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Challenges in Modern Shipbuilding Technology-Pipavav's Perspective

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1. Introduction

Indian Navy is seen to be transforming itself into a Blue Water Force spreading its area of operation to a large extent. The National Policy Makers have come to realize the role and the importance of a capable Navy in International diplomacy and maintenance of force levels. The conversion of this National Policy into hard facts require a fine trade-off between the capabilities required vis-à-vis the budgetary consideration. Therefore, it is prudent at the present state of economy, to establish a build philosophy which is technologically advanced and at the same time economical to build and above all, easy to maintain and support through its life.

2. What Needs to be Done

During the iterative design process of Warship and Submarines, the biggest challenge is in defining the general architecture and integration of system onboard. It would mainly consist of (a) managing the requirements of the Customer, (b) selecting the good compromise between all the systems characteristics, and (c) reducing the cost of integration and overall cost of construction.

Modular Construction is one of the most efficient solutions which could achieve the intended aim of "build anywhere integrate anywhere", thus reducing the cycle time of construction and eventually the cost of construction.

As a prelude to modular construction, it is important to have a sound design base to "design the way it is built", and have a "Product & Process Hub" which will integrate the Engineering Hub and the Manufacturing Hub – a concept of Product Life Cycle Management.

3. Modular Construction

Modular design and construction can be seen as an architecture where functional subsystem are physically localized in a well-defined area and can be installed on a dedicated structure. These elements have well defined interfaces and minimal interdependencies in the overall system. In this type of construction, the ship's design is entirely in a modular fashion. The section or blocks are fabricated separately; and the major assemblies and sub-assemblies (also called aggregates) are fabricated and tested separately. The assemblies are then packed into a designated section / block as a "Modular Deck Section" .

The modularity can be grouped into possibly four groups – at the design level, at the construction level, at the manufacturing level and at the maintenance level.

Modularity at the Design Level is a very difficult yet challenging activity, which aims at meeting all the prescribed technical specification of the Customer (Navy & Coast Guard). This primarily addresses the functional partition as well as geographical partitions

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and has a direct impact on the displacement of the vessel. Taking the example of a Warship, the segregation of functions are reflected in formation of blocks – control rooms, living accommodation, main machinery compartment, auxiliary department, weapons compartment, the super structure etc.

Modularity at the Construction Level envisages construction of blocks or mega blocks in different location / shipyards; and final integration at the prime contractor's location / shipyard.

At the Manufacturing Stage, modularity is mainly characterized by pre-outfitting done on the cradles or decks. Such pre-out fittings in dedicated workshops with system / sub-system checks eases out the integration process to a large extent. Here the principles of 'Full Kit Management System' need to be applied rigorously, which demands seamless co-ordination between manufacturing and procurement processes to synchronize the equipment deliveries in sync with manufacturing process.

Modularity from Maintenance point of view calls for easy inspection, ease of shipping / unshipping of equipment and systems from the Warship / Submarine (alleyways, large hatches, soft patches etc.) for maintenance and repairs.

On the whole, during the complex process of ship construction, lot of meticulous engineering activity is envisaged in the pre-manufacturing stage. This concept of modularity forms the back-bone of modern ship building, and results in reduction of risks due to re-work and consequently increased productivity leading to optimization of cycle –time and reduction of cost.

- Basic Design
- 3D Modelling and "Virtual Reality"
- Design & Engineering in Modules
- Construction and Outfitting of Modules
- Assembly & System Integration

4. Digital Shipbuilding

The process of modularization in Warship Construction activity would largely depend upon the extent of digitization one does right from the concept design stage. Once the conceptual design (or base design) is made and validated through theoretical calculations (FEA, CFD analysis etc.); the basic design undergoes detailed engineering. The concept design with sufficient data get further validated through a Model Test keeping designer's margin in the final results.

The detailed engineering would invariably get digitized to form a 3D – Model of the object. The 3D-modelling, which is purely rule-based, resolves most of the interferences, sequencing issues, walk-throughs. It also addresses the three fundamental requirements of ship construction – Accessibility, Operability and Maintainability (A-O-M). The model gets further refined through "Virtual Reality (VR)" projection wherein the operator / end-user gives vital inputs on the three aspects of Warship Operation.

Figure 2.

The entire detailed engineering and 3D Modeling is driven by Product Life cycle Management (PLM) Platform, where all the minute details of ship construction process is linked seamlessly to provide

Figure 1.

an Integrated Digital solution. Through PLM, following essentially are delivered:

- Production Drawings
- Complete Bill of Material
- Isometric Generation
- Shipping in / out routes
- Complex jigs & fixtures.

PLM Platform also provides an essential feature of Change Management – all design changes during the construction process is captured in the system and one finds the latest drawing popping up at any given time. All these modern methods are implemented to have "an error-free production". If you achieve minimum re-work in Warship / Submarine Construction activity, the productivity and deliveries tend to improve resulting in substantial savings in cost.

5. What Pipavav Shipyard Has?

Pipavav Shipyard has a modern Design Office with fully trained design engineers in Triborn M3 and AVEVA Marine. During the course of Design and Engineering, other relevant softwares viz. MAXSURF, Pipenet, MSC Nastran, CADWIN Systems are being used to establish Basic and Detailed design. A sound e-data bank has been created for a class of ships, which gets continually improved upon.

During the course of basic design of certain class of ships, all facets of stability calculation, powering calculation, load distribution, structural analysis using FEA, and vibration, buckling & fatigue analysis is being done. Detailed engineering and production drawings for Warships and Offshore platforms are generated using AVEVA Marine Software for hull structure, piping and HVAC modules.

Pipavav uses most modern methods of shipbuilding through modular construction and equipment modules (aggregates). In terms of material handling, the shipyard has a no. of low bed self elevating hydraulic transporters capable of transporting blocks upto 400 T. The shipyard is also equipped with 80 EOT / Gantry / Semi-Gantry / ELL Cranes of various capacities upto 150 Tons.

For the final integration of mega blocks; the Shipyard has one of largest dry docks in India measuring 662 M x 65 M, and a 30 M wide and 980 M long pre-erection berth with all necessary yard facilities. Two Goliath Cranes of 600T each with a span of 150 M to cover the dry-dock and pre-erection area for handling large and heavy modular blocks.

Pipavav Defence and Offshore Company have even gone into critical Naval Systems – Combat Management System being one of the latest Naval Systems, the TOT being done from M/s. SAAB, and Sweden.PDOC has now been qualified by the Navy for design and manufacture of 6.

6. Combat Management System

Pipavav Defence and offshore Company having build one of the largest shipyard in the country is now poised to bring in the latest technology in Weapons and Sensors in partnership with the global leaders.

We have a track record of undertaking projects in collaboration with Govt. PSUs and Global companies.

The Company's objective in systems area is to locally produce high end systems in technology partnership with global leaders as per DPP13 guidelines for "Buy and Make Indian" category systems .We plan to synergize local industry strengths and take advantage of lower manufacturing cost opportunity in India. We have some of the best strategic partners like SAAB, DCNS,and MDL etc.

We have entered into teaming agreement and signed Local Industrial package contract with Saab to produce open architecture Combat Management Systems. The systems using open architecture will be flexible and scalable.The system being modular can be scaled up from Situational awareness terminal on a small boat to the Sea control for a large ship like LPD or Aircraft carrier.The software components could be reused or customized or newly developed based on operational requirements of the platform .System integration is the most challenging task and a group dedicated to System Integration who will interact with the shipyard and all other system suppliers to evolve a system design integral to the CMS development.

7. Conclusion

Modularity coupled with system engineering approach and digitization of ship building, would go a long way in enhancing productivity and reducing cost. 'Build anywhere – integrate anywhere' concept would benefit in accelerating construction of Warships and Submarines with minimum interdependencies and highest focus on the modules. But the biggest challenges lie in realization of the concepts of modularity and imbibe the technological know-how of building Ships and Naval Systems.