3rd GRADUATION DAY ADDRESS

AMET University

Advances in Marine Technology & Opportunities

By

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1. I am delighted to participate in the 3rd Graduation Day function of Academy of Maritime Education and Training – AMET University. My greetings to the Chancellor His Excellency Mr. Edthimios E Mitropoulos, President Dr J Ramachandran, Vice Chancellor Col. Dr. G Thiruvasagam, Members of the Board of Management. I express my thanks to the Chancellor and President for honouring me with the Degree of Doctor of Science (Honoris Causa). I extend my greetings to the faculty members for their excellent and devoted efforts to shape the young minds for meeting the challenges of tomorrow and to the graduates who have successfully completed their course. The graduation marks the end of one phase of life which provides a solid foundation for the challenges that you all will encounter in future. A very exciting future beckons all of you as you step out of this institution.

2. AMET has got the unique status of being India's first Maritime University having students from India and abroad. With a short span, starting 1993, it has taken long strides to reach where it is today. I am happy to note that AMET covers the entire gamut of the maritime field that is a necessity for a seafaring country like ours. AMET fulfils a necessary area that was not fully enveloped by institutions in this field.

3. The need of the hour is for universities to provide liberating, invigorating, innovative as well as adapting environments. Universities should also necessarily involve in undertaking research which are deemed essential for future growth and direction, apart from regular teaching forming the Technology Incubator. I am happy to note that AMET is taking active part in

encouraging research. I am sure we will hear about the research findings in the years to come.

4. India has a rich maritime history. As you are well aware, sailing has been instrumental in the development of civilization, affording humanity greater mobility for trade, transport or warfare. In ancient maritime history, even before two millennia, there is evidence of maritime trade. The first prehistoric boats are presumed to have been dugout Canoes which were developed independently by various Stone Age populations. Maritime history embraces many aspects of history, such as navigation, oceanic currents, maritime transportation, coastal society, development of ports and port-towns, sea-borne trade and commerce, port- hinterland relations and so on.

5. As far as India and the Indian Ocean regions are concerned, maritime studies have a great relevance in the exchange of culture, establishment of political power, the dynamics of society, trade & commerce and religion. As early as 3rd Millennium BC, the Mauryan started an organized Navy to send massive diplomatic missions. During the Medieval Period, the Chola Dynasty was at peak, Rajaraja Chola I and Rajendra Chola I extended their kingdom using their Navy. The region was extended as much as to Indonesia, Malaysia and other eastern countries. The proof of which is that Chola King was called as ***"Kadaram kondan"*** (who conquered Kadaram). History proves that our maritime heritage has been rich.

6. I would now like to briefly dwell upon the various facets of the maritime field, the chosen one by all of you, but that effects the entire world as well as India and its quest for progress.

The Potential

7. 71% area of the Earth is covered by water. India has a vast coastline of 7500 km with 2 million sq. km of Exclusive Economic Zone (EEZ), coastal population of 370 million bestowing us with a huge potential to exploit the sea for our needs. The Indian economy is dependent on its sea routes, both for imports as well as exports. In order to meet the resurgence of India as a world

power, in my opinion the sea route will provide the best resource. Besides, exploitation of the vast EEZ will itself add to its resources, when India starts to utilise the same. However, the seas also provide a gateway for entry to the shores of India and would need to be guarded against the wrong doers. We need to focus on the defence aspect related to the seas as well in our maritime strategy formulation.

8. How can we benefit from the vast potential of the seas?

(a) **The trade potential**: Slowly and steadily, as you can gauge, Indian economy is expanding, very soon we would be the 2nd largest, if not the largest, economy in the world. We would need to transport huge amounts of raw materials and produce to and from our industries in India as well as abroad. The sea would be the most ideal and cost effective mode.

(b) **The energy potential**: Seas are potential energy sources, both in terms of hydrocarbons (oil and gas fields) as well as non-conventional forms – wind, tide, thermal, current etc are potential sources waiting to be tapped.

(c) **The mineral potential**: The seas cover vast areas that can yield rich harvest of minerals when the challenge of extraction from the sea floor is overcome.

(d) **The medicine potential**: The use of marine plants and other organisms from the oceans, for medicinal purposes have been known to the people, particularly those residing long the coasts, since long. The invertebrates, such as sponges and molluscs, in the ocean bear a large group of structurally unique natural products and offer exciting possibilities as sources of new drugs. Research is also underway to produce anti-inflammatory steroids extracted from the enzymes of invertebrates such as sponge, or coral. Ocean offers anti-bacterial agents, drugs for osteoporosis and so on from its treasure.

(e) **Other potentials**: Seas may provide us a viable solution to overcome water crisis in large cities by suitable means of desalination. And in not so distant future, we may have floating as well as underwater cities to live in.

9. Some of the potentials I have covered above are already in various stages of development. We need to prioritise and focus on them so as to harness the benefits. It is a fact that we know much less about the seas and oceans than what is on land. Thus, the potential is still largely unchartered and should interest many of you, if not some.

MARINE TECHNOLOGIES

10. Now, let me present before you the advances happening in the maritime defence field, particularly with reference to the Indian scenario. The DRDO is in the forefront of cutting edge and innovative research and development in various fields of maritime technologies. Be it materials, propulsion system including AIP like fuel cells, communication system, global positioning system, weather monitoring system, life saving and other safety systems, hydrodynamics, AUV technology, corrosion protection, environmental technologies etc. etc. You all may wonder if I have left out anything. It is pertinent to note that in maritime field all technologies that are in use today as well as cutting edge space technologies find increasing use. It is an environment where only the best of technologies can perform and there are no second chances.

11. As famously concluded by Pt. Jawaharlal Nehru that “to be secure on land we must be supreme at sea”, maritime defence plays a vital role in India’s prospects. To safeguard our maritime interests, we need to have maritime power, not only in terms of a powerful Navy, but also in terms of technologies to stay on top – for being a blue water super power. With a rich history of Indian maritime power, the country, though has lost some edge, is rapidly progressing on the path to regain its position among the powerful ocean faring countries. Not only we have to safeguard our coastal boundaries and inland territories from incursions, but also guard our coastal assets and provide

security to our commercial interest over sea-lanes. We at DRDO and BrahMos Aerospace have been leading, in equipping the Indian Defence Forces, particularly the Indian Navy to be in the forefront.

12. Let me appraise you of some of the technologies that we are working on. These are steps towards making India self-reliant in maritime field. Some of these have been in use as well, or in test & trial phase and in the process of induction.

(a) **Materials:** The shipbuilding quality steel has been indigenized and the recently launched Aircraft carrier of Indian Navy constructed at Cochin Shipyard is built using the same. Stronger steel for submarines is already in the process of induction. Work on composite material and other stronger and safer material for marine application are also happening. Solvent free anti-corrosive paint is used to paint the Interior compartment of ships, storage tanks for petroleum products and in areas that are prone to spillage of acid. High build chlorinated rubber-tar anti-corrosive paints used for painting underwater hull and boot top areas, wetted areas of platforms and pontoons located in Sea. Stratifiable paint blend comprising of epoxy and silicone alkyd resin has been developed with reduced solvent shows very good inter-coat adhesion between the layers that is used for underwater painting. With a quick drying time of 3 hours and an over coating interval of 4 hours, this paint allows rapid underwater painting and the ships need not to be brought back to a dry dock.

(b) **Environment Protection by Bio-degradation**: Marine pollution due to petroleum product such as high speed diesel is a big threat to the marine fauna and flora. The natural dispersion of high-speed diesel, a slow process, is attributed to an overall combined effect of physico-chemical and biological processes which take months for complete dispersion. Naval Materials Research Laboratory (NMRL) has developed a technology for Bio-Remediation of marine oil spill. The bioremediation of pollutant oil is carried out by spraying bio-

emulsifier, oil degrading marine bacteria and nutrient mixture at polluted site in 3 days intervals for complete removal of oil. The oil hydrocarbons are degraded by bacterial alkane monoxygenases and associated enzymes releasing CO_2 and water and no toxic substance. The other bio-molecules generated get incorporated as biomass and 'Bio-emulsifier' as a by-product. The bio-emulsifier developed is a heat stable compound having a molecular weight of ~5000 as determined in a gel permeation chromatography (GPC). Bio-emulsifier is a surface active biomaterial which facilitates emulsification of oil-in-water, enhancing bioavailability of oil for biodegradation in eco-friendly manner.

(c) **Sonar System**: Naval Physical and Oceanographic Laboratory (NPOL), Kochi is engaged in development of underwater sensors for the Indian Navy. The laboratory has made country self-reliant in development of all types of sonars (hull mounted, submarine, air borne and towed array). The systems developed by the laboratory are at par with the existing sonars of the developed countries. Sonars developed by NPOL are extensively exploited by the Indian Navy and are supported by state-of-the-art signal processing techniques and introduction of micro electronics for miniature devices.

(d) **Maritime Surveillance & Sensors**: Maritime surveillance of all the potential threat targets and illegal activities is important even during peacetime. It makes the naval forces aware of the activities going on in the territorial waters and in the general geographical region around the country. The illegal activities comprise all shipping, fishing, smuggling, mining, and surface as well as subsurface military threats. Now, it has become important to keep an eye on the movement of terrorists, even through the sea routes. The surveillance system helps the forces in taking defensive actions. Once detected by the sensors that certain specific illegal activities are taking place, remedial actions follow. Long-range surveillance helps in neutralising the threat well before it gets on to the place to

be protected. It means deployment of appropriate sensors for detection and adequate mobility of the forces to take counter action. Underwater sensors (submarine-based as well as moored), airborne platforms, surface ships and even space-borne sensors are used to conduct maritime surveillance. Target acquisition, an important element of offensive operation, comprises various stages like detection, recognition, identification, and location of a target.

(e) **Research Vessel – INS Sagardhwani**: A floating laboratory of 2000 ton ship of NPOL has got many special facilities for conducting underwater ocean environmental and acoustic experiments both in shallow and deep waters. It is equipped with facilities to carry out research through observation programmes in physical and chemical oceanography; marine meteorology, acoustics, and geology; and geo-acoustics. Data can also be stored in computers connected to individual equipment. The ship is also equipped with navigational aids including satellite navigator, GPS, navigation computer etc. Software which helps in planning of cruise tracks, geo-scientific and oceanographic studies and for monitoring the navigation, quality and, graphical display of data along tracks during marine surveys. The research vessel is equipped with 10 modern laboratory facilities, sophisticated sensors and state-of-the-art handling gears. The data collection is a continuous process based on annual mission plans drawn. It generates a vast database and analysis reports in the form of atlases published regularly to provide vital inputs to design organisations and the Navy for operational purposes.

(f) **Tsunami Sensors**: To provide timely warning to the coastal regions to avert the consequences that we faced the last time – in terms of human lives and property lost. It consists of transducers, acoustic modem and opto-electronic sensors deployed at the ocean bed for detection of earthquake epicentre and the propagation of waves including speed for providing alert in advance. With the expertise of underwater sensors at DRDO and

satellite based communication technology at ISRO, these two organisations joined together to develop satellite based communication network measurement and the Tsunami sensors.

(g) **Underwater Weapons Technology**: The underwater weapons technology is multidimensional, encompassing almost all disciplines of engineering and science. Due to technology denial, the scientists face the most challenging task to develop every bit of technology indigenously for which infrastructural and industry backup are lacking. Naval Science and Technological Laboratory (NSTL), Visakhapatnam has been engaged in the development of torpedoes, sea mines, deep mobile target, decoys, fire control system, versatile acoustic target, and simulators. World class hydrodynamic test facilities have been established for hydrodynamic performance evaluation of ships, submarines and torpedoes through model studies. The technologies related to development of light-weight torpedo, wire-guided torpedo, processor-based mine and fire control system have been developed. Thermal propulsion technology, the most guarded technology with the developed countries for heavy weight and long range torpedoes, has been realised and will be integrated with a weapon system soon. To meet the requirement of reduced self noise of torpedoes and to make them stealthier, a pumpjet propulsion system has been developed and integrated with the torpedo.

(h) **Autonomous Underwater Vehicles**: These state-of-the-art vehicles that are unmanned are stealthy, have relatively longer endurance and are capable of carrying payloads based on mission profile. Their small size and low cost enable them to be deployed on board any ship. Maritime UAVs can be deployed for various missions like anti-surface warfare, anti-surface missile defence, anti-submarine warfare, airborne early warning, mine countermeasure (MCM), and command control & communication in deep waters as well as in littoral waters. These missions include battlefield surveillance, early warning, target acquisition,

intelligence gathering, artillery fire adjustment, battle-damage assessment, and communication relay.

(i) **Nanotechnology**: Among the many new technologies which are gaining global attention today is nanotechnology which is said to revolutionize the next century. Nanotechnology offers a wide range of possibilities of highly efficient and miniaturized systems and devices. Nanotechnology is a creation of functional materials, devices and systems through control of matter on the nanometer length scale (1- 100 nm), and exploitation of novel phenomenon and properties (physical, chemical, biological, mechanical, electrical, etc.) at that length scale. This wide group of materials enables access to new range of electronic, magnetic, mechanical or optical properties. Nanosensors may be used as powerful transponders for electronic communication for naval activities. There are many applications of nanodevices and nanosensors in marine applications. Nano devices and sensors may be used as buoys to transmit airborne data via radio frequencies to remote management computers at ships sailing somewhere in the sea. A swarm of nanobuoys or nano submerged devices can provide key information about sea. Similarly a swarm of nanorobots/ satellite in the space can monitor and predict the behaviour emanating out of ocean. Nanomaterials also offer a wide range of possibilities for the fabrication of mechanical/ stealth/ corrosion resistance structures for the navy. The mechanical structures in the form of nanocomposites are promising. The stealth properties of nanoparticles are excellent.

(j) **Stealth**: Development of enhanced surveillance capabilities of naval platforms and lethality of the advanced naval weapon systems have significantly increased their ability to inflict casualties on forces that can be easily detected, classified, and tracked. Every naval platform has a unique signature, which can be sensed either through the radiations emitted by the platform (passive sensing) or through the echo signals that are received after the sensor

irradiates the platform (active sensing). The signatures, which make naval vessel vulnerable to detection are Electromagnetic Signature (Radar Cross Section), Infra Red Signature, Acoustic Signature, Magnetic Signature, Electric Signature, Hydrodynamic Wake and Extra Low Frequency Emissions (ELFE).

(k) **C^4I**: With the advent of network centric warfare taking prime position in today's scenario, there is a need to integrate all levels of information gathering and bring the useful information in presence of decision making bodies. C^4I^2SR stands for Command Control Communications Computing Information Intelligence, surveillance and Reconnaissance. This provides a host of facilities to gather all information from various sensors deployed at multiple locations, integrating the same and filtering to generate usable data for commanders. This gains importance with likelihood of cyber-warfare gaining ground, as future wars will be fought in cyber space. Maritime domain knowledge would help in increasing our efficacy to protect our maritime interests and assets.

(l) **Space Technology**: Satellite remote sensing applications help in the coastal zone studies with mapping and monitoring of vital habitats, marine protected areas, impact of sea level rise and integrated coastal zone. Potential Fishing Zone (PFZ) maps based on Chlorophyll and Sea Surface Temperature have been developed and are in use in 436 nodes connected through phone, fax email and electronic display board. Indian Regional Navigation Satellite System (IRNSS) provides terrestrial, aerial and marine navigation with accurate position information service to users in around the region extending up to 1500 km from the boundary. Applications of IRNSS also include vehicle tracking and fleet management; mapping and geodetic data; capture terrestrial navigation aid for traveller; and visual and voice navigation for drivers etc. Images from Satellite also help in the monitoring of vessel movement on the sea. Using Synthetic Aperture Radar (SAR), high resolution image of less than 10 m can be obtained.

Satellite communications through a transponder fitted on the ship that automatically communicates to all neighbouring ships thus enhancing maritime traffic safety extensively.

13. I am also proud to showcase a highly successful partnership model that we follow at BrahMos. The model as I will describe now, has borne fruits in a short span of time in a highly complex field as you can imagine, fostering bridges between two different cultures/ countries.

The BRAHMOS Joint Venture – A successful model worth emulating….

India-Russia Joint Venture BrahMos was established in India through an Inter Governmental Agreement signed in February 1998 between the two countries. Defence Research & Development Organisation (DRDO) from India and the JSC MIC NPO Mashinostroyenia (NPOM) from Russia are the joint venture partners of the Company in 50.5% - 49.5% ratio. The JV Company is responsible for joint design, development, production and marketing of Supersonic Cruise Missile Systems with the participation of multiple Indian and Russian institutions and industries. The BRAHMOS system is already inducted in Indian Navy, Army and Air Force. Russian Armed Forces are in the process of finalising appropriate platform for the Induction of BRAHMOS. The system will also be exported to friendly countries. Joint Venture BrahMos is an exemplary example of seamless integration and rapid development of high technology defence products.

Indian Armed Forces and particularly the Indian Navy today has reposed faith in BrahMos by inducting the missile in increasing numbers and for frontline units. The BrahMos missile has been proved highly successful in all its launches. Coupled with the surveillance network on Indian coast, the missile would provide a potent deterrent for any incursions from sea.

The Unique Universal Vertical Launcher Module (UVLM) was designed by the BrahMos Design team. This launcher can be installed in any type of vessels like frigates, destroyers and submarines and can house 8 BRAHMOS missiles. It is a general purpose launcher system that can be accommodated in any type of vessel of any nationality. The unique design of UVLM spreads

out the shock resultant from the missile's exit evenly, and ensures that the shock does not affect the vessel's structure. The greatest advantage of the UVLM is that the missile can take any of the 360 degree direction after the launch. The design of the UVLM has been patented.

Why is BrahMos successful:

A class leading product. BrahMos is a world class product that is highly sought after by customers. The advantages are:

- Universal missile – multi platform, multi-role capability. Multi dimensional capability like launch from ship / coastal batteries as well as underwater to hit floating or land targets
- Long flight range with supersonic speed all through the flight.
- Shorter flight time leading to lower target dispersion and quicker engagement.
- Wide range of flight trajectories.
- 'Fire and Forget' principle of operation.
- Higher destructive capability reinforced by high kinetic energy
- Greater effectiveness against ship / land targets.

Hallmark of the BrahMos Joint Venture

- **Govt Support**. Political will as a national programme, strong commitment from both countries, joint funding.
- **Industry Consortium**. Fairness in partnership, shared vision, high level of commitment.
- **Trust and sharing of expertise**. Pool of experts available on demand, mutual learning leading to better performance, access to cutting edge technology.
- **Strengthened by traditional relation**. Long term mutual cooperation, relationship based on partnership instead of buyer- seller.

A blend of Public-Private enterprise. A number of industries have been identified in India and Russia for the production of different sub-systems of the missile, The company enjoys full support of Indian and Russian industries.

Indian industries in particular, seeing the tremendous growth potential of BrahMos have invested from their own resources and set up independent work centres for producing different sub-systems.

Thus, we provide a successful model for other sectors to follow

NETWORK OF CORE COMPETENCIES

14. University education in India in the present century must be in a competitive environment, where research and teaching are to be integrated. Learning for the students depends upon their aptitude, creative minds to innovate and look for something new. This environment in the educational institutions can be created only by introducing research – teaching – research. Good teaching emanates from research. Teachers love for research and their experience are vital for the growth of the institutions and for the students. Any university is judged by the level and extent of the research work it accomplishes. This sets in a regenerative cycle of excellence through quality teaching to the young minds which transform them to researchers.

15. Opportunities are knocking at our doors. It is time for the University to have tie up with national Organisation / Institutes like Naval Research Boards, Naval Laboratories of DRDO, NIOT, National Institute of Oceanography and International organisations like Office of Naval Research, USA and State Marine Technological University, Russia to form Centres of Excellence in the Niche areas such as Offshore Wind energy, Ocean Energy, Deep-sea resources, Environment modelling, space-time signal processing, sensing methods, surveillance technologies including vessel monitoring, green ship design, bio-fuels and Hydrogen fuels etc.

16. Time has come to focus our attention on missions which will directly bring economic development of the Nation. The wealth provided by the Ocean in the EEZ of our country is large enough to solve many of our problems. Academic institutions should focus their research that brings prosperity using technology as a tool. Govt. R&D Organisations, Academia and Industries need to be integrated and networked to achieve desired results.

17. Please remember that there is no greater joy in life than to work for a great purpose and to see that the purpose is realized with your contribution. I am sure AMET has given all of you a good grounding and as you venture out to shoulder greater responsibilities, remember that you alone can make a difference. Believe in yourself. I end by saying **"If we are to achieve results, never before accomplished, we must expect to employ methods never before attempted, but with utmost honesty"**.

18. Maharishi Patanchali in Yoga Sutra says:

> "When you are inspired by some great purpose, some extraordinary work, all your thoughts break their bounds, your mind transcends limitations, your consciousness expands in every direction and you will find yourself in a new great and wonderful world. Dormant forces, faculties and talents become alive and you discover yourself to be a greater person by far than you ever dreamt yourself to be."

19. I wish all the best in your future endeavours.