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Knowledge-Humility-Excellence

ISF Institute of Research and Education (IIRE)

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IIRE Journal of Maritime Research and Development

Maritime sector has always been influencing the global economy. Shipping facilitates the bulk transportation of raw material, oil and gas products, food and manufactured goods across international borders. Shipping is truly global in nature and it can easily be said that without shipping, the intercontinental trade of commodities would come to a standstill.

Recognizing the importance of research in various aspects of maritime and logistic sector, IIRE through its Journal of Maritime Research and Development (IJMRD) encourages research work and provides a platform for publication of articles, manuscripts, technical notes, papers, *etc.* on a wide range of relevant topics listed below:

- Development in Shipping
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- Maritime Safety and Environmental Protection
- Technological Developments
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Editorial

IIRE has now ventured into publishing of books in the maritime sector also. The first book that was formally released at a reputed industry function at Mumbai was 'Technology integration in shipping – potentials and challenges'. This book reworks a regular research thesis into a scholarly book devoid of its academic debris with an aim to find appeal to the operations sector of the industry. Unlike a thesis, the book has an organic unity held together by a clear narrative thread, drawing the arguments together into a coherent and a satisfying whole. The chapters are subtly linked providing necessary pace and momentum to hold the interest of hard-pressed operations executives. The book unravels the root causes of un-optimized technology integration in shipping turning it into a bane rather than a boon and sends out strong messages to operations executives for course corrections.

Much in the same vein, this issue of the journal carries papers as mix of potentials and challenges of technology integration. While on the one hand Artificial intelligence (AI) is seen to be making in-roads into maritime applications, on the other hand the industry is seen to be still grappling with issues of non-standardised technical documentation as two papers address these issues respectively. Furthermore, a third paper highlights the limitations of poorly implemented Safety Management systems, notwithstanding soft versions replacing the paper based systems. Simple technology not delivering in any other similar safety-critical industry is unimaginable, what is it that makes the shipping so unique in making this effort unproductive? For cogent answers one needs to grab a copy of the above mentioned book, retailed on amazon.com

From this issue onwards, a section is being devoted to student level research publication of their works to provide the necessary encouragement to undergraduate student of marine colleges in as much as the colleges making such initiatives possible in their campus.

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IIRE Journal of Maritime Research and Development (IJMRD)

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ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING IN MARITIME FIELD

Mr. T. Mohan

Abstract

Artificial intelligence (AI) is becoming increasingly inevitable for the maritime industry and is going to play an important role in the near future. The influence of automation in the maritime activities along with the demand for more autonomous shipping has led to an increase in the demand for AI. Predictive maintenance, intelligent scheduling, and real-time analytics will drive AI to play a more important role in Maritime Field.

***Keywords*:** Machin e learning, Artificial Neural Networks, Internet of Things, Cognitive analytics

1. INTRODUCTION:

The buzzword of modern times in industry and business is **Artificial Intelligence**. This AI technology is vital to the digital transformation happening today as organisations are trying to capitalize on the exponentially growing amount of data that being generated and collected. This vast ocean of data has necessitated intense research into the means this data can be processed, analyzed and utilized for further action.

2. MACHINE LEARNING:

Artificial Intelligence is a concept of building machines which are capable of thinking like humans using the digital binary logic of computers. The field of research which has been more fruitful in recent years is what has become known as "machine learning". The concept of machine learning is that rather than have to be taught to do everything step by step, machines, if they can be programmed to think like humans can learn to work by observing, classifying and learning from its mistakes.

Given data, a machine learning algorithm can recognize patterns and learn from data to make predictions about new data, all through the use of clever statistics. In short, if you have data and a pattern in the data, your machine can learn. As in much of engineering, however, there is obviously more to machine learning than that simple explanation when it comes to execution and delivery. Within the field, there are three types of machine learning algorithms: supervised learning, unsupervised learning and reinforcement learning. Supervised and unsupervised are currently the most popular learning methods. They differ as follows:

- **Supervised learning:** In this method, the algorithms are trained by entering an input and a desired outcome to create labelled examples. The machine is able to find errors by comparing the actual outcome with the outcome that it knows should be correct based on the information originally entered. An example would be an algorithm for identifying credit card fraud. The machine can spot unusual charges by comparing them to the expected transactions.

- **Unsupervised learning:** As opposed to supervised learning, unsupervised learning does not have “right” answers – or historical labels – to compare the information to. Rather, the algorithm must look at the information provided and draw its own conclusions. This method is helpful for finding attributes by which to sort groups, such as identifying what consumers can be targeted by the same marketing campaign.

- **Reinforcement learning:** While not as popular as the previous two methods, reinforcement learning is an important part of the field. As opposed to supervised and unsupervised learning, this algorithm learns through trial and error, ultimately learning how to choose the option that will result in the greatest reward. This method is common in robotics, navigation, gaming etc.

Machine learning is growing in popularity and importance in large part because companies and government agencies have large quantities of data that need to be sorted, analyzed and leveraged to ensure a boosted return on investment. The data that is used in these algorithms can include everything from customer spreadsheets, past buyer information, loaner information, census information, survey information, website visiting rates and much more. Machine learning can not only reveal trends about this information, but can also give insight toward predicting things about future behaviour.

While machine learning is related to the broader field of artificial intelligence, these terms are not synonyms. AI is a branch of computer science that is primarily focused on creating machines that are capable of intelligent thought. However, this is hard to accomplish without the contributions of machine learning.

AI is basically the intelligence – how we make machines intelligent, while machine learning is the implementation of the compute methods that support it. AI is the science and machine learning is the algorithms that make the machines smarter, "So the enabler for AI is machine learning."

Though the idea of a machine making decisions on its own and thinking independently may sound almost like a work of fiction, machine learning is actually more common than many people may expect. The general public can find elements of it in many areas of daily life. For instance, services provided by websites, such as the way that Amazon.com recommends items that consumer might be interested in based on his browsing history and previous purchases. While these are very useful applications of machine learning for the average person, the field is much more than shopping and entertainment.

3. Artificial Neural Networks (ANN):

The application of neuroscience to IT system architecture has led to the development of Artificial Neural Networks (ANN). Although this field was evolving quite some time it is only recently that computers with adequate power have been made available to make the task a reality. Neural networks take a different approach to problem solving than that of conventional computers. Conventional computers use an algorithmic approach i.e. the computer follows a set of instructions in order to solve a problem. Unless the specific steps that the computer needs to follow are known the computer cannot solve the problem. That restricts the problem solving capability of conventional computers to problems that we already understand and know how to solve.

But computers would be so much more useful if they could do things that we don't exactly know how to do. Neural networks process information in a similar way the human brain does. The network is composed of a large number of highly interconnected processing elements (neurones) working in parallel to solve a specific problem. Neural networks learn by example. They cannot be programmed to perform a specific task. The examples must be selected carefully otherwise useful time is wasted or even worse the network might be functioning incorrectly. The disadvantage is that because the network finds out how to solve the problem by itself, its operation can be unpredictable.

On the other hand, conventional computers use a cognitive approach to problem solving; the way the problem is to be solved must be known and stated in small unambiguous instructions. These instructions are then converted to a high level language program and then into machine code that the computer can understand. These machines are totally predictable; if anything goes wrong is due to a software or hardware fault.

Neural networks and conventional algorithmic computers are not in competition but complement each other. There are tasks that are more suited to an algorithmic approach like arithmetic operations and tasks that are more suited to neural networks. Even more, a large number of tasks, require systems that use a combination of the two approaches (normally a conventional computer is used to supervise the neural network) in order to perform at maximum efficiency.

An Artificial Neural Network (ANN) is an information processing paradigm that is inspired by the way biological nervous systems, such as the brain, process information. The key element of this paradigm is the novel structure of the information processing system. It is composed of a large number of highly interconnected processing elements (neurones) working in unison to solve specific problems. ANNs, like people, learn by example. An ANN is configured for a specific application, such as pattern recognition or data classification, through a learning process. Learning in biological systems involves adjustments to the synaptic connections that exist between the neurones. This is true of ANNs as well.

An artificial neuron is a device with many inputs and one output (Figure 1). The neuron has two modes of operation; the training mode and the using mode. In the training mode, the neuron can be trained to fire (or not), for particular input patterns. In the using mode, when a taught input pattern is detected at the input, its associated output becomes the current output. If the input pattern does not belong in the taught list of input patterns, the firing rule is used to determine whether to fire or not.

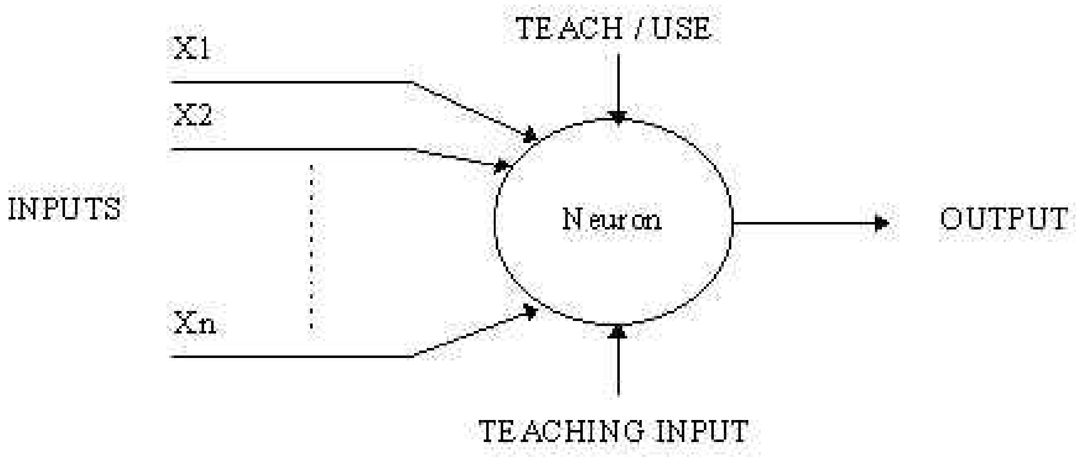

Figure 1

An important application of neural networks is pattern recognition. Pattern recognition can be implemented by using a feed-forward (Figure2) neural network that has been trained accordingly. During training, the network is trained to associate outputs with input patterns. When the network is used, it identifies the input pattern and tries to output the associated output pattern. The power of neural networks comes to life when a pattern that has no output associated with it, is given as an input. In this case, the network gives the output that corresponds to a taught input pattern that is least different from the given pattern.

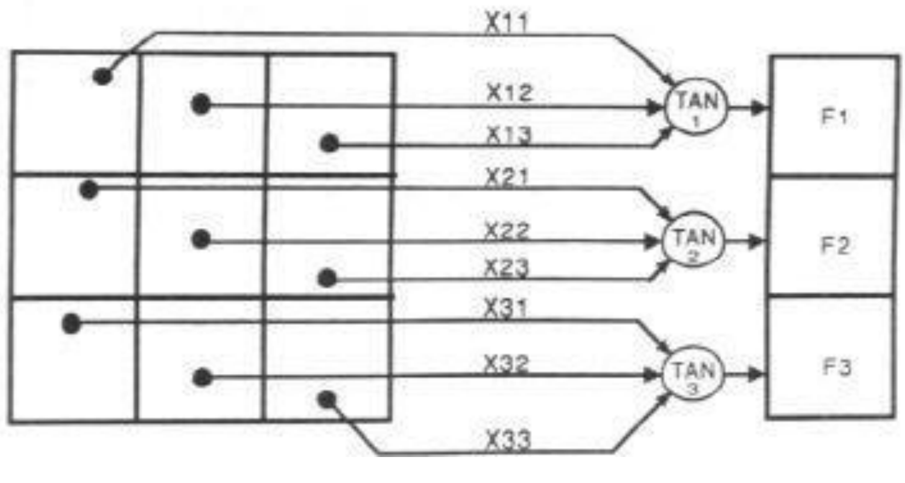

Figure 2

For example, the network of (Figure 3) is trained to recognise the patterns T and H. The associated patterns are all black and all white respectively as shown below.

Figure 3

A more sophisticated neuron (Figure 4) is that the inputs are 'weighted'; the effect that each input has at decision making is dependent on the weight of the particular input. The weight of an input is a number which when multiplied with the input gives the weighted input. These weighted inputs are then added together and if they exceed a pre-set threshold value, the neuron fires. In any other case the neuron does not fire.

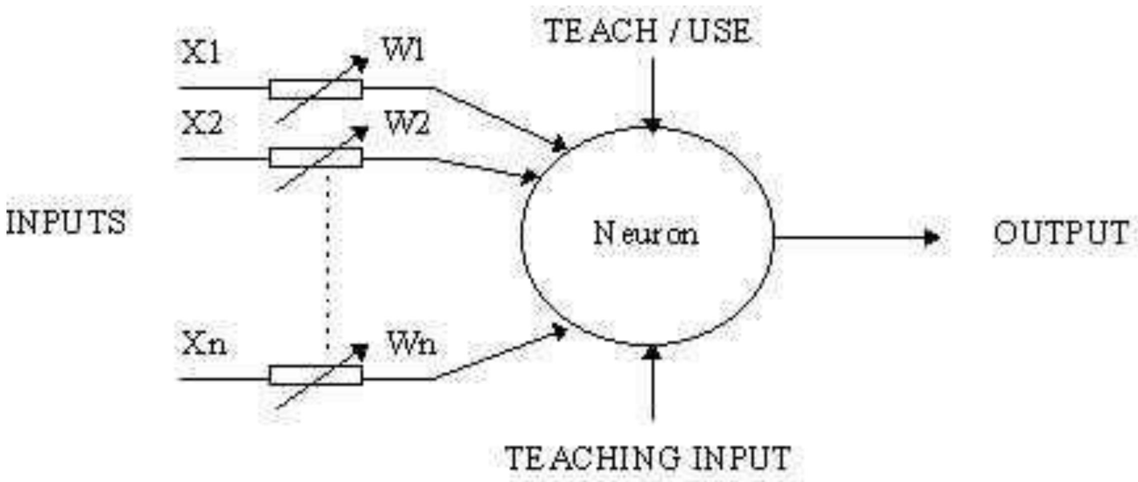

Figure 4

In mathematical terms, the neuron fires if and only if; X1W1 + X2W2 + X3W3 + ... > T

The addition of input weights and of the threshold makes this neuron a very flexible and powerful one. Various algorithms exist that cause the neuron to 'adapt'; the most used ones are the Delta rule and the back error propagation. The former is used in feed-forward networks and the latter in feedback networks.

The commonest type of artificial neural network consists of three groups, or layers, of units: a layer of "input" units is connected to a layer of "hidden" units, which is connected to a layer of "output" units. (See Figure 5)

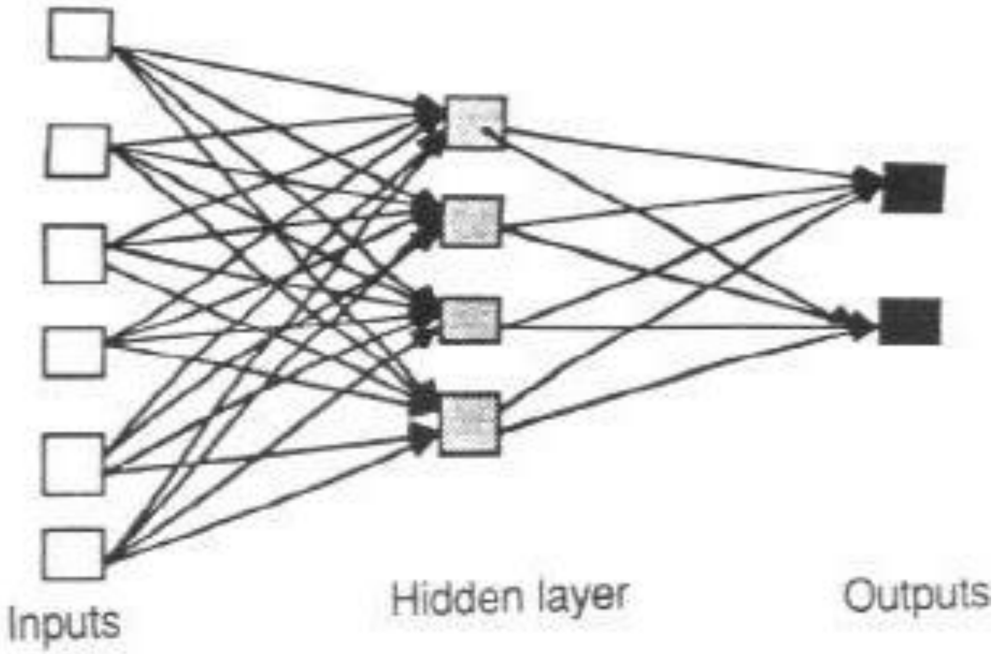

Figure 5

The activity of the input units represents the raw information that is fed into the network. The activity of each hidden unit is determined by the activities of the input units and the weights on the connections between the input and the hidden units. The behaviour of the output units depends on the activity of the hidden units and the weights between the hidden and output units. Feedback networks are very powerful and can get extremely complicated. Feedback networks are dynamic; their 'state' is changing continuously until they reach an equilibrium point.

Artificial Neural Networks (ANN) is currently a 'hot' research area in medicine and it is believed that they will receive extensive application to biomedical systems in the next few years. At the moment, the research is mostly on modelling parts of the human body and recognising diseases from various scans (e.g. cardiograms, CAT scans, ultrasonic scans, etc.).

Another single most enabling factor has been the explosion of data availability from things shared on social media and machinery data from industry connected through IOTs (Internet of Things). This means computers now have a universe of information available to them, to help them learn more efficiently and make better decisions.

4. MARITIME APPLICATIONS:

With more and more new sensors and IOT devices on ships, more data being generated but only little of that data is actually being put to good use. According to surveys very little of all shipboard generated data are analyzed in a meaningful way. Ship owners, Regulatory entities and machinery manufacturers are increasingly interested in harnessing the value of data being collected on board ships. The possibilities are detection of mechanical anomalies in real time, categorizing these anomalies into minor, intermediate or serious, showing these anomalies in 3D displaying which component inside the machine is causing the anomaly and the automated model building can predict when failure might occur. Classification societies can create a notation for the ships using these technologies and grant considerable extension of time for survey.

Machine learning and cognitive analytics tools provide all of these capabilities, detecting anomalies in machine operations and predicting failure with high degree of accuracy. Machine learning will be a game-changer for the maritime sector. The ability to apply machine learning tools to shipboard generated data is now more widely available. The progression of analytics from descriptive (what happened?) to diagnostic (why did it happen?) to predictive & prescriptive (when is it likely to happen and what can be done to prevent it?) is changing the way the industry can harness the value of machine learning tools in data analysis.

Additionally, machine learning empowers fleet managers to reduce unplanned out-of-service time, protect against malicious threats, and provide cognitive query of relevant vessel-operating information from a variety of sources. This further allows for savings in maintenance and capital cost replacements, extending the life of critical shipboard assets. Operators in the maritime space are increasingly interested in this new technology for following reasons: (i) Cognitive analytics provide the capability to ingest the terabytes of data that are already being generated, and find the insights contained within to save money and reduce off-hire (ii) Cognitive analytics allow more intelligent planning of major maintenance periods such as special surveys and dry-dock periods, spare parts and consumables inventories, and support to seagoing staff in assessing whether maintenance needs to be performed in-voyage, in a port turnaround, or over a longer period of time (iii) Ship- owners and operators find value in developing a deeper understanding of shipboard machines rather than leaving it to yard periods or warranty and insurance claims.

For an industry that has used some of the same systems for years, artificial intelligence and machine learning offer an opportunity for revolution in shipping. The commercial shipping industry runs on a lot of data; every ship has a manifest, every container has an identification number, every box has a packing slip. AI advancements in gathering and analyzing that data could allow the shipping industry to plan further out and more accurately, particularly for busy times of the year that are known to be a challenge. The result could be not just greater efficiency for the industry, but significant cost savings.

5. CONCLUSION:

Dependency on a new technology to understand the behaviour of machines is a paradigm shift away from thinking about ships. Lloyd’s Register, in its “Global Marine Technology Trends 2030,” estimated a 4,300% increase in the annual data generated by ships by 2020, and says that “by 2030, that figure will have increased even further as this is an accelerating trend.” Data itself can now be considered a new class of “asset.” And if ship-owners look after the asset that is their data, their data will help look after everything else.

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BOXING AND DANCING: THE CHALLENGES OF ENFORCEMENT IN GLOBAL SHIPPING

Dr. Nippin Anand

Abstract

In recent years, the spread of inspections and other forms of enforcement (audits, surveys, vetting, assurance *etc*.) has reached a stage of 'explosion' in terms of both scope and frequency. There is a real concern that the enforcement regime, *i.e.* compliance with rules, regulations and industry standards, has fallen victim to its original intentions of managing safety risks. Many seafarers I have interviewed believe that on-board inspections are merely paying lip service to regulatory and commercial obligations and not necessarily addressing genuine safety risks.

Keywords: Ship Surveys, Inspection and Audit, Ship Vetting

1. SAFETY IS A JOKE:

Two discrete narratives form the backbone of this paper. Both were triggered by posing a simple question to the crew on-board – how effective are on-board inspections in addressing safety risks? After all, it is the end user whose opinion matters the most – or so it is said. The first response comes from a chief engineer who explained what he felt was the focus of inspectors and his innovative 'fix' to the problem:

'Every time they [inspectors] come on-board they have to find something. So what I do, I will put some paint cans in engine room or remove a fire extinguisher from its location. Makes them happy when they find something, very happy – you should see their face. The moment they find something they stop looking so that makes my life easy.'

In another case an infuriated Master had to say this about a recent inspection: 'After six days of extreme heavy weather I arrived in port and thanked all my crew for their wonderful efforts in running a safe operation. This guy [inspector] comes on-board and the first thing he asks – 'Captain how did you dispose of 20 litres of cooking oil from the galley?' I felt like banging my head against the wall. Tell me where is the sense?'

These responses are neither exaggerated nor isolated; similar issues have emerged during many discussions with the seafarers and the managers ashore. The managing director in one company explained how a major accident within the fleet brought to surface some serious safety issues despite the vessel ‘flying through every inspection and audit for the past few years’.

In another case, an inspector made an observation that there should be a ‘hold the hand rails’ sign next to the accommodation ladders for crew safety. (Note – Several studies have shown that excessive use of warning signs leads to risk blindness – workers simply stop paying attention to warning signs.) Nobody on-board could recall if the structural strength and maintenance of the accommodation ladders were examined with the same spirit by the inspector. Collectively, all these anecdotes highlight systemic problems in the enforcement regime and a lack of appreciation, or at least focus, on genuine safety risks. Safety, it appears, has become a joke in global shipping.

2. BOXING AND DANCING:

A general theme in the above narratives is that, far from adding value, on-board inspections have become a nightmare for the crew. One seafarer described the experience of undergoing inspections as ‘getting punched in the face’ with defects and non-compliances. This seafarer decided to switch to ‘entertainment mode’ when dealing with inspectors, by fabricating and feeding to the inspectors something that satisfies their quest for ‘punching’. Boxing describes the intentions of the inspector (at least from this seafarer’s perspective) – and dancing is the crew’s response.

Let us identify some key questions that emerge from this trend towards boxing and dancing in global shipping.

1. What explains the mismatch between the representatives of the enforcement regime (inspectors, surveyors, auditors and SHEQ staff) and those on-board?

2. Why is the focus of on-board inspections (commercial, regulatory and internal alike) so much on petty issues whilst leaving aside the major risks?

3. Are there alternatives to our existing approach to on-board inspections? What can we learn from other high risk industries in making the enforcement regime an effective tool for risk management?

These questions will be answered in the body of this paper.
Recognising there is a problem and discussing it honestly and openly is the first step towards resolving it.

3. THE INSPECTOR'S CHALLENGE:

Economic turbulence is affecting almost every business worldwide and the maritime industry is no exception. Most public and private bodies conducting on-board inspections are facing resource and budget constraints. Ships and ship operations have grown increasingly complex. Hull, machinery, navigation, cargo loading systems, fire and lifesaving systems, safety management systems, are all vast disciplines of expertise on their own. Expecting any one inspector to accurately and meaningfully apply the relevant regulatory instruments is a challenge. Regulatory bodies try hard catching-up with fast paced technologies but this only adds to the scope of inspections.

Port turnaround times have reduced considerably, and this puts enormous pressure on everyone to complete the inspections in time. Alongside inspections, a number of parallel operations are undertaken in port – crew changes, bunkering, stores, attending to port officials, repairs and maintenance *etc*. The inspectors often have to work with seafarers who are stretched beyond normal hours of work attending to hectic port schedules. The inspection may include reviewing maintenance history, interviewing crew members to verify their competence and assessing the adequacy of support functions that facilitate operations from the shore side. Apparently, the intention is to make ships safer. But communicating complex and delicate matters in a common language and forming initial trust with those on-board in a short lived relationship is a challenge for any inspector.

4. THE SEAFARER’S DILEMMA:

Given the non-standardised and highly fragmented nature of the industry, regulatory requirements can vary depending on the vessel type, size, trading area, age, flag of registry, *etc*. Exactly which regulation, code, circular, #ag state requirement, industry standard, manufacturer’s recommendation or company procedure applies in what context is not easy to determine, even with all the information available on-board in this internet age. The volume and complexity of regulations seem to have gone through the roof. Take the case of ECDIS for instance. Amongst the many regulations are everything from design, approval, installation, commissioning, operation and training of the end users. As one colleague puts it, the situation is so complicated that for the end user even knowing with confidence if the electronic charts can be termed as a primary means of navigation as against paper charts can be tricky. The primary means of navigation can change between voyages or even during the same voyage depending on the availability of up-to-date electronic charts in a particular area. And this is only one of the many aspects of ECDIS requirement. There is a limit to how much we can expect an individual to know, especially so if this individual is overworked and exhausted attending to the many jobs in port. But this is no excuse for lack of ‘familiarisation’ with the safety management system.

There is also the issue of power distance, when a major proportion of seafarers from developing countries navigate through ports in developed countries and deal with the port officials. There is an implicit acceptance of power inequality especially amongst those from developing countries. A prime example of this behaviour emerged when the Chinese container vessel Cosco Busan met with an accident while departing San Francisco in dense fog conditions. A watch officer was overheard on the voyage data recorder saying, ‘For American ships under such conditions, they would not be underway’. This is a powerful statement from a seafarer who feels in the uneven world of global shipping, only certain nationalities can exert authority. Similar examples of submissive behaviour have come up in my own experiences during on-board inspections when the seafarers simply nod and smile to keep the inspector ‘happy’.

5. NEGATIVE REPORTING:

An interesting aspect of inspections is the constant hunt for broken components, rule violations and human failures. From the inspector's perspective, it is more important to prove 'look what I found wrong today' than 'see how many things go right every day' to justify his presence on a vessel. A handful of problems have to be found – this is an unspoken rule of on-board inspections.

The format of inspection reports supports this unspoken rule all too well. Most inspection results are based on a negative vocabulary – defects, deficiencies, failure, non-compliances, detentions, (negative) observations *etc*. This negative language can adversely affect the morale of crew members who try to get their jobs done with limited resources. What is more, this negative vocabulary instigates fear and insecurity amongst the crew.

During an inspection, a non-compliance was raised against a vessel when an engineer was unable to demonstrate the proper functioning of the emergency steering system. His first concern was that if this went down on paper, it would cost him his job. How are we to expect any learning or improvement from the inspections, if the first question raised is who is to be held responsible and who should be fired for the screw-up? Tolerance for human imperfection and technical failures is close to non-existent. But this behaviour is a symptom of deeper problems within the industry.

6. SAFETY VERSUS MARKETABILITY:

The outcome of inspections plays a decisive role in the marketability of the vessel. In an ideal world, vessel operators should strive for the highest standards of operations and maintenance whilst avoiding the curse of negative inspection results. In order to achieve this, many companies are moving towards ambitious but unrealistic quality, environment and safety targets such as zero accidents, zero downtime and zero spills, so their vessels score better in a competitive market. In practice, however, failures and malfunctions are inevitable when a vessel carries high risk cargoes, navigates in shallow waters, experiences horrendous environmental problems of ice, fog and storms and faces intense production pressures with minimum manpower.

If malfunctions and failures are bound to come up during inspections and yet play a decisive role in the marketability of the vessels, what is the way forward out of this impasse? One solution is to set up performance indicators to monitor and control malfunctions. And this is simple! Some companies would set up performance indicators as vague as ‘compliance with mandatory rules and regulations’ and internalise these measures in individual KPIs. But underneath such broad KPIs there is a powerful message – dispute, negotiate and defend non-compliances, defects and failures because all of these can affect the commercial viability of the vessels and ultimately the staff bonuses. Safety comes in direct contradiction with marketability, and all this can lead to defensive attitudes and conflicts between the inspector and the operator. This is not necessarily being dishonest; it is a practical way in which companies set up targets and manage their vessels – except that it completely undermines the value and purpose of the inspections.

7. INDEPENDENCE OR SUBSTANCE:

Given that safety and environment issues almost always concern the public interest, the logic of independence is deeply embedded in the enforcement regime. This assumption is valid both for internal controls as well as external inspections. The reporting lines for safety departments are kept independent, so that personnel can report directly to the highest level of management without the fear of intervention from commercial and operations. For external regulatory inspections, the role is fulfilled either by public maritime administrations or assigned to third party organisations.

While independent assessments are critical in matters of public safety, equally important is the competence of inspectors and the content and substance of the inspection. The content of the inspection report may sometimes tell us more about the biases and competences of the evaluator (inspector) than any genuine reflection of the vessel being evaluated. Inspectors with engineering qualifications focus more on machinery spaces, whereas those with nautical qualifications often dig deeper into nautical issues. But such biases are to be expected from all human beings including inspectors.

In some cases, however, the inspections are carried out with a strict 'compliance mentality', and it is here that the inspectors become excessively engaged with petty issues where compliance and noncompliance is easy to establish. Rather than using regulations and rules intelligently to identify and address the risks that are specific to the vessel, the inspectors chose to focus on issues that are obvious to the eye and meet with minimum resistance from the operator. As a result, a typing error on a certificate, a missing entry in a log book, or insufficient frequency of checks (rather than the quality and output of maintenance) become the prime focus of inspections. What is common about such petty issues is that much of this can be picked up and reported from the comfort of a 'couch' without engaging with the crew or paying attention to the messy details of operations.

8. TECHNICAL SAFETY:

Of course not all inspections focus on the obvious, trivial and readily accessible. On the contrary, to ensure technical integrity many inspectors have to enter into claustrophobic, confined and remote spaces (even sewage tanks!) where normal workers would simply refuse to go. But technical know-how and sophistication has increased remarkably in recent years, and so has our struggle to control and deliver on them. Today, computer based technologies no longer show obvious signs of failure and neither do new technologies follow a straightforward maintenance schedule that could be assessed independently by a third party inspector. Failures can emerge without warning, and specialist technical knowledge is often controlled by the vendors and manufacturers who are directly involved in the repair, servicing and inspection of their technologies. Without access to this specialised knowledge, the inspector's role in technical safety is limited.

The scope for technical assessment may become limited to virtual testing and extrapolations. Already, there are far too many examples. We simulate loss of main power to check if the emergency generator would start automatically, lifeboats are lowered at the most to embarkation deck, in calm seas. The FMEA trials dynamic positioning system in sheltered waters, load testing on lifting appliances takes accurate account of load distribution, meta centric height and external influences.

These are by and large controlled experiments carried out systematically with meticulous planning, adequate manning, risk assessments, authorised permits, and with the best guesstimate that the technology would function as intended in an unexpected situation. The operational context, however, is harsh, wet, messy, greasy, slippery, corroded, uncertain, dynamic – and nearly always undermanned and overstretched. Would the lifeboats still lower under the influence of gravity, and is the remote closure of watertight doors going to operate as intended when the vessel develops a list and sinking becomes imminent? Isolated testing of technical components says little about system behaviour in an operational context, particularly so when system boundaries are pushed to their limits. These are not matters of access or intelligence of an inspector; they are issues that require a shift of thinking – one that involves a focus on safety risks that are specific to the context, and delivering inspections that are sensitive to those risks. Put simply, without context even the most detailed technical inspection runs the risk of adding marginal value to the management of safety risks.

9. THE WAY FORWARD:

The unfortunate state of enforcement that I have described in terms of boxing and dancing needs serious action. But serious action does not mean yet another set of regulations waiting to be rolled out. An Argentine shipmaster once said to me, 'Today, if I wish to install a toilet seat on my vessel there will be endless queries, risk assessments, and certificates. But if I tell my company that my crew needs some rest before we sail out from the port, no one would respond. There is too much administration but very little policing'. As this Master has correctly pointed out, the situation in global shipping today requires intelligent political intervention, and not increased administration. Call it smart regulation or simply inspections with a meaning and fit for purpose.

Examples can be drawn from high risk industries such as the nuclear sector or the oil and gas industry. Here, compliance with rules and regulations is driven by a larger purpose such as the prevention of major accidents or matters concerning organisational reputation. This could also be achieved in the maritime industry through the use of the ISM Code as a risk management tool rather than a mundane compliance exercise. The fundamental difference is that safety is no longer seen as an evil against marketability and profits, as but an integral part of cost saving and risk taking. In short, business is safety.

To achieve this requires a move towards designing smart and focused SMS (safety management systems). And for this, key operations (section 7 of the ISM Code) should be placed at the heart of the SMS. Here, key operations should not be mistaken for generic shipboard activities such as navigation, cargo operations or bunkering but the core business of an organisation (for example delivering just-in-time cargoes, safe carriage of dangerous pollutants, search and rescue operations, pipe laying or exploration and drilling).

Starting from this point makes so much business sense when every initiative, control measure, resource and KPI is developed bearing in mind the (operational) context and assessed with a purpose, whether it is internal audits, reporting lines, competence management, procedures for routine and non-routine tasks, emergency preparedness, technical safety or organisational learning. Take the case of emergency preparedness – sudden loss of propulsion can have very different consequences on a container vessel operating within just-in-time constraints than an anchor handling vessel carrying out rig moves. The former may cause delays to operations and may or may not undermine navigational safety, while the latter clearly has the potential for a major accident. Similarly, for a company operating deep draft tankers concerned with safety of navigation, meaningful indicators of safety become clearly identifiable – adjustments to passage plans, off-track alarms, rest hours of crew and the adequacy of SOPEP. It is here that we start to get a clear sense of compliance with MARPOL, SOLAS, STCW *etc* as a tool for managing the risks, rather than as compliance for its own sake.

Equally important is that the enforcement regime should move beyond a culture of negative reporting *i.e.* non-compliances, failures, defects, detentions and human errors. Rather, the focus should be on understanding how, despite all the environmental, social and technical obstacles, people generally succeed in carrying out their jobs. This leads to an entirely different and motivational language of safety, one that is characterised by every day trade-offs, adaptability, adjustments, or ‘seamanship’ – and one where human performance is seen as a solution and not the problem. Hidden in this term ‘human performance’ are endless stories of success – but also those that could potentially lead to failures. It is not difficult to figure this out on a vessel where seafarers often find ways to carry out tasks differently than set out in procedures and rules, due to lack of resources, unstable work environment, time pressures, inadequate procedures and substandard designs of vessel and equipment that leave no choice but to violate those procedures. What is required from a meaningful inspection is a degree of open mindedness to understand the underlying reasons for the gap between procedures and practice – rather than just highlighting those gaps.

There will always be organisations that choose to hide behind compliance, content with addressing petty issues of marginal relevance. But experience has shown that there are also companies operating at the higher end of the value chain, where the emerging trends of ‘boxing and dancing’ are seen as counterproductive both for safety and business reasons. These are companies that demand constructive tension and value for money from the representatives of enforcement regimes. The senior management view safety as a business opportunity. In such organisations, absence of evidence (of harm) is not mistaken for evidence of absence. Change is within our reach.

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TOWARDS MANDATORY STANDARDIZATION OF TECHNICAL DOCUMENTATION

Dr. (Capt.) Suresh Bhardwaj

Abstract

Technical documentation guides the operators in handling machinery and technology safely.
In the operation of ships and its machinery, there is no standard for technical documentation. Every manufacturer creates technical documentation the way he thinks is best. Because of this, all technical manuals delivered for a ship look different and are structured differently. In case of an integrated system, the designer or yard delivers own technical documentation separately and merely adds the manuals from the component manufacturers, which for the crew is a nightmare to use.
This paper advocates mandatory standards for technical documentation in the operation of ships and its equipment.

***Keywords*:** Operation Manuals, Technical documents, ASD S1000D

1. INTRODUCTION:

Technical documentation guides the operators in handling machinery and technology safely.

In the operation of ships and its machinery, there is no standard for technical documentation. Every manufacturer creates technical documentation the way he thinks is best. Because of this, all technical manuals delivered for a ship look different and are structured differently. In case of an integrated system, the designer or yard delivers own technical documentation separately and merely adds the manuals from the component manufacturers, which for the crew is a nightmare to use.

BIMCO 2015 report says that technical manuals delivered with many ships do not give “any form of rational guide for operation and maintenance of the ship and her equipment,” and that this is “responsible for a number of accidents” [BIMCO 2015].
CHIRP (Confidential Human factors Incident Reporting) Maritime Advisory Board has recommended that “Manufacturers of equipment for safety critical marine applications should provide operating and maintenance manuals to a common document standard” and that “A relevant authority should verify the compliance and audit its continued compliance” [CHIRP 2014, p. 2].

This paper is contributing to this field by suggesting a concrete technical documentation (TD) standard, which is ASD S1000D. (ASD is Aerospace and Defence Industries Association of Europe)

This specification is already mentioned in a document of the Institute of Marine Engineering, Science and Technology (IMarEST) which was handed in to the Maritime Safety Committee of the IMO in 2014[IMarEST 2014].

2. TD CAUSED ACCIDENTS:

An analysis of the accident reports published in MARS (Mariners' Alerting and Reporting Scheme – a confidential reporting system run by Nautical Institute, UK) for the years 2012 to 2015 is carried out with specific reference to failures in maintenance and operation which is classed as follows:

- Missing maintenance, - At the first sight this seems not related to TD. But TD contains not only instructions on how to perform the job, but also how often and under which conditions.
- Maintenance procedures missing - Here the difference lies in the responsibility for the failure which in this case is on the manufacturers or yard side.
- Maintenance procedures not respected - is the case when the crew was performing maintenance, but not in line with the procedures being available
- Maintenance procedure wrong, - where the crew followed the instructions, but these were not correct or incomplete.
- Operations information not respected,
- Operations information missing, and
- Non standardized communication – different interpretation of TD

Deeper analysis revealed that an average 17 % of the accidents related to TD whereas 7 % of all the accidents related to TD involve casualties.

Furthermore, requiring the TD onboard ships is only one aspect, but requiring it be used is another. When this aspect is compared with Civil Aviation, Civil Aviation requires the maintenance organization to "provide a common work card or worksheet system - that transcribes accurately the maintenance data onto such work cards or worksheets [EASA 2003, para. 145.A.45(e)]

Such a provision would necessarily require the TD to be onboard ships and it being used at the same time. This would suitably address the most common reasons for accidents involving the usage of TD.

An Australian Transport Safety Bureau (ATSB) investigation report is noteworthy. While being at anchor the vessels "number two oil-fired thermal oil heater exploded. The explosion seriously injured three crew members and severely damaged the thermal oil heater and surrounding equipment and fittings" [ATSB 2012, p. iii]. As to the cause for the explosion, it was found "that, during maintenance, the thermal oil heater burner nozzle had been assembled incorrectly. This was because ... the manufacturer supplied instructions were not clear and detailed" [ATSB 2012, p. iii].

3. TD RECOMMENDATIONS DO EXIST:

In Shipping, recommendation on TD do exist. MSC.1/Circ. 1253 states "that the attention of all relevant stakeholders needs to be drawn to the importance of ships' crews having access to up-to-date, accurate and user-friendly shipboard technical operating and maintenance manuals, particularly for safety-critical marine equipment" [IMO 2007, para. 1]. It is these manuals which are commonly referred to as technical documentation (TD).

So also, IACS Recommendation 71 provides criteria for the development of user-friendly technical manuals for operation and maintenance of the ship and her equipment [IACS 2000, para. 1]. Recommendation 71 stresses the usability of TD to be of considerable importance and puts the responsibility on those who provide it, i.e. the manufacturers.

IACS Recommendation 71 also introduces *information categories* for the content to be delivered. These are:

a) Purpose and planning (what is the system/equipment for);
b) Handling, installation, storage and transit (how to prepare it for use);
c) Technical description (how it works);
d) Operating Instructions (how to use it);

e) Fault action list (how to restore operating condition)

f) Maintenance instructions (how to keep it working);

g) Maintenance schedules (what is done when);

h) Parts list (what it consists of);

i) Modification instructions (how to change it),

j) Disposal instruction (how to dispose of it).

ISM code also in its Paragraph 1.4 specifies in the functional requirements of the SMS that the "company should develop, implement and maintain":

a) "Instructions and procedures to ensure safe operation of ships and protection of the environment in compliance with relevant international and Flag State legislation". [IMO 1993, para. 1.4.2]

b) "Procedures to prepare for and respond to emergency situations." [IMO 1993, para. 1.4.5]

These instructions and procedures mentioned above must rely on the TD coming from the yard or manufacturers. It includes maintenance as well as operational information, and both are required to operate the vessel safely.

Matter-of-fact, currently the only regulation that could be interpreted as requiring manuals to be held on board ships is the ISM Code, BUT the obligation lies with the vessel's owners and does not extend to a general requirement for manufacturers to supply such manuals" [MAIB 2010, p. 28]

"Specifically, these regulations (the ISM code) apply to vessel owners and operators, and do not address the role that equipment manufacturers and shipbuilders have in ensuring that equipment is safe and fit for purpose. Consequently, poor design, limited access for maintenance, and weak instruction manuals are regularly found as contributory factors in accidents." [MAIB 2010, p. 33].

A recent amendment to ISM Code vide MSC 353(92) effective 1st Jan 2015 – may cover this to some extent:

"12.2 The Company should periodically verify whether all those undertaking delegated ISM related tasks are acting in conformity with the Company's responsibilities under the Code." However, it really depends on the owner or operator, as to how much they can push. Standardization yet remains a far cry.

4. THE BASIC S1000D PROCESS:

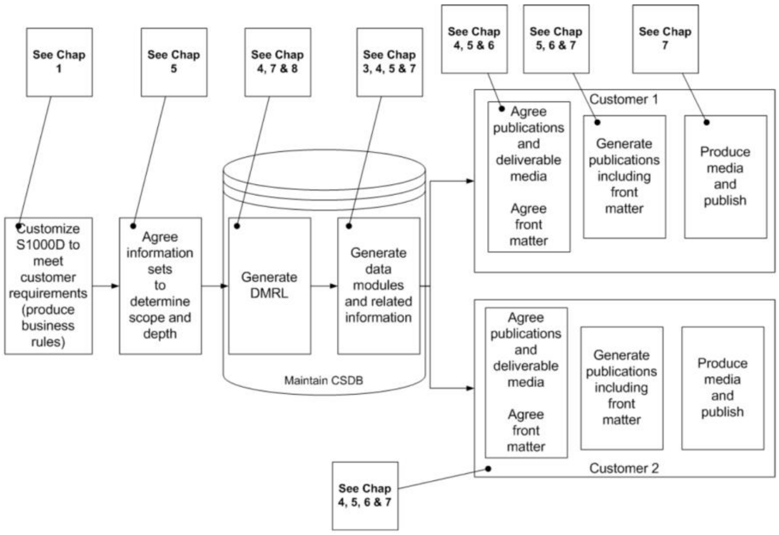

Figure 1: The basic S1000D process [ASD 2012, Chap 2.1 p. 2]

The basic process used by the S1000D specification is shown in Figure 1. In the context of the shipping industry: In the initial phase of the project the ship-owner and the marine engineers discuss the features of the future vessel. In this phase the design becomes clear, what equipment will be used and what conditions it will be operated in.

This represents the first box in Figure 1 where the same is done for the TD. Already before the TD is being created the requirements for it are agreed with the yard or manufacturer. S1000D supports this process with supplying projects with a list of so called business rules (BR).

The next step is to agree on what kind of information is needed.
For this S1000D introduces the term ‘information sets’. A basic feature of S1000D is to focus on information units instead of monolithic manuals. Such an information unit might be the procedure how to assemble the nozzle of the thermal oil heater burner. These information units are called Data Modules (DM)

Based on the design from step 1 one can already derive which components have to be considered. Together with the decision on what kind of information is needed in step 2 a list of required DM can be set up, the so called Data Module Requirement List (DMRL)

"The (DMRL) supports planning, reporting, production and configuration control". It is usually a contractual document that specifies the extent of the TD to be delivered. This step is represented by the third box from the left in Figure 1.

The production of the DM is represented in Figure 1 by the fourth box from the left. When the production of the DM and related information like illustrations is finished, the data can be published.

The TD of a component like a main engine can easily consist of several thousands of DM. In addition, there are illustrations or multimedia contents too. All these objects must be managed in a consistent way. The S1000D concept for achieving this is the Common Source Database (CSDB).

"It (the CSDB) is an information store and management tool for all objects required to produce the technical publications within projects.

The major objectives for a CSDB are:

– support the technical publication process
– support the controlled authoring
– support the QA process – verification by manufacturer and client
– support the data exchange with partners, suppliers and customers - allows for merging parts of the TD coming from different manufacturers into one CSDB
– support the delivery of technical publications on various media independent from the source storage format" [ASD 2012, Chap 4.2 p. 1]

Very important - the layout of the data shown to the crew is the same for all TD.

In addition, the same content can be used on different media like hand held devices or even an optical head-mounted display in the future.

5. CONCLUSION:

For addressing the quality of the TD the introduction of ASD S1000D as a technical documentation standard has been suggested. The basic S1000D process covers all aspects of the life cycle of TD. It supports the projects from the beginning and again gives clear guidance on what to agree on during each stage of the project.

The specified quality assurance cycle allows for keeping the TD up-to-date while clearly addressing verification methods and responsibilities. The exchange of the TD using S1000D transfer packages allows for a seamless exchange according to fixed rules.

The rather high number - 7 % of all accidents that are related to TD and involve casualties is seen as a justification enough for making this mandatory.

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Dr (Capt) Suresh Bhardwaj has 40 years of work experience, which includes 5 years as Master and in command of various types of ships of the merchant marine; subsequently 25 years of multi-disciplinary shore experience in senior and top management positions spanning the marine industry verticals of commercial operations, consultancy, academia and research.

2018 WORLD MARITIME REVIEW

Dr. Shashi Kumar

Abstract

Is world shipping finally out of its decade-long melancholy? That appears to be the case at least in spirit although individual major markets continue to bleed from their prolonged downturn. Perhaps the industry can have a collective sigh of relief on overcoming the worst and reassure themselves that there are clear sightings of a silver lining. And, may be, this might be that long- elusive stabilizing year during which optimism prevails in all markets not solely in spirits but also in realized market outcomes. But then, so were the Sisyphean attempts at rolling the great boulder to the top of the mountain!

***Keywords*:** Annual Shipping Review

1. INTRODUCTION:

The 2018 World Economic Outlook[1] estimates 3.7 percent growth in global output in 2017, surpassing its earlier revised projection by 0.1 percent and has also revised its growth forecasts for 2018 and 2019 by 0.2 percent to 3.9 percent. The global growth momentum is partly driven at least in the short-term by tax policy changes in the U.S. and remains susceptible to faster than expected increases in core inflation and interest rates as witnessed by the early February worldwide financial market corrections. Regardless, the IMF equates the current resurgence as evidence of the broadest synchronized global growth surge since 2010 in 120 countries. All major advanced and emerging economies are on an upswing with strong consumer confidence and firm manufacturing activity ahead.

A corresponding uptick is readily visible in world shipping markets too. BIMCO refers to 2017 as the "year of change."[2] Ship ordering activity, the perennial Achilles' heel of ship owners and operators remained subdued throughout the year for most ship types and the backlog in ship construction fell below 200 million deadweight tons for the first time since 2004. Moore Stephens, the global accounting and consulting company, found overall shipping confidence to be at its highest levels since 2014 based on their periodic surveys, and projects an optimistic 2018 for the industry despite its predictable idiosyncrasies and geopolitical uncertainties.[3] All three major shipping markets are now in a phase of cumulative net positive sentiments.

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[1] IMF, "World Economic Outlook Update, January 2018," http://www.imf.org
2 BIMCO, "2017 Was Year of Change in Shipping-Caution Required in 2018," http://www.bimco.org
[3] Moore Stephens International, "Shipping Confidence Survey," https://www.moorestephens.co.uk/

2. SHIPPING MARKETS:

The confidence boosting 2017 could not have come sooner for an industry that has been reeling under an unusually long downward cycle. Although none of the markets is truly out of its doldrums, in general, ship owners and operators demonstrated remarkable self-discipline in sync with the growth in global GDP and the corresponding increase in world trade volume, which the World Trade Organization estimated to be at least five index points over analogous periods in 2016.[4]

Although ship owners and operators often make seemingly irrational investment decisions, the industry itself is very cost-conscious and has made excellent progress in cutting down their expenses for at least three decades now. Yet, the total operating cost for the worldwide fleet tracked by Clarksons exceeded $100 billion in 2016, the largest component of which was crew cost at 43 percent. They estimate $17 billion increase in operating cost from 2008 when the recession began in contrast to the $168 billion massive decrease in aggregate ship earnings during the same period.[5] Therein lies the ongoing existential dilemma of international commercial shipping.

3. DRY BULK MARKET:

China's insatiable appetite for iron ore and steel production and its increasing soybean imports used as animal feed, were the primary impetus for lifting this market off the rock bottom it had reached in 2016. The consequent growth in demand for dry bulk shipping services exceeded expectations but so did the increase in supply which preliminary estimates place between 3.2 percent and 4 percent.[6] The Baltic Dry Index (BDI) registered a six-fold increase from 297 in February 2016 to 1,702 in early December 2017, the highest it has been in last five years. Unlike the short-lived uptick in 2013, the 2016 recovery has endured, with average daily earnings reaching $10,986 in 2017.[7] [8]

[4] World Trade Organization and UNCTAD, "Latest Quarterly Trade Trends, World Merchandise Trade Volume Developments," https://www.wto.org/english/res_e/statis_e/daily_update_e/latest_trade_trends_e.pdf
[5]Clarksons Research BLOG (19 May 2017), "Cost…OPEX Tops $100 Billion," https://clarksonsresearch.wordpress.com
[6] BIMCO estimates fleet growth of 3.2 percent in 2017 versus Clarksons' estimate of 4 percent.
[7] The average daily earnings since 2011 is $9,475 per day and had dropped to $7,077 per day in January 2013. For details, see Clarksons Research BLOG (2 March 2018), "Getting Airborne: Time to Fly," https://clarksonsresearch.wordpress.com

There is a sustained decline in newbuilding orders for bulk carriers; it is now close to the historic low levels ordered in 2002 although the vessels on order now are significantly bigger in carrying capacity. Clarksons estimates that a total of 456 new vessels (38.4 m dwt) were delivered in 2017 which is about two-third of the peak levels reached in 2011. Also, the level of non-delivery remains high, with one-third of all projected 2017 new deliveries being either deferred to a later year or cancelled. Correspondingly, the market value of dry bulk fleet tracked by VesselsValue registered a two-year net growth of $56 billion, matching the current tonnage value of the worldwide tanker fleet and surpassing the combined value of the global container and LNG tonnages.[9]

The recovery is still fluid and the BDI losing one-third of its recent market gains in late February 2018 clearly demonstrates lingering volatility. Although some related this to the Lunar New Year slowdown, there is a strong school of thought that China's plans to address air pollution by curtailing steel production and the proposed U.S. imposition of steel tariffs project choppy waters for this market.[10]

4. TANKER MARKET:

The challenges engulfing the tanker market is extra-ordinarily unique. On one side, there was an unprecedented supply surge from the U.S., a non-traditional crude oil supplier, with export volumes exceeding that of its traditional forte of oil products, and reaching over 30 countries in 2017.[11] The increase in U.S. crude exports during the first ten months of 2017 provided employment for 75 additional very large crude carriers (VLCCs), and rose to nine VLCCs a month during the last quarter.[12] By end 2018, the U.S. crude output is expected to reach 11 million barrels per day, and exports will exceed the equivalent of one VLCC (of two million barrels capacity) per day. The LOOP (Louisiana Offshore Oil Port) terminal is preparing for

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[8] The BDI itself underwent a structural change on 1 March 2018 when it became an exchange traded fund. Handysize bulk carrier segment will not be represented any longer in estimating the index value whose composition will be reallocated amongst the other three bigger ship sizes.
[9] "Value of Dry Bulk Tonnage Soars," Maritime Executive Newsletter, 13 March 2018.
[10] China ordered steel producers in 28 cities to cut down steel production between mid-November 2017 and mid-March 2018 to reduce air pollution. Some believe this may continue beyond the winter months. Source: Reuters, "Baltic Index Approaches 6-Month Low," Reuters, 1 February 2018.
[11] "Gulf Coast Shipping Boom: U.S. Oil Exports Pour into Worldwide Markets," Reuters, 8 February 2018.
[12] "U.S. Crude Exports Exceed Oil Products Exports," Maritime Executive Newsletter, 12 December 2017.

accommodating VLCC exports and has made its first ever export on such a large-size vessel.[13] The benefit of such shipments is a saving of $300,000 in direct costs and one to four days in cycle time.[14] What is even more noteworthy about this trend besides the obvious ease in shipping logistics and the depleting role of oil traders is where the oil is headed. With China buying about a quarter of these exports, there is significant increase in vessel utilization (represented in tonne- miles) and revenues for the owner. Another new customer is India, world's third largest oil importer. While one would expect these developments to drastically change the market fortunes, that has not realized.

The supply of crude oil carrying capacity increased through a surge in new ship deliveries during the year.[15] In addition, because of the return of backwardation[16] in oil markets, it is less desirable to store crude oil now. The OPEC nations are trading off their stockpiled oil reserves which then releases ships used for floating storage (mostly of the VLCC size), adding to the number of crude tankers seeking new employment. So, cumulative tonnage supply growth exceeded the demand growth in 2017. Overall, market for the bigger crude oil tankers remain lackluster especially in light of anticipated cutback in crude oil stocking by China. Although there was a major uptick in tanker recycling towards the end of the year, it was not substantial enough to make a dent in the reported $50 billion decline in value of worldwide tanker tonnage from 2015 to 2017 or the lackluster commercial outcomes.[17]

5. LINER MARKET:

In retrospect, 2017 was a good year for the liner market with freight rates rising and many operators displaying uncharacteristic self-discipline. The ordering of new tonnage followed the restraint demonstrated in 2016 and led to 2.9 percent annual growth in deadweight capacity in 2017 as opposed to a demand growth estimated at

[13] "Looking to Export, America's Busiest Oil Terminal Tests Loading of First Supertanker," Reuters, 13 February 2018.
[14] "Supertankers Sailing from U.S. to Cut Time, Money and Traders," Bloomberg News, 26 February 2018.
[15] Clarksons estimates 4.7 percent increase in total tanker fleet and 15.2 percent increase in tanker deliveries in 2017 compared to 2016. For details, see Clarksons Research BLOG (5 January 2018), "2017 Review: How are the Year End Stats Looking?" https://clarksonsresearch.wordpress.com
[16] A financial term used in the oil futures market which implies that the market anticipates near-term prices to exceed those in later months.
[17] See Note 8

over 5 percent for the year.[18] The surplus capacity, built up over the years and kept inactive in recent years, was brought into service; simultaneously, the recycling of older ships also slowed in 2017. As a result, the Alphaliner charter index registered an unprecedented 46 percent annual increase for the year. Drewry, the U.K.-based shipping consultant, estimates collective year-end profits of $7 billion, a welcoming change after losing $10 billion in 2016.[19] This is evidenced by the increase in operating profit reported by Hapag-Lloyd, CMA-CGM and others.[20]

BIMCO notes that market conditions will remain balanced in 2018 and that profitability may only come through cost cutting and slow-steaming. The recent resurgence in ordering highly fuel- efficient, very large container ships(VLCS)[21] validates this as also the increasing market consolidation and mergers among top operators. It is remarkable that the current fleet size in number of ships has gone up by only 109 since 2012 while the corresponding growth in nominal capacity has been 5.6 million twenty-foot equivalent units (TEUs) and a 24 percent increase in the number of containers carried.[22] The efforts to embrace Blockchain technology and crypto currencies is another testimonial to carriers' desire to enhance transparency and efficiency within the liner-oriented global supply chain.[23] At the same time, a recent McKinsey and Company Report finding that twenty years of surplus capacity in the industry has destroyed over $100 billion in shareholder value is unnerving for the investors. The top ten owner groups now own 46 percent of the total gross tonnage making it second only to the cruise industry in market concentration; market share of the top five operators is expected to increase to 57 percent in 2018 (Fitch Ratings).[24]

[18] See reference listed for Note 14.
[19] Drewry. "Container Market Outlook and Freight Rate Trend," 2018.
[20] "Hapag-Lloyd Triples Operating Profit in 2017," Reuters, 28 February 2018.
[21] The latest 20,600 TEU vessel delivered for CMA-CGM in late January 2018 will have a daily fuel cost of about $70,000 compared to the typical $94,000 daily expense of other VLCS in use today. Source: "CMA CGM Slashes Fuel Costs on New Flagship," The Loadstar, 30 January 2018.
[22] Clarksons Research BLOG, "Box Shipping Still Feeding the 5,000….," 16 February 2018. https://clarksonsresearch.wordpress.com
[23] 300 cubits, a Hong Kong-based company, has launched a dedicated new crypto currency "tokens" called the TEU. Maersk and IBM have announced a joint effort to use Blockchain technology to manage the paper trail involved in container shipping movements.
[24] Fitch Ratings (1 March 2018). "Staying Profitable May be Tough for Container Shippers." https://www.fitchratings.com/site/search?content=research&request=Container%20Shipping

6. THE U.S. MERCHANT MARINE:

A glaring weakness of the Merchant Marine in recent decades has been the industry's dismal failure to capitalize from its ubiquitous contributions to societal welfare and enhanced standard of living worldwide.[25] For a fast-paced world mesmerized by instant communications, autonomous vehicles, hyperloop movements and space-age flight to Mars, vintage commercial shipping operations simply lack the pizazz. Shipping movements today are totally mundane and any attention received is typically limited to catastrophic human errors or vessel failures, and also when used as a convenient target for settling political scores at opportune times.

The atypical attention the industry received in the U.S. in 2017 falls squarely between the above two frames of reference. The USCG as well as the National Transportation Safety Board released their findings on the *El Faro* tragedy that cost 37 lives in 2015. Both reports include excellent recommendations that should enhance safety standards in U.S. shipping operations as well as worldwide. In contrast, the attention received during the 2017 hurricane season, in particular post-Hurricane Maria--the fierce storm that devastated the island of Puerto Rico--was either because of sheer ignorance or as part of a clever strategy to settle old political scores. The post- hurricane relief activities in Puerto Rico ran into numerous logistical challenges and could have been executed far better than how it went. If any "one" logistics sector rose to the occasion and delivered a flawless Humanitarian Assistance and Disaster Relief (HADR) operation there, it was by the U.S.-flag commercial ships that serve the U.S.-Puerto Rico trade[26] and the Maritime Administration (MARAD)-owned training vessels used by FEMA to shelter their first responders. What the maritime industry received in return was not accolades but a barrage of seemingly coordinated but misguided political attacks that were exquisitely timed and well-choreographed. Their campaign painted indelible images of a vile, crafty, and villainous U.S.-flag commercial maritime industry that not only hampered the relief activities but also schemed to ruthlessly exploit the Puerto Rican economy. The false and misleading arguments

[25] Containerization of cargo alone has raised GDP by $15 trillion as per the 2018 McKinsey and Company Report on Container Shipping. http://mckinsey.com

[26] "Crowley: Six Months After Hurricane Maria, Puerto Rico's Road to Recovery is Being Made By Sea," Editorial, gCaptain, 20 March 2018, http://gcaptain.com/six-months-after-hurricane-maria-jones-act-fleet-continues-to- ensure-a-steady-flow-of-supplies-to-puerto-rico/

used to make that case stretched from wild and fanciful pontification at one extreme to sheer ignorance at the other, their laser focus being on the cabotage provisions of the venerable Jones Act (of 1920).[27]

The unique role of the U.S. merchant marine in peace and war remains grossly misunderstood by the public at large. The industry's role during every crisis the nation has faced since its founding days is well documented, but it is either rarely recognized or often forgotten by the citizenry. While the contemporary economic contributions of the industry may not be much more than of "insurance" value, it is its increasingly vital national security role that sadly remains a complete enigma to the populace. That part of the merchant marine mission and its strategic role in global force projection and the maintenance of national security interests worldwide ought to be disseminated more effectively and receive wider recognition than ever before.

One of those untold stories is that of the 61 commercial ships, maintained on five-day readiness status by a skeleton crew at the behest of the U.S. Transportation Command through MARAD and the Military Sealift Command (MSC)[28]. These vessels are the logistics backbone for troop mobilization and force projection. While routine maintenance might see to their technical readiness, the equally important operational readiness of those vessels is fully dependent on the availability of mariners with the appropriate USCG credentials. A recent Report to Congress[29] found that 11,678 mariners with unlimited USCG credentials are required to mobilize the sealift vessels whereas reliable estimate of such mariners, who have sailed within the last 18 months, is only 11,768. Thus, full mobilization along with the simultaneous operation of 181 commercial vessels that keep the U.S. economy moving will wipe out almost the entire pool of available qualified mariners. Losing any more than two commercial ships from the current fleet will significantly impact the RRF's readiness capability. Given the voluntary nature of mariner services and the likelihood of all future mobilizations being in a contested and hazardous operating environment, the assumption that all qualified mariners will report when called upon is simply

[27] For a good discussion of various misinformation related to the Puerto Rican relief activities, see Mark Ruge, Sarah Benson, and Elle Stuart, "Facts Still Matter," Maritime Executive Newsletter, 25 February 2018.
[28] MARAD maintains 46 of these ships and MSC, 15. For details, see http://marad.dot.gov
[29] Department of Transportation. "Maritime Workforce Work Group Report." Report to Congress, FY 2017 Pub. L. No 113-328, Section 3517. Washington, DC: DOT, 23 January 2018.

unrealistic. Finally, the Report identified the need for 13,607 qualified mariners for sustaining the mobilization and commercial operations concurrently under highly optimistic assumptions of no loss of life or property. The identified pool of mariners will therefor provide three to four months of force projection support at best, taking into account the necessary crew rotations. The reason why we are in this predicament stems from the rapid depletion of our commercial fleet size, particularly since 2012 when drastic changes were made to the carriage of foreign aid cargoes on U.S. bottoms.[30] Any attempt to tinker with the Jones Act as currently articulated will only hasten a precipitous diminution of our indispensable surge sealift capability.

The argument that freedom from Jones Act will bring an immediate cure to Puerto Rico's economic woes does not seem rational. Leaving aside all the national security interests, even focused economic studies have been non-conclusive at best.[31] The assumption that all cost factors will remain *ceteris paribus* in a world without Jones Act is rather heroic. A case in point is the recent decision by the U.K. government to mandate that mariners working in their waters must earn salaries equivalent to the British national wages regardless of the ship's flag. It is inconceivable that in today's political environment, such an initiative will not be instituted by other traditional maritime countries. This one move alone will wipe out any crewing-related cost advantage of a foreign-flag operator allowed to partake in noncontiguous U.S. waterborne commerce transportation.

7. AUTONOMOUS VESSELS:

With the evolution of driverless cars, the use of artificial intelligence in shipping operations has garnered considerable attention. Remarkable progress is being made by innovative companies like Rolls Royce, Kongsburg, Google, Wärtsilä, Transas, and others to lay the course for the dawn of autonomous vessels.[32] "Yara Birkland," world's first autonomous, zero emissions cargo ship, developed jointly by Yara

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[30] The total number of U.S.-flag ships of the size that employs mariners with unlimited credentials has declined from 281 in year 2000 to 181 by end 2017. About fifty vessels departed the U.S.-flag after the legislative changes in 2012.

[31] See U.S. Government Accountability Office, "GAO Report to Congress: Puerto Rico – Characteristics of the Island's Maritime Trade and Potential Effects of Modifying the Jones Act," Washington DC, March 2013.

[32] "Unmanned Ghost Ships Could Set Sail as Early as 2020, But Experts Warn They May Result in More Accidents," Daily Mail, 7 September 2017, http://www.dailymail.co.uk/sciencetech/article-4861298/Expert-warns-challenges- unmanned-ghost-ships.html

International and Kongsburg Gruppen, is expected to move cargo between three Norwegian ports in sheltered Norwegian waters from 2020. Norway has designated a second autonomous vessel test area in the proximity of another maritime cluster which will be used by Rolls Royce, Google, and their partners.[33] The U.K. Ship Register has already registered its first unmanned vessel which can also operate conventionally. All these are spectacular developments in adopting emerging technologies by the maritime industry. However, commercialization of crewless ships facilitating waterborne movement of the 10 billion tonnes transported by cargo ships today remains farfetched. Neither the littoral states nor the industry has reached acceptable risk tolerance levels that would permit free access to vessels laden with even harmless consumer goods let alone dangerous commodities like petroleum or its derivatives.[34]

There is no assurance that the level of sophistication and the risk avoidance capability of artificial intelligence-driven ships is anywhere close to the intricate mastery of manoeuvers that a diligent watchkeeping officer often executes when navigating in the vicinity of a flotilla of small fishing boats or pleasure crafts, many of which are often too small to be detected by even modern radars. The uniqueness of an experienced mariner comes not from any extra-ordinary intellectual capability but from the possession of simple commonsense and sound judgment (euphemistically referred at sea as behaving in a *seamanlike* manner) built upon years of exposure to the maritime environs, and the willingness to subject oneself to the rigors of self- discipline of the highest order. Autonomous vessel navigation in sheltered coastal waters or making epoch-making trial runs in the Scandinavian fjords will never be comparable to the skillful maneuvering of a fully laden VLCC or VLCS in congested waters off the South China Sea or the Malacca Strait in a tropical rainstorm or in the English Channel in thick fog with zero visibility. Even if all the technical challenges were resolved and this author is proven totally wrong, the economics of autonomous vessel operations remain unproven.

The total cost associated with an autonomous vessel system including construction and

[33] "Norway Nominates Another Autonomous Ship Test Area, "Maritime Executive Newsletter, 3 October 2017.
[34] See comments by Soren Skou, Maersk CEO, "Unmanned Containerships Not in My Lifetime," World Maritime News, 16 February 2018.

resiliency costs, vessel operation and supporting system costs, enhanced insurance costs, and the unprecedented training costs associated with a fail-safe transoceanic navigation system far exceeds that of a traditional vessel operating system. Even the magnitude of the costs associated with an autonomous vessel and its supporting systems remains more of a guess than one associated with any level of confidence. As discussed earlier, shipowners who are highly cost conscious and make every effort to control it, barely make normal returns at best on their current shipping investments. Convincing them to switch over to another much more expensive and unproven system in a cyclical and often volatile market will be a Herculean task, at least in the foreseeable future.

There may indeed be a role for autonomous ships on short, sheltered coastal voyages, and for the military and perhaps even for certain niche port-to-port cross-border cargo movements between neighboring states[35] but their evolution as a superior alternative to traditional cargo ships, the proven contemporary *workhorses*, is far from commercial reality. These arguments are not intended to belittle the scope for increased automation and robotics on board ships; such innovations are essential and may help lower operating costs. Lastly, even if the autonomous ship technology were available and the economics made sense at some point in the future, reaching global consensus on the legal framework required to facilitate trans-border or oceanic movement of commercial cargoes, regardless of the nature of those cargoes, is far off from acceptable levels of multilateral risk tolerance that exist today.[36]

8. OUTLOOK:

The world maritime sector is on the cusp of a new era of optimism and enthusiasm, and there are several *a prioriori* indicators of favorable market conditions. While the U.S. merchant marine will benefit from the global rising tide, the undercurrents that shape its immediate future are more tenuous. Any course towards resurgence will therefore be laden with many complex obstacles, and traverse far beyond commonly

[35] Such near-term disruptions involving the use of drone technology, hyperloop, and rockets are well within the reach of early adoption.
[36] For example, see the global outcry following the Prestige casualty (Ref: "Court Awards Spain $1.9B for Prestige Spill," Maritime Executive Newsletter, 15 November 2017); the general reluctance of coastal states to open a port of refuge for foreign vessels in distress; or, the protracted sixteen-year discussion that preceded the adoption of the 2004 Ballast Water Management Convention and the ongoing challenges with its final implementation.

analyzed economic and market considerations. The tangential benefits one sees for the industry domestically must be weighed more against the multitude of shrewd manoeuvers that percolate within the corridors of political power--whether those be related to the ascendancy of China on the maritime power curve, cyber warfare on the U.S. maritime infrastructure, anti-Jones Act machinations, or the declining commercial fleet size and mariner pool--than Alfred Marshall's twin blades of the same scissor. Indeed, the future is no longer quite what it used to be.[37]

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Dr. Shashi Kumar is a Master Mariner, Fulbright Senior Specialist Fellow, and Professor Emeritus of International Business and Logistics. He sailed extensively for over a decade prior to entering academe, and is now in his 32nd year of distinguished leadership and educational services to the maritime community. This is his 15th Merchant Marine Annual Review published by the US Naval Institute Proceedings.

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[37] A quote from 1937 attributed to Paul Valery, noted French poet and philosopher.

HYDEL POWER GENERATION AND REGENERATION OF ENERGYS
(GREEN PORT DEVELOPMENT)

R. Jangra (Cadet)
S. Majumdar (Cadet)
K. Anand (Cadet)
P. Seth (Cadet)

Abstract

This projects aims at utilising the flow and the wave energy specifically from the flowing rivers. The project is primarily designed for the inland waterway project which is at its growth in India. Here, we have proposed two different designs that is one is fixed unit and the other is a floating unit. The flow energy of river is utilised and converted to electrical energy via a rotary impellor and the wave energy is converted to the electrical energy through a rack and pinion mechanism or by one more mean that is through the phenomenon of electromagnetic induction. These designs can be installed as per there suitability towards the river behaviour and can serve to the need of the rising demand of green energy with minimum investment and maintenance. A proper experimental and stimulation data have been complied to prove the feasibility and application of the design along with getting to know the areas to work on more. In our paper we have specifically displayed worked upon by taking into consideration the parameters of river Ganga for carrying out the experiment and stimulation's, similarly the parameters of other rivers can be taken into consideration for designing the components of the device in order to be installed in that particular river. The proposed device could bring renewable power generation as close as the nearest flowing water, making micro-hydro a reality for many who live near streams and rivers. It is both efficient and cost-effective, as well as less intrusive to the environment than other hydroelectric solutions.

Keywords: Hydel Power Generation

1. INTRODUCTION:

India has around 14,500 km of inland navigable waterways. There are twelve rivers which are classified as major rivers, with the total catchment area exceeding 2,528,000 km^2 (976,000 sq. mi). All major rivers of India originate from one of the three main watersheds:

- The **Himalaya** and the Karakoram ranges
- **Vindhya** and Satpura range in central India
- **Sahyadri** or Western Ghats in western India

Also it has an extensive network of **inland waterways** in the form of rivers, canals, backwaters and creeks. The total navigable length is 14,500 km (9,000 mi), out of which about 5,200 km (3,200 mi) of the river and 4,000 km (2,500 mi) of canals can be used by mechanized crafts.

So, it is highly sensible and important to utilise the hydel energy stored in water in some of the other way. This energy can be further utilised as per our requirements. Our design aims at utilising the flow for producing electricity at the most cost effective way.

The project consists of two design:

1. FLOATING UNIT (FLOATING HYDRO WHEEL)
2. FIXED UNIT (HYDRO WAVE IMPELLOR)

Both the designs aim at generating electricity from water.
The floating hydro wheel is a floating unit which converts the river flow into electricity. The hydro wave impellor is a fixed instalment unit which converts the river flow into electricity and also generates electricity through waves and variable river depth.

2. PROPOSED SYSTEM DESIGN and OPERATION:

A. System design and configuration

1. FLOATING UNIT (FLOATING HYDRO WHEEL)

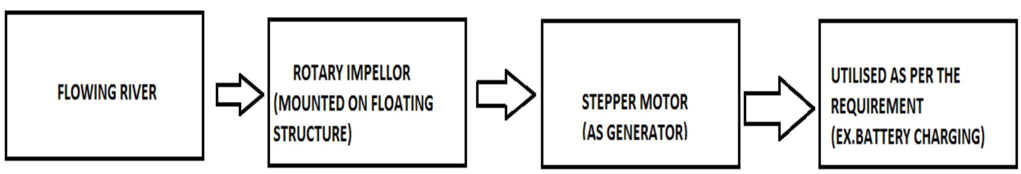

Figure.1: Block diagram describing the utilisation of river flow

The river flow rotates the impellor mounted on the floating structure. The shaft on which the impellor is mounted is geared with the stepper motor. The electricity produced can be further utilised as per the requirements.

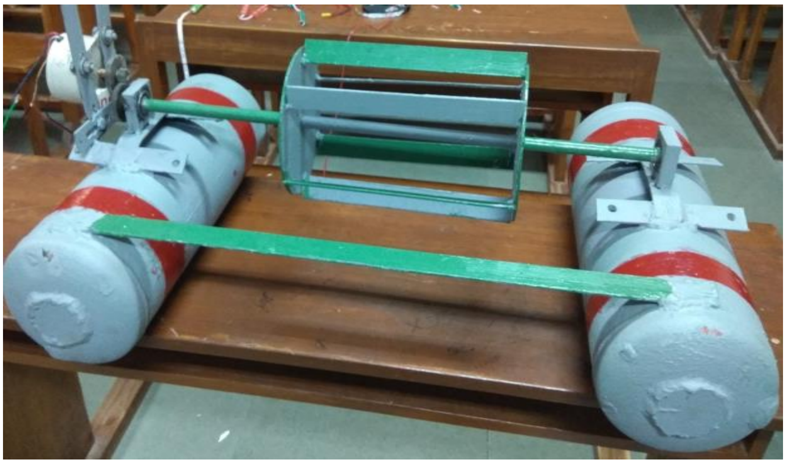

Figure.2: Floating unit

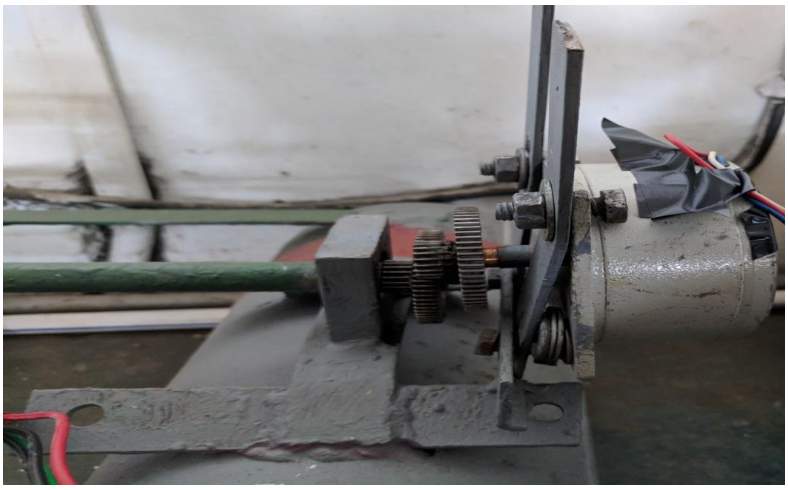

Figure.3: Shaft geared with the stepper motor

3. SCOPE OF IMPROVEMENT:

- **Catamaran Hull**: For streamline flow of water

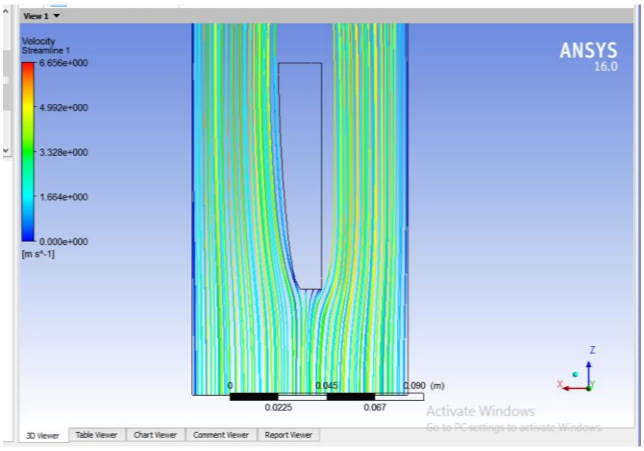

Figure.4: Comparison of flow analysis of catamaran hull and cylindrical hull

On a higher scale the floating structure can be made of a catamaran hull, in order to reduce the river drag so that more of the river flow can be utilised to rotate the impellor rather than just forcing the entire unit backwards. Here, we have put up a CFD analysis of a Catamaran hull in comparison with the normal cylindrical hull used in our experiment. And the difference in the velocity over the body can be seen, from which the formation of eddies and thus drag can be seen.

- **Aluminium Fins:**

To reduce the moment of interia of the rotor the Fins can be made of aluminium.

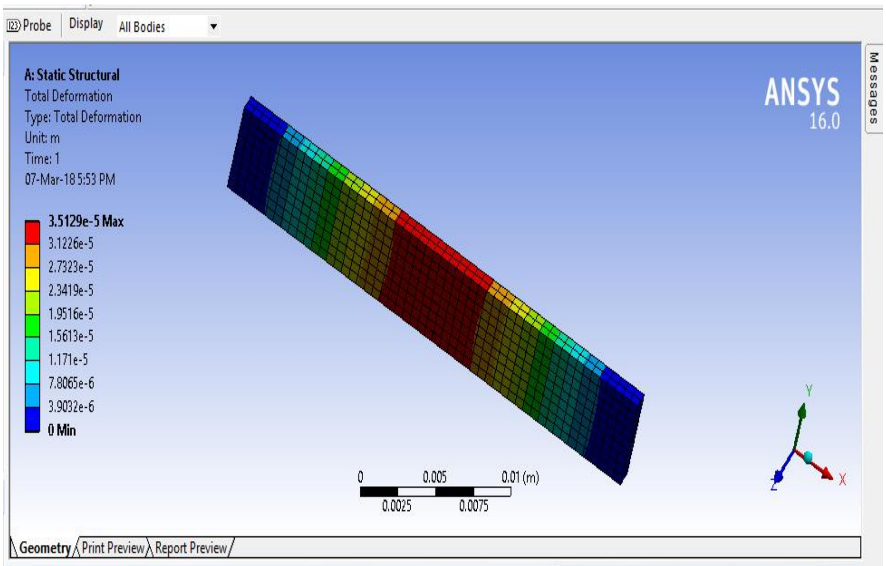

Figure.5: Deformation analysis of aluminium fins

We have performed a deformation analysis of a aluminium blade in order to find out the degree to which it can take up the river flow pressure. In the analysis we have applied the 5bar pressure which resulted in the maximum deformation at the center of blade but the amount is still small. So, it can be concluded that the blade is safe.

- **Hydrofoil Blade:**

Due to the limitation we had in manufacturing facility and in the availability of material we chose to have a flat shape blade but the most optimise shape will be a hydrofoil shape.

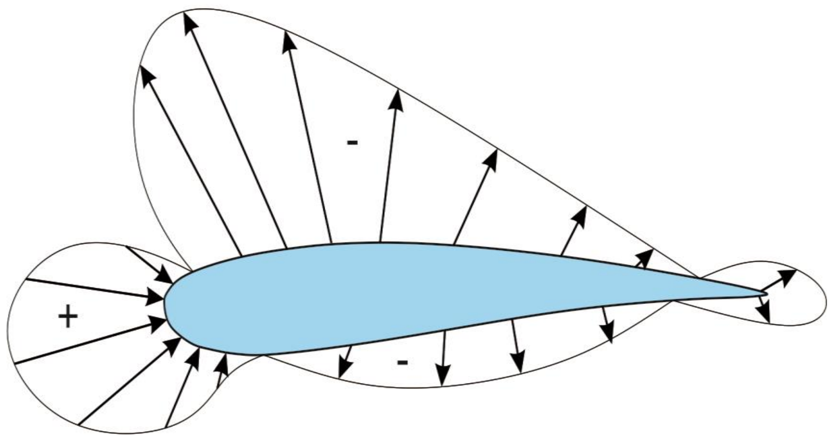

Figure.6: Positive and negative pressure distributions along hydrofoil surfaces

with application the hydrofoil blade the impellor will be assisted with more torque leading towards more rotation. Since, the thrust of water will more be utilised in the lift force rather than in the drag force.

4. FIXED UNIT (HYDRO WAVE IMPELLOR):

This design is a fixed instalment which generates which utilises flow as well as the waves of the river to generate electricity

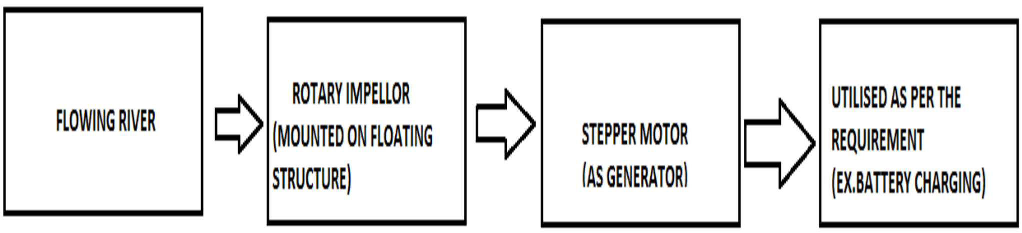

Figure. 7: Block diagram describing the utilisation of river flow

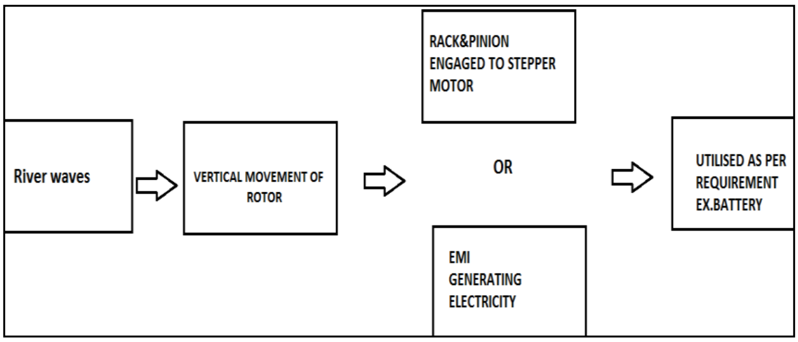

Figure.8: Block diagram describing the utilisation of river waves

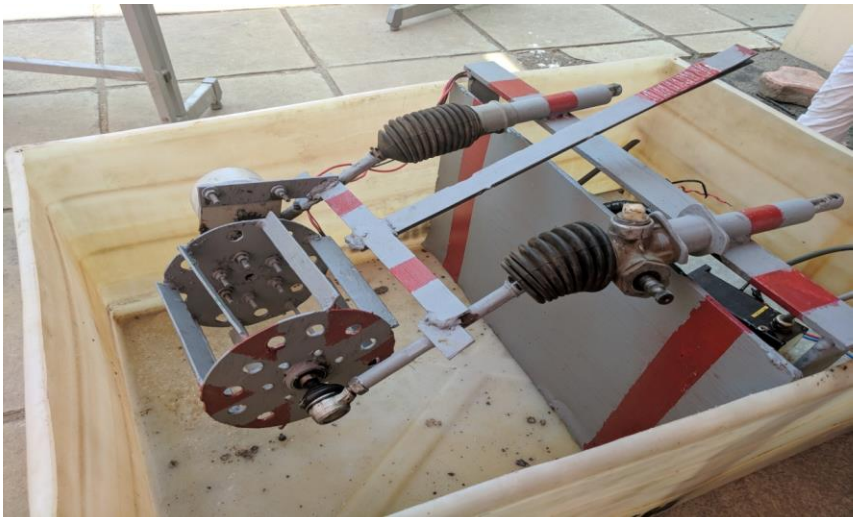

Figure.9: Fixed instalment design

The river flow rotates the impellor mounted on the floating structure. The impellor is geared with the stepper motor. In case of waves the impellor will move vertically up and down which will lead the rack connected on its backside to undergo a reciprocating motion leading to the pinion connected to the another stepper motor to rotate. This vertical motion can also be utilised by connecting current transformer instead to the rack and pinion leading to generation of electricity via EMI phenomenon. The electricity produced can be further utilised as per the requirements.

The ball joints are employed so that in case of any thrust by the river flow in any transverse direction the rotor can adjust itself and do not get damaged.

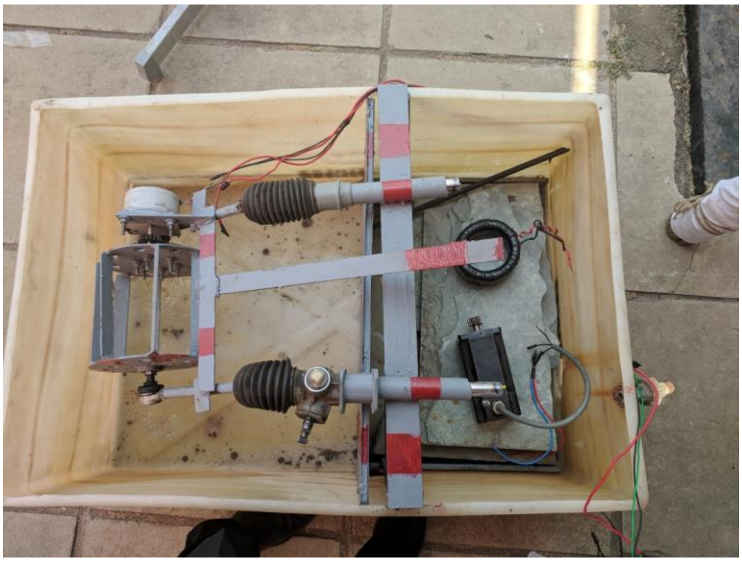

Figure.10: Fixed installation (Top View)

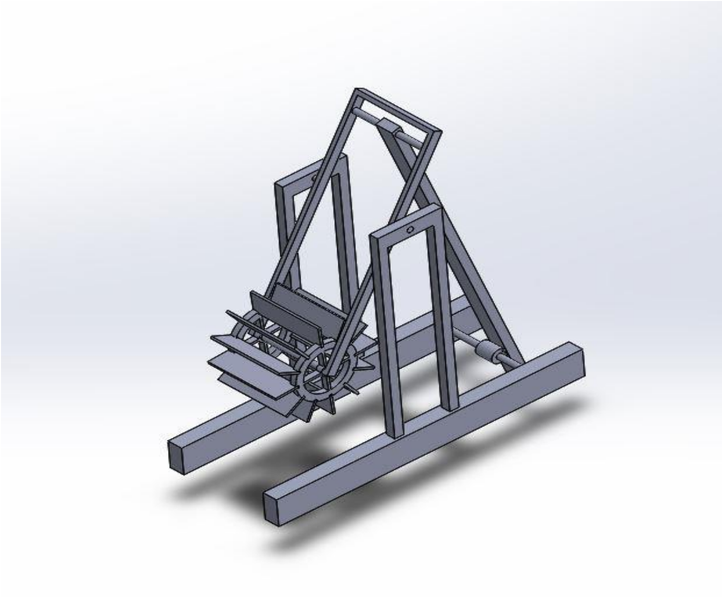

Figure.11: Proposed designed

5. PROJECT ELECTRICAL CIRCUIT DIAGRAM:

Switches that can be turned to different positions to make a connection with the contacts in that particular position. A rechargeable battery, storage battery, or accumulator is a type of electrical battery. It comprises one or more electrochemical cells, and is a type of energy accumulator. It is known as a secondary cell because its electrochemical reactions are electrically reversible. Rechargeable batteries come in many different shapes and sizes, ranging from button cells to megawatt systems connected to stabilize an electrical distribution network. Several different combinations of chemicals are commonly used, including: lead–acid, nickel cadmium (NiCad), nickel metal hydride (NiMH), lithium ion (Li-ion), and lithium ion polymer (Li-ion polymer). When electricity is produced in DC generator, current passes through the rectifier and rechargeable battery is charged. When power is needed during the night time, selector switch is on and rechargeable battery supplies required power.

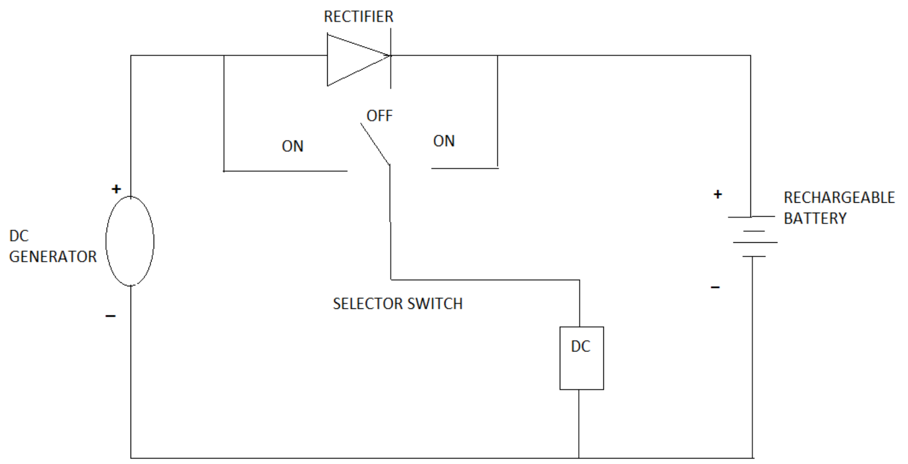

Figure.12: Circuit diagram

6. ANALYSIS AND RESULT:

This was the result found after the performance of our device.

Experiment conducted at the institute lake.

RPM:1000

Voltage Produced:12V

Current: Greater Than 0.125Amp

7. SCOPE OF OUR PROJECT:

The device can be installed at-

- Rivers near the embankment-where the generated electricity can be transmitted to the sub-stations. This means this device can be used on certain intervals of distance in particular region of suitable rivers (where the flow rate is more favourable). So, the units as a whole can supply the electricity to the sub-station which can further be used for the nearby locality and inland waterway terminals.
- The unit at night can also be used for the harbour lighting.
- For the rivers where the flow rate is less than the required a separate water tunnel can be constructed, which would channelise the river water onto the unit by increasing the velocity of the flow. At the same time that channel can act as a way through at the time of river flooding.

- Since the unit is floating apart from generation of electricity it can also be used for installing signal transmitting antenna and also as a guiding lights at ports.
- If this device is installed in units than it can also be equipped with the PPM meter or Viscosity sensor which can detect the oil spill and pollution and send signal immediately to the nearby inland waterway terminal. So, that suitable action can be taken as soon as possible.

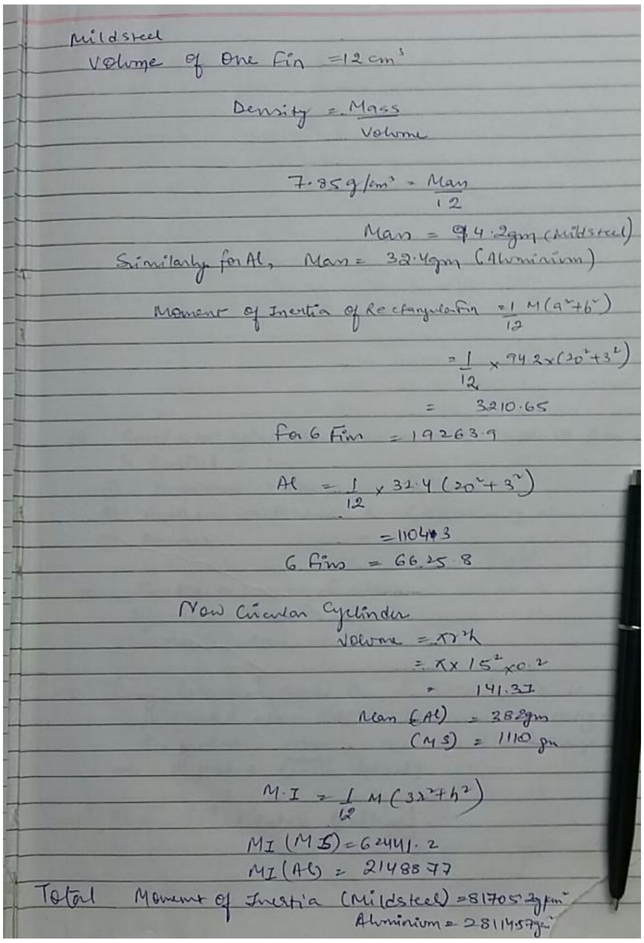

Figure.13: Calculations for moment of inertia (Aluminium and Mildsteel)

8. CONCLUSION:

In coming days, it will prove a great boon to the world, since it will save a lot of electricity of power plants that gets wasted in illuminating the street lights. As the conventional source are depleting very fast, then it's time to think of alternatives. We got to save the power gained from the conventional sources for efficient use. So this idea not only provides alternative but also adds to the economy of the country. Now vehicular traffic in big cities is more, causing a problem to human being. But this vehicular traffic can be utilized for proper use by taking this specialised speed breaker into use. It has advantages that it does not utilize any external source. Now the time has come to put forte this type of innovative ideas, and also researches should be done to upgrade its implication. In future, if the flywheel speed control device and voltage protection devices are added with large generation process, it would be a model all over the world. After some modification of the designed project, the efficiency of the whole system can be increased by increasing the capacity of the generator and applying more weight. Also during our experiment, we have used mild steel due to availability but if we replace this by aluminium the effectiveness increases which is shown in the calculations above

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