Design for Configuration: A Modular Approach to Increasing Vessels' Operational Flexibility

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Modularization: Definition, Objectives and Benefits

• Modularization:
  – Textbook Definition: The concept of modularization is used for reducing the complexity of a system. This system is deconstructed into more or less independent units (“modules”). The modules should be able to exist independently from each other, but the system as a whole can only function as an integrated structure.
  – In Design Context: Breaking down designs into reusable components, readily and rapidly mix-and-matchable developing new configurations → Design for Configuration.

• Modularization Objectives and Benefits:
  – Reusability: The design modules can be applied on any future designs, saving design manhours.
  – Repeatability: The repeatability of the design modules allows for manufacturing efficiency; lower production manhours, speedier production.
  – Rapid (Re)Configuration: A design with many options. Having your cake and eating it (with a bit of compromise).
Modularity in OSV Design (Illustrated)

- Not a new concept, most designers do try to modularize designs
- **Ideally** the entire OSV design can be modularized; reused, repeated and reconfigured (like LEGO®)
- **Practically** only selected options/ upgrades can be implemented considering cost vs. benefits vs. performance.

Images Credit: “Modular approach to offshore vessel design and configuration”, Henrik Tvedt, NTNU
Reconciling the Dichotomy: Performance vs. Production

Design for Performance:
- Optimizing the design for one of more design parameters e.g. deadweight, speed, bollard pull etc.
- Example: Navy Destroyer optimized for deadweight (payload) by using fabricated profiles (cost is less of an object)

Design for Production:
- Optimising the design for production by standardizing blocks, sub-blocks, scantlings and profiles for maximum repeatability
- Example long parallel midbodies in merchant vessels etc.
Limitations of (Practical) Design for Configuration

• Design for configuration (modularization) is a satisficing approach, not a panacea for good design
• Also not to be confused with multi-purpose vessels
  – Multi purpose vessels have multiple missions (can be modularized also)
  – Modular vessels have single missions with options (upgrades)
• Limitation:
  – Vessels designed around mission equipment e.g. pipe-laying vessels, integrated SAT Dive vessels etc. challenging to modularize
  – Proportional limits to performance e.g. for the same beam, LOA cannot be increased infinitely
• Commodity OSVs in general e.g. PSV, MPSV, AHTS, AWB and IMR vessels are readily designable for configuration
Quest for the Longest Series

- Design for configuration is but a tool, the ultimate end is a longer series; Designer and Builder holy grail
- Economies of scale in design, production and operation with savings returned to shipowner
- Volume not necessarily only from a single shipowner, but several
- Multiple similar designs with different configurations (different options/ upgrades exercised)
- Good pedigree hullform ensures performance
- Familiarity in operation, crew readily jumps from ship to-ship

Images Credit: Rolls-Royce Marine
The Design for Configuration

#1 Select a Proven Hullform

#2 Consider Propulsion Concept(s)

#3 Pre-engineer Plausible Options

#4 Standardize Maker List

#5 Build to Nth Number
#1 Take a Proven Hullform

- Don’t reinvent the wheel
- What is a proven hullform? Answer: A delivered hullform where all performance parameters have been demonstrated e.g. speed, deadweight, thrust deduction etc.
- There are various proprietary database of proven hullforms (belonging to designers)
- Select a good basis hullform that is:
  - Consider mission profile; single or multi-purpose
  - Optimal L, B, D, T for required deadweight, speed and mission
  - Flexible platform with future conversions in mind
#2 Decide Propulsion Concept(s)

- Propulsion concepts include:
  - Diesel Mechanic, conventional 2-engine or 4-engine TISO* (*more for AHTS)
  - Diesel Electric
  - Hybrid

- Closely tied with Mission Profile
  - Proportion in DP vs. Steaming
  - DP variability favours diesel electric propulsion
  - Consider system redundancy and ERN/ SKP

- Consider first and lifecycle cost:
  - Up to 40% of equipment cost is power and propulsion
  - Diesel-electric up to 15% premium over diesel-mechanic propulsion of same capacity

- Forms a space consideration
#3 Pre-engineer (All) Plausible Options/Conversions
#4 Standardize Maker List

- European makers command up to 15% premium over Asian makers for proven quality and reliability
- Recommend power, propulsion and mission critical equipment by reputable makers
- Considerations include:
  - Fleet management (e.g. standardisation) and accessibility of spares
  - Volume discounts from makers for large orders, both in first cost but also in spares and services
  - Integrated design and equipment packages or best of breed (or price)

*Not Exhaustive*
#5 Build to Nth Number

- A good modularizable design on its own is not enough
- Building to nth number is opportunistic, depending on value basics including:
  - Design branding
  - Price (including payment terms & financing)
  - Delivery
  - Makerlist
- Exercise of leadership in the shipowner-designer-shipyard-makers value chain to increase value
- Examples of value-chain leadership demonstrated by:
  - Shipowner: BOURBON
  - Shipyard: NAMCHEONG
  - Maker: ROLLS-ROYCE MARINE
- The ultimate end is towards the longest series

The Longest OSV Series to date: UT 755 179nos Delivered and/or under Construction

Images Credit: Rolls-Royce Marine
Case Study: ROC Flex Class AHTS

• Modular design suitable for bollard pulls 100-150t

• Based on VS4612 proven hullform; 20 vessels delivered and in operation

• Engineering friendly:
  – All practical options pre-considered and designed in
  – Standardized engine room regardless of power or propulsion (up to 12,000hp)

• Production Friendly:
  – Standardized equipment layout
  – Standardized scantlings and profiles across both LOA (72m or 78m)

• Upgrade options include:
  – 2x99 and 3x99 (Base: ERN 1x99)
  – LP AHT Winch ((Base: HP)
  – Twin Sharkjaws/ Towpins (Base: Single Set)
  – FIFI2 (Base: FIFI1)
  – OSR-C1 (Base: OSR-C2)
  – Up to 60pax Accommodation (Base: 32pax)
  – Middle East (Ambient 45ºC/ Seawater 36ºC)
Conclusions and Predictions

• Increasing envelope for modularized commoditity vessels designs. The benefits are obvious:
  – Economies of scale for designers, shipyards and makers with benefits returned to shipowner (creating value i.e. better asset prices)
  – Familiarity in operation (crew training, safety etc.)

• Predictions (we believe):
  – The new normal (lower) oil price demands more value from asset; a relevant topic now and in better times
  – Less and less specialized design for commodity vessel segment
  – Rationalization of commodity designs to fewer but proven and popular modularizable designs
  – Good modularized vessels combined with value chain leadership can lead to the longest series
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ROC covers an area of about 500,000m² by the Yangtze River. ROC has 2 covered building slip-ways (180mx45m and 180mx35m) and an outfitting and mooring test berth of 326m fitted for mooring up to 50,000 DWT vessels.

Main product lines of ROC include Offshore Support Vessels (includes PSV, MSV and AHTS), Subsea Vessels (includes IMR and DSV), Accommodation and Construction vessels (includes AWB and OCV) and Self Elevating Platforms (includes Wind Turbine Installation Vessels and Liftboats).