposition; the naval architect should do deep-sea service for at least a year, and preferably two, in more than one type of foreign-going ship.

The shipowner can hardly object to 'short-service commissions' if he gets useful work from men whose ultimate destiny is to design ships to which professional seamen can be attracted more readily than they are today.

I suggest that a naval architect, reaching the end of a sound training, with practical shipyard work behind him, would make as good an Assistant Watchkeeping Engineer as many fitters who have served their time in non-marine engineering, and there is little reason why he should not go to sea as a junior member of the ship's complement and be paid the going rate.

After studying naval architecture, I obtained positions onboard vessels. My inexpertise in handling a flogging hammer demanded some forbearance by my Chiefs, but a basic knowledge of ships and their systems amply bridged the gap and I earned ready acceptance as a Senior Watchkeeper.

If naval architects spent time at sea I think perhaps we would see a different perspective of the professional seafarer's 'right to be involved in all aspects of ship design.'

'Rights' are secondary to obligations and responsibilities—the responsible naval architect is surely obliged to acquaint himself with the functional aspects of the vessel he professes to design, and with the manner in which seamen live and work in the environment he has presumed to create. Only then will he earn the professional seafarer's recognition that he is a fully competent authority on the design of ships.

P G Martin

Co Clare, Ireland

Stern bush failure

Sir,
I wish to share my experience of a difficult repair job carried out on a Japanese-built tanker of about 60 000 t. She sailed from the Persian Gulf with a full load of oil for Japan.

The tanker was fitted with stern tube seals of a well-known make. The outer seal failed; oil leaked out and seawater leaked in.

The shaft was running in emulsified oil for sometime before the main engine was stopped and the problem investigated.

The problem was confirmed and the vessel was ordered to sail at reduced speed to Singapore. The cargo was then discharged and the tanks gas-freed. As no dry-dock was available the repairs were carried out at a jetty by trimming the tanker so that the propeller shaft was clear of the water.

Once the propeller was removed it was seen that the brass alloy stern bush had seized onto the tail shaft. All efforts to loosen it proved futile and the shaft could not be withdrawn. It had to be removed by cutting it into three sections. The forward bush was found to be in a satisfactory condition. The bush housing had become oval and was bored true by a boring bar. The stern bush was undercut, rebuilt by welding and machined to its proper diameter with an adequate margin for shrink fitting.

This bearing bush, more than 1.5 m long, was supposed to be remetalled centrifugally but, as there was no such facility available, it was remetalled by conventional means. The bonding of the white metal to the bush was checked ultrasonically but was found unsatisfactory on the first attempt. Fortunately an 80% bonding was achieved during the second attempt. To help fit this bush without damage, it was cooled by dry ice and fitted into place. The spare tailshaft was fitted in place after proper bedding of the taper in the propeller. All the seals were renewed.

These repairs were approved by the classification society. The dock and sea-trials proved satisfactory.

This tanker has now been sailing for many years without any further problem. No damage to white metal or bearing housing has been observed during subsequent surveys.

The failure occurred during the first loaded voyage after dry docking. She sailed through rough weather, and seal failure was observed immediately afterwards. We were fortunate that the bearing bushes were made of brass and could be rebuilt and machined, allowing the work to be completed within four weeks. We would have had to wait three months for delivery of a new one.

I J Varma

Satkar Maritime Services
Bombay.

Mechanical transmission of power

The above article, by R Dean, CEng, FIMarE, in the February 1985 issue, contained an omission in the reference to the maximum distance between shafting supports in relation to shaft diameter.

On page 8 under the subhead 'Alignment' in the third paragraph—'a bearing distance of 400 to 630 $\sqrt{\text{shaft dia}}$ has been recommended.' The $\sqrt{\ }$ should have been included.

Electromagnetic compatibility problems

Sir,
I would welcome any technical references or practical experience from readers on the estimation of contamination levels due to harmonics in power circuits, eg, thrusters up to 3MW, thyristor supplies, and in the estimation of the needed suppression and attenuation of radiated and conducted interference, including the shielding of power cables and the use of multiple grounding for screened high power cables run above deck level.

In the latter case the shielding fulfils two purposes: the prevention of cable-radiated magnetic and electric fields, and the reduction of conducted interference induced by the radiation from ship radio and radar transmitters.

R T E Carr

Automation & Microelectronics Dept
British Ship Research Association
Wallsend.

We invite observations, discussion threads from readers, taking cues from these sepia-soaked MER pages. – Hon.Ed.

IME (I) GOVERNING COUNCIL, BRANCH, AND CHAPTER COMMITTEE ELECTIONS 2025-27

As the elections for The Institute of Marine Engineers (India) approach, we wish to notify all Corporate Members of the following procedures:

SCHEDULE

Soft Copy of Nomination Papers:

- The entire election process will be communicated exclusively through electronic media.
- Nomination forms will be sent via mass email and can also be downloaded from the IME(I) website. Completed forms must be returned to the Election Officer.
- Nomination papers for Council elections will be emailed by **15th May 2025** to the registered email ID.
- The Institute's office must receive the completed nomination papers by **15th June 2025**.
- The last date for withdrawing nominations is **30th June 2025**.
- The Election Committee will complete the scrutiny of nomination papers by **5th July 2025**.
- After scrutiny, the Election Officer will publish the CVs of eligible candidates on the IME(I) website.

E-VOTING

As a Corporate Member (on the Roll as of **15th May 2025**), you can cast your vote in the upcoming IME(I) elections using the **e-Voting** system exclusively.

- Two voting options will be available:
  - o **Head Office (HO) Elections**
  - o **Branch Level Elections** (if applicable)
- Overseas Members will have the option to vote **only for the HO level elections**.
- If your email address has changed, you must update it by emailing **electionofficer@imare.in** no later than **15th June 2025**.
- Members will receive the e-Voting link **only** at their registered email addresses as per IME(I) records on **1st June 2025**.
- To update your email ID or contact details, write to **membership@imare.in** by **10th May 2025**.
- E-Voting will commence on **15th July 2025** and remain open until **1700 hrs on 31st August 2025**.

ELIGIBILITY TO STAND FOR ELECTION

- All office bearers of the **Council and Council Members** must be **Fellow Members** from branches or chapters only.
- Office bearers and Council Members must have been Corporate Members for at least four years at the time of filing their nomination and must have served at least one full term on the executive committee of a local branch or chapter before being eligible to stand for election from that branch.

USE OF WORKPLACE / OFFICIAL EMAIL IDS

- In the past, mass emails have been blocked by certain organization domains, flagged as spam, or led to the blacklisting of the IME(I) domain. To avoid this, we **strongly recommend using personal email IDs only**.
- Using your personal email ensures you receive all important election-related communications.

For any queries, please contact: **Election Officer**
electionofficer@imare.in

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