Skilling Modules

The Underwater Domain Awareness (UDA) framework requires massive skilling to support nuanced career opportunities and effective capacity & capability building across diverse stakeholders. The UDA framework is elaborated in enclosure-1 to this document. The entire UDA skilling modules have been divided into four categories:

- (a) Corporate Training Programs
- (b) Diploma Programs
- (c) BVoc Programs
- (d) Post Graduate Programs

The **Corporate Training Programs** will comprise of customized modules specific to the stakeholder. These will be of one day, five day, three weeks, three months and six months duration. The stakeholders are enumerated below:

- Security Forces involved in Maritime and Waterfront Security
    - o Indian Navy
    - o Indian Coast Guard
    - o Marine Police
    - o Paramilitary Forces involved in Water front Security
- Blue Economy
    - o Shipping Industry
    - o Fisheries & Aquaculture
    - o Deep Sea Mining
    - o Oil & Gas Industry
    - o Inland Water Transport
    - o Tourism
- Sustainability & Climate Change Risk Management
    - o Freshwater Resource Management
    - o Water Quality Management
    - o Environmental Regulators
    - o Disaster Management Authorities
    - o Climate Change Risk Assessment
    - o ESG Managers
- Capacity & Capability Building
    - o Research Scientists
    - o Academia
    - o Skilling Ecosystem
    - o Innovation
    - o Digital Transformation (Marine Spatial Planning)

The **Diploma Programs** are two-year duration programs that will cover the specific aspects of the UDA framework at the working level for varied stakeholders. These will enable the participants to acquire the required skills to be relevant to a specific aspect across stakeholders. The aspects that will get covered are:

- Technician who will operate, maintain and repair instrumentation for acoustic survey, bio-sample handling and data handling & robotics.
- Data logger and bio-sample collector to make sure the digital data and the bio-samples are collected properly to ensure minimal loss of their characteristics.
- Deployment specialist to make sure the equipment for data collection or bio-sample collection is undertaken properly.

The common subjects for all the six courses for the first semester will be as follows:

Semester-1
- Underwater Domain Awareness (UDA) Framework (42 hours)
- Tropical Waters and their Unique Characteristics (42 hours)
- Instrumentation and Robotics (42 hours)
- Communication Skills (42 hours)
- Sustainable Development Goals (42 hours)
- Literature Review and Seminar (42 hours)

The five courses will be formalized as follows:

(a) *Sonars*   Acoustic survey in the underwater domain is undertaken using sonars. Sonar is a generic term for any instrument that processes sound to extract information underwater.

Semester-2
- Types of Sonars (42 hours)
- Basic Electronics (42 hours)
- Circuit theory (42 hours)
- Display Systems (42 hours)
- Acoustic Transducers (42 hours)
- Sonar System Engineering (42 hours)

Semester-3
- Electronic Circuit Design Practical (42 hours)
- Electronic Fault Diagnosis Simulator Training (42 hours)
- Sonar Systems Onboard Field Visit (42 hours)
- Sonar Fault Diagnosis Simulator Training (42 hours)
- Sonar System Practical Exposure (42 hours)
- Visit to Sonar Manufacture Facility (42 hours)

Semester-4
- Project on One Type of Sonar (Complete understanding of design and operations) (84 hours)
- Field Deployment and Data Collection (84 hours)

- Case Study on Typical Defect Identification and Defect Rectification (DIDR) (84 hours)

(b) *Marine Biotechnology* .

Semester-2
- Analytical Techniques introduction (42 hours)
- Microscopy, Centrifugation and Spectroscopy (42 hours)
- Immunochemical and Chromatography techniques (42 hours)
- Radioisotope techniques (42 hours)
- GLP (Good laboratory practice) (84 hours)

Semester-3
- Introduction to Marine Biology (42 hours)
- Marine resources assessment: Principal methods (42 hours)
- Population study and Marine environment protection (42 hours)
- Oceanography (42 hours)
- Wet Lab Bioresources, Biodiversity & Oceanography (84 hours)

Semester-4

- Aquaculture Technology: Culture systems and Hatchery techniques. (42 hours)
- Introduction to marine pharmacology (42 hours)
- Manipulation techniques; Microbial techniques (42 hours)
- Diseases diagnosis (42 hours)
- Lab on Marine Microbiology & Aquaculture Technology (84 hours)

(c) *Data Logger* The acoustic data in the underwater domain needs to be collected in a manner to ensure minimal distortions. The data after recording needs to be stored in the appropriate format for easy access for processing.

Semester-2
- Types of Sonars (42 hours)
- Data Formats (42 hours)
- Data Acquisition Systems (42 hours)
- Ambient Noise & Acoustic Propagation Characteristics (42 hours)
- Acoustic Transducers (42 hours)
- Sonar System Engineering (42 hours)

Semester-3
- Basic Digital Data Handling (42 hours)
- Data Storage Devices (42 hours)
- Sonar Systems Onboard Field Visit (42 hours)
- Sonar Fault Diagnosis Simulator Training (42 hours)
- Sonar System Practical Exposure (42 hours)
- Visit to Sonar Manufacture Facility (42 hours)

Semester-4
- Project on One Type of Sonar (Complete understanding of Design and operations) (84 hours)
- Field Deployment and Data Collection (84 hours)
- Case Study on Data Handling in Sonar Systems (84 hours)

(d) **Bioprospecting**   Bioprospecting in the underwater domain involves discovery and innovation, where the remarkable adaptability and unique features of marine life become reservoirs of inspiration for the creation of new and commercially valuable products. Through the synergistic collaboration of science, technology, and environmental stewardship, bioprospecting unfolds as a promising avenue for unlocking the untapped potential of the underwater world.

Semester-2
- Introduction to Marine Biology (42 hours)
- Principles of Bioprospecting (42 hours)
- Marine Microorganisms and Biotechnology (42 hours)
- Underwater Flora and Fauna Identification (42 hours)
- Underwater Conservation and Sustainable Use (42 hours)
- Environmental Impact Assessment in Underwater Bioprospecting (42 hours)

Semester-3
- Bioactive Compounds in Marine Organisms (42 hours)
- Marine Genetic Resources and Bioprospecting (42 hours)
- Bioprospecting in Deep-Sea Environments (42 hours)
- Advanced Bioprospecting Techniques (42 hours)
- Industry Applications of Underwater Bioprospecting

Semester-4
- Collaboration with industry experts and site visits. (84 hours)
- Independent research project in the underwater domain. (84 hours)
- Analysis of case studies and real-world applications of bioprospecting. (84 hours)

(e) **Deployment Specialist**   Waterfronts offer unique challenges, when we plan deployment of sonars or collection of Bio-samples. The platform that will be able to deploy the sensor or provide the means for bio-sample collection or even other abiotic samples will require specialized understanding of the local conditions.

Semester-2

- Surface & Sub-surface Platforms (42 hours)
- Manned & Unmanned Platforms (42 hours)
- Deployment Challenges (42 hours)
- Maritime Safety Protocols (42 hours)
- Seamanship Skills (42 hours)
- Communication onboard Marine Platforms (42 hours)

Semester-3
- Seamanship Practical (42 hours)
- Visit to a Seamanship Yard (42 hours)
- Visit to Autonomous Underwater Vehicle (AUV) Facility (42 hours)
- Sailing onboard Fishing Vessel (42 hours)
- Visit to Offshore Support Vessel (42 hours)
- Visit to Sonar Manufacture Facility (42 hours)

Semester-4
- Project on One Type of Deployment (Complete understanding of Deployment and Operations) (84 hours)
- Field Deployment and Data Collection (84 hours)
- Case Study on Typical Deployment Challenges and Customized Deployment (84 hours)

The **BVoc Programs** are three-year duration programs that will cover the larger UDA framework at multiple levels and for varied stakeholders. These will enable the participant to acquire the required skills to be relevant to cross section of stakeholders. The broad aspects that will get covered are digital transformation, acoustics, programming skills, signals & systems, instrumentation, sample handling, sustainable development goals, traditional knowledge, communication skills, etc. The common subjects for all the three courses for the first year will be as follows:

Semester-1
- Underwater Domain Awareness (UDA) Framework (42 hours)
- Digital Transformation (42 hours)
- Underwater Acoustics (42 hours)
- Communication Skills (42 hours)
- Sustainable Development Goals (42 hours)
- Literature Survey & Seminar (42 hours)

Semester-2
- Tropical Waters and their Unique Characteristics (42 hours)
- Climate Change Risk (42 hours)
- Geopolitics and Geostrategy (42 hours)
- Traditional Knowledge (42 hours)
- Mini Project – Appreciation of the UDA and a specific application (84 hours)

Three broad courses will be formalized as follows:

(a) **_Acoustic Survey_**   Acoustic survey is the only means of visualizing the developments underwater. The acoustic survey will require hardware as well as software to undertake the actual operations in the water bodies. The tropical waters have their unique impact on the acoustic propagation in the underwater domain.

   Semester-3
   - Principles of Underwater Sound (42 hours)
   - Instruments for Underwater Measurements (42 hours)
   - Signals & Systems (42 hours)
   - Python Programming (42 hours)
   - Digital Signal Processing (42 hours)
   - Acoustic Propagation in the Tropical Waters (42 hours)

   Semester-4
   - Data Analytics (42 hours)
   - Field Experiment Planning (84 hours)
   - Actual Field Deployment (84 hours)
   - Analysis and Documentation (42 hours)

(b) **_Biotechnology & Biosciences_** The biotic content underwater has tremendous value in terms of resources and if not protected can be a major cause of sustainability concern. The assessment of the underwater domain for biotic content and wellbeing will require specialized bio-technology & biosciences expertise. The biotic survey will require hardware as well as software to undertake the actual sample collection and testing in the water bodies. The tropical waters have their unique impact on the biodiversity in the underwater domain and even the way the components of the ecosystem interact with each other.

   Semester-3
   - Underwater ecosystems and biodiversity (42 hours)
   - Biotechnological Tools for Aquatic Environments (42 hours)
   - Hardware and Software for Biotic Survey (42 hours)
   - Advanced Biotic Survey Methods (42 hours)
   - Molecular Analysis of Underwater Organisms (42 hours)
   - Genetic Diversity and Adaptation in Underwater Species (42 hours)

   Semester-4
   - Sustainable Resource Management in Underwater Environments (42 hours)
   - Remote Sensing and Underwater Monitoring (42 hours)
   - Capstone Project: Integrated Biotic Survey and Conservation (84 hours)
   - Industry Internship (84 hours)

(c) ***Underwater Data Analytics*** Data Analytics requires nuanced appreciation of the data, application and the site-specific local conditions. Acoustic data in the tropical waters require specialized signal processing and machine learning capabilities for effective data analysis.

Semester-3
- Signals & Systems (42 hours)
- Python Programming (42 hours)
- High Performance Computing (42 hours)
- Machine Learning (42 hours)
- Sonar Signal Processing (42 hours)
- Acoustic Propagation in the Tropical Waters (42 hours)

Semester-4
- Data Analytics (42 hours)
- Modelling & Simulation (M&S) (84 hours)
- Field Experimental Validation (84 hours)
- Analysis and Documentation (42 hours)

Semester-5&6
Project Planning & Execution (Real World Problem Solving)
Four Seminars (every two months) for Evaluation of Progress
Final Project Presentation

The ***Post Graduate Program*** are two-year duration programs that will cover the application specific requirements across multiple stakeholders. This will enable the participants to get deployed directly on the field for multiple stakeholders. The emphasis here will be field experimental learning and real-world problem solving. They will be fully ready for deployment for specific applications, relevant to multiple stakeholders. The first semester will common for all the ten programs as mentioned bellow:

(a) ***Digital Transformation in the Underwater Domain***
(b) ***Sediment Management***
(c) ***Freshwater Management***
(d) ***Aquaculture & Fisheries Management***
(e) ***Inland Water Transport (IWT) Management***
(f) ***Strategic Security Management***
(g) ***Underwater Archaeology***
(h) ***Marine Spatial Planning***
(i) ***Climate Change Risk Management***
(j) ***Sustainable Development Goals***

The first semester will be common to all and the subjects are as follows:

Semester-1
- Underwater Domain Awareness (UDA) Framework (42 hours)
- Digital Transformation (42 hours)
- Underwater Acoustics (42 hours)
- Communication Skills (42 hours)
- Literature Survey (42 hours)
- Tropical Waters and their Unique Characteristics (42 hours)

Semester-2
- Traditional Knowledge (42 hours)
- Four Course Specific Modules
- One Slot will only be for Guest Lectures specific to the domain. Every week two to three, Guest Lectures will be arranged to expose the participants to domain experts, industry leaders and policy makers.

Semester-3&4
Project Planning & Execution (Real World Problem Solving)
Four Seminars (every two months) for Evaluation of Progress
Final Project Presentation

Additionally, **E-Learning Modules** have been developed to provide a nuanced exposure to the students and young professionals on varied aspects of the UDA framework. The modules have been developed in series of submodules that cover the varied dimensions of the topics. The series are mentioned below and the concept note for each is linked:

(a) **_Basic & Advance Level Modules for the UDA Framework._** This has been uploaded in the IGOT platform of the Government of India, to expose the government officials across the Union Government and the States.
(b) **_Blue Economy._**
(c) **_Climate Change Risk Management._**
(d) **_Sediment Management across Marine & Freshwater Systems._**
(e) **_Digital Transformation for Coastal & Riverine Communities._**
(f) **_Tyranny of Small Decisions._**

Underwater Domain Awareness (UDA) Framework

The concept of Underwater Domain Awareness (UDA) in a more specific sense will translate to our eagerness to know what is happening in the underwater realm of our water bodies. This keenness for underwater awareness from the security perspective, means defending our Sea Lines of Communication (SLOC), coastal waters and varied maritime assets against the proliferation of submarines and mine capabilities intended to limit the access to the seas and littoral waters. However, just the military requirement may not be the only motivation to generate undersea domain awareness. The earth's underwater geophysical activities have a lot of relevance to the wellbeing of the human kind and monitoring of such activities could provide vital clues to minimize the impact of devastating natural calamities. The commercial activities in the underwater realm need precise inputs on the availability of resources to be able to explore and exploit them for economic gains effectively and efficiently. The regulators on the other hand need to know the pattern of exploitation to manage a sustainable plan. With so much of activities, commercial and military, there is significant impact on the environment. Any conservation initiative needs to precisely estimate the habitat degradation and species vulnerability caused by these activities and assess the ecosystem status. The scientific and the research community need to engage and continuously update our knowledge and access of the multiple aspects of the underwater domain. Fig. 1, presents a comprehensive perspective of the UDA. The underlying requirement for all the stakeholders is to know the developments in the underwater domain, make sense out of these developments and then respond effectively and efficiently to them before they take shape of an event.
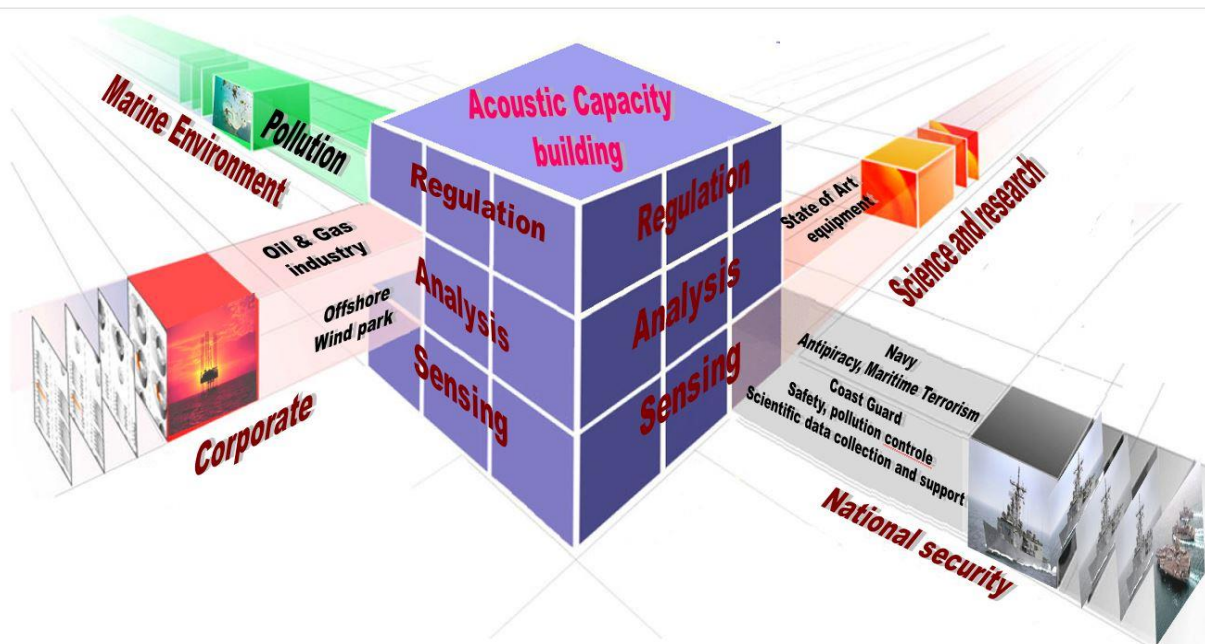

Fig. 1 Comprehensive Perspective of Undersea Domain Awareness

The UDA on a comprehensive scale needs to be understood in its horizontal and vertical construct. The horizontal construct would be the resource availability in terms of technology, infrastructure, capability, and capacity specific to the stakeholders or otherwise. The stakeholders represented by the four faces of the cube will have their specific requirements, however the core will remain the acoustic capacity and capability. The vertical construct is the hierarchy of establishing a comprehensive UDA. The first level or the ground level would be the sensing of the undersea domain for threats, resources, and activities. The second level would be making sense of the data generated to plan security strategies, conservation plans and resource utilization plans. The next level would be to formulate and monitor regulatory framework at the local, national, and global level.

The figure above gives a comprehensive way forward for the stakeholders to engage and interact. The individual cubes represent specific aspects that need to be addressed. The User-Academia-Industry partnership can be seamlessly formulated based on the user requirement, academic inputs and the industry interface represented by the specific cube. It will enable more focused approach and well-defined interactive framework. Given the appropriate impetus, the UDA framework can address multiple challenges being faced by the nation today. Meaningful engagement of Young India for Nation Building, probably is the most critical aspect that deserves attention. Multi-disciplinary and multi-functional entities can interact and contribute to seamlessly synergize their efforts towards a larger goal.

The UDA Framework as proposed above has been formulated jointly by the Maritime Research Centre (MRC), Pune and M/S NirDhwani Technology Pvt Ltd (NDT). The focus is on all the three aspects namely Policy, Technology & Innovation and Human Resource Development.