Joint Support Ships
Trumping the Jack of All Trades

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SYNOPSIS

The shared experience of naval requirement setters around the world encompasses the outward-facing expansion of national policies to include international presence in humanitarian, peace enforcing and support operations, in parallel with economic pressures that limit the resources available for the procurement of additional classes of purpose-built ships.

The aspiration of many navies is to make a single hull meet a number of capability requirements, often simultaneously. This often results in multi-commodity replenishment vessels which also include a degree of sealift or joint logistics support. The logistic support and sealift role is often seen as being complementary to fleet replenishment and therefore all of the above roles can be accomplished within a single multi-role vessel. From the requirements point of view, this approach makes perfect sense. Why pay for two or more distinct classes of vessel when one class can cover the required range of capabilities?

The designer needs to consider how the often conflicting requirements for weight, space, layout and compliance with regulation can best be met within a single platform, without incurring a significant cost penalty.

This paper seeks to explore the issues underlying the design of Joint Support Vessels. The author highlights the potential solutions and overall concepts that are possible, and highlighting those aspects of the design that will pose significant problems and require significant compromise in terms of capability and cost. The paper ultimately seeks to address the issue of single role versus multi-role and asks the question “Is one hull better than two or just cheaper?”

Author’s Biography

Andy Kimber is a Senior Manager at BMT Defence Services, where he is responsible for a team of Naval Architects engaged in a variety of surface ship design tasks. He has undertaken a variety of auxiliary ship and warship design studies including the joint BMT - Skipskonsulent AEGIR family of replenishment ships and the BMT Venator reconfigurable small warship. Previous to his current role, he held the position of Platform Architecture Manager for the CVF for three years. Andy joined BMT Defence Services after completing a degree in Naval Architecture and Ocean Engineering at University College, London.

Introduction

Naval auxiliary and logistic vessels may be described as the work horses of the fleet, providing the invaluable support needed to maintain operations and deployments. The variety of vessels may be categorised as those for bulk commodity replenishment at sea (tankers and stores ships), logistics vessels for transport of vehicles and personnel between theatres, maintenance, support and repair vessels and those for specialist support tasks (for example medical vessels or those specifically for aviation support and training).

Multi-role Auxiliaries are Not New

Traditionally separate ships have been procured for these roles, each optimised for the specific cargo or payload.

A well established combination is the multi-commodity replenishment ship, broadly introduced in the 1960 and 70's. A good example of this vessel type which is designed for more than one cargo type, is the Canadian AOR vessels (Reference 1).

The AOR concept developed from the "one stop" idea, where a warship could receive both fluid and solid stores in one replenishment activity. The multi-commodity replenishment ship (commonly referred to as the AOR) combines the concepts of a tanker with a cargo ship and is today common place in many fleets. Typically, these designs incorporate a centre cargo tank section with cargo holds arranged forward and aft. The replenishment equipments themselves are arranged centrally and over the cargo tank area with the solid stores flow provided by a "clearway" (a wide unobstructed passageway of sufficient width to allow the transfer of stores) between the forward and aft areas.

A further good example of this type of vessel is the UK RFA FORT VICTORIA, delivered in the early 1990's. As a further evolution of the multi-role idea, these ships were also developed to provide a significant aviation support capability. A large hangar capable of stowing and maintaining a number of helicopters, allowing the vessels to provide a level of support beyond that provided on a frigate (Reference 2).

Evolution of the Multi-Role Auxiliary

The classical AOR design combines features of a tanker and stores cargo vessel. The next evolution which has occurred in several projects is the development of combined replenishment and logistics ships. In this case, the primary driver appears to be emerging requirements for nations to move troops and vehicles beyond traditional deployments but within the budgetary constraints of not being able to procure specific vessels. As the AOR is already a bulk cargo ship, it appears logical to expand the design to incorporate the logistic role also.

This trend is driven in part by the perception that the multi-role auxiliary ship offers the opportunity for enhancing a navy's capability without significant investment in many new hulls.

However, multi-role auxiliaries can become complex vessels in which the individual roles may become compromised as the design seeks to pack as much capability into the smallest hull possible. Therefore, there has to be a point at which the multi-role ship seizes to be cost effective as it becomes too much of a compromise.

The Impact of Standards on Complexity Auxiliaries

Naval auxiliary ships will often adopt commercial standards which are enhanced by selective use of specific naval standards where appropriate. This practise follows from the assumption that most naval auxiliaries are based on commercial ship types and therefore adoption of the commercial standards represents a mature and low risk approach. Whilst some standards are transversal across all or many ship types, others are either specific or have specific sub-sections relating to particular types of vessel. For example, the MARPOL rules relating to carriage of bulk fuel cargo on tankers or SOLAS rules relating to passenger carrying vessels.

For the multi-role auxiliaries, there is now a complication in terms of which commercial standards apply and where standards for several ship types are used, whether they contradict with each other when applied to a single design. Figure I illustrates some typical standards (noting it is not exhaustive) that might apply to a naval auxiliary and which have a significant impact on the vessels configuration.

	SI 1997/1509[1] & SI 1999/643[2]	CAA - CAP437[3]	IMDG Code	SOLAS	SI 1997/1508[4]	DEF-STAN 02-107[5]	MARPOL	DEF-STAN 00-101[6]	
Accommodation	X		X	X	X	X		X	Generally apply to all ship types
Machinery Spaces	X		X	X	X	X		X	
Other Tanks	X		X	X	X			X	
LSA				X	X			X	
Magazines			X					X	Solids Cargo and logisitic Ships
Vehicles Decks				X					Logisitics Ships
Cargo Fuel Tanks	X		X	X	X		X	X	Tankers
Cargo Manifold							X	X	
Flight Deck		X		X					Aviation capable ships

Notes:
1. SI 1997/1509 The Merchant Shipping (Cargo Ship Construction) Regulations 1997
2. SI 1999/643 The Merchant Shipping (Cargo Ship Construction) (Amendment) Regulations 1999
3. CAA CAP 437 Offshore Helicopter Landing Areas - Guidance on Standards
4. SI 1997/1508 The Merchant Shipping (Crew Accommodation) Regulations 1997
5. Def-Stan 02-107 Requirements for Accommodation in HM Surface Warships and Submarines 2002
6. Def-Stan 00-101 PART 1 Design Standards for Explosives Safety in MOD Ships and Submarines Part 1 Surface ships

Figure I Application of Standards to Ship Types

Using these standards, it is possible to begin assessing the relative positions of the different functions and to assess where functions can and cannot be located together.

Deadweight Versus Volume Cargo Ships

Watson and Gilfillan (Reference 3) described three types of vessel in their paper on design methods:

- The deadweight carrier - These vessels are distinguished by the principal dimensions being fixed in order to provide sufficient buoyancy to carried a specific deadweight, i.e. payload according to its weight such as a tanker.
- The capacity carrier - These vessels are distinguished by the principal dimensions being fixed in order to provide sufficient internal volume to accommodate a specific volume of cargo, i.e. payload according to its volume such as a container ship.

- The linear dimension ship - These vessels are distinguished by the principal dimensions being fixed by considerations other than those of deadweight or volume, for example a Ro-Ro defined by the required length of the vehicle deck (as lane metres, LIMs).

Figure II presents ratios of deadweight and Gross Registered Tonnage (GRT) to ship size (length L, Beam B and draught T) for a range of vessels types, illustrating the grouping of deadweight and capacity carrying commercial vessels. The graphs broadly indicate the relation of deadweight to the ship dimensions and how the different vessels types group into different lines. This reflects the effective density differences in the vessels types. Hence, a high deadweight / LBT ratio is typical for a tanker and can be taken as a deadweight driven design, whilst a low deadweight / LBT ratio indicates a volume carrier such as a ferry or Ro-Pax. As GRT is more closely related to the volume available for cargo than the actual deadweight that may be carried, this graph is effectively the inverse.

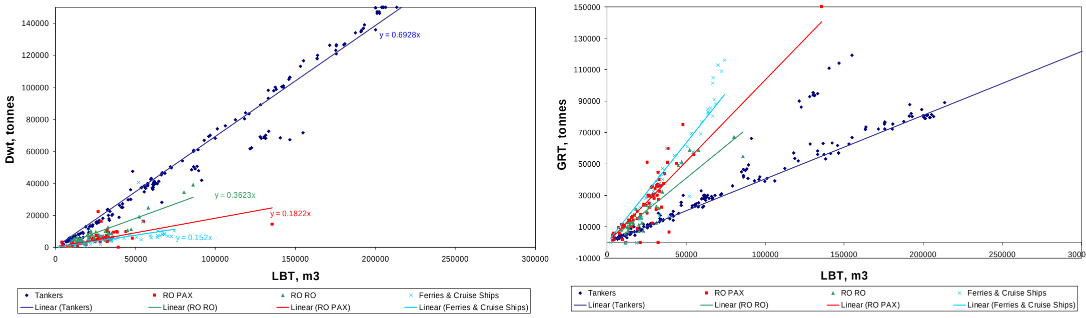


Figure II - Deadweight and GRT versus LBT for Commercial Vessels

Figure III indicates the deadweight / LBT ratio for a variety of naval vessels, superimposed on the regression lines from Figure II. For the naval vessels, it can be observed that there are broadly two lines. The replenishment ships with a significant fluid cargo fall broadly in a line similar to that of the commercial Ro-Ro's and are below the ratio for the deadweight dominated commercial tankers. This is largely due to other special demands for higher levels of accommodation, flight decks and other naval features (refer to Reference 4).

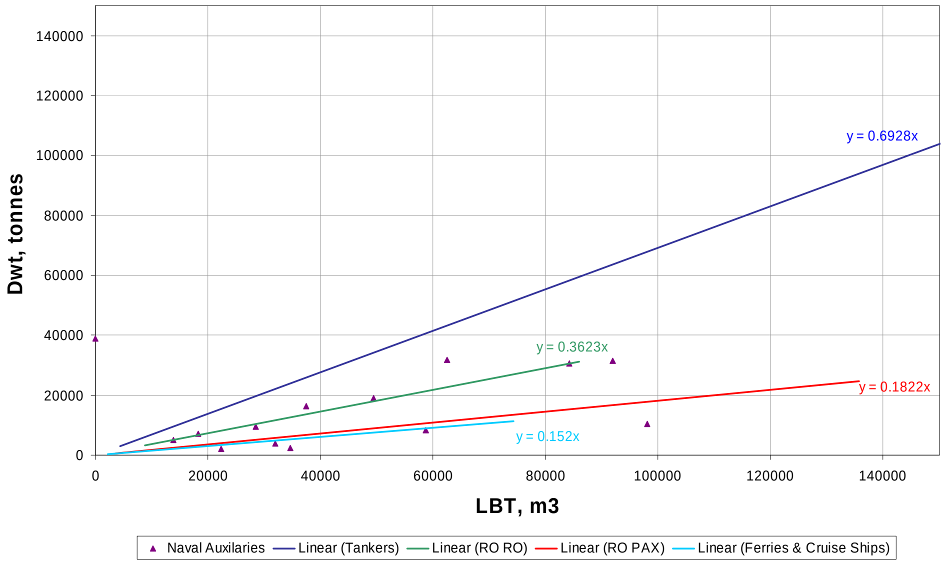
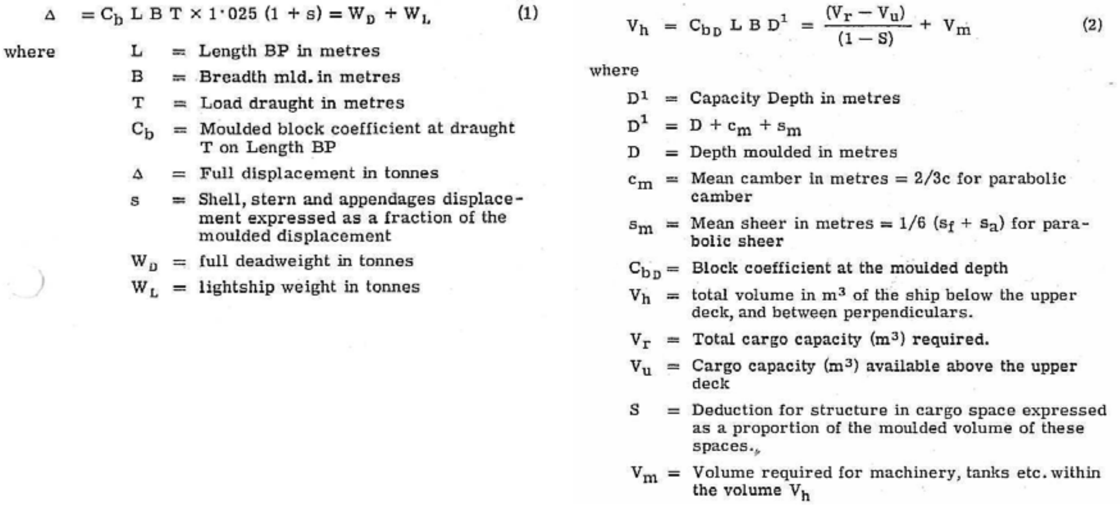


Figure III Deadweight versus LBT for Naval Auxiliaries Vessel

The multi-commodity naval replenishment ships move further into the capacity carrying category as the relative mix of solid and fluids adjust. The second apparent line of naval auxiliaries, following broadly the same LBT / deadweight ratio as the Ro-Pax and ferries represents the solid replenishment ships and military Ro-Ro's. In developing a multi-role logistics / support ship, the question is therefore where to start; deadweight, volume or dimensional constraints. This represents a challenge to the designers, as the starting point is not necessarily obvious at the out set.

Balancing Deadweight and Volumetric Solutions

Considering this further, the design sizing methods proposed by Watson and Gilillan have been explored to demonstrate whether the two methods can be converged to a common solution, where a mixed volume and weight payload is required. The equations for the two ship methods are reproduced from Reference 2 below:



$$\Delta = C_b\, L\, B\, T \times 1{\cdot}025\,(1 + s) = W_D + W_L \qquad (1)$$

where
L = Length BP in metres
B = Breadth mld. in metres
T = Load draught in metres
C_b = Moulded block coefficient at draught T on Length BP
Δ = Full displacement in tonnes
s = Shell, stern and appendages displacement expressed as a fraction of the moulded displacement
W_D = full deadweight in tonnes
W_L = lightship weight in tonnes

$$V_h = C_{bD}\, L\, B\, D^1 = \frac{(V_r - V_u)}{(1 - S)} + V_m \qquad (2)$$

where
D^1 = Capacity Depth in metres
$D^1 = D + c_m + s_m$
D = Depth moulded in metres
c_m = Mean camber in metres = 2/3c for parabolic camber
s_m = Mean sheer in metres = $1/6\,(s_f + s_a)$ for parabolic sheer
C_{bD} = Block coefficient at the moulded depth
V_h = total volume in m^3 of the ship below the upper deck, and between perpendiculars.
V_r = Total cargo capacity (m^3) required.
V_u = Cargo capacity (m^3) available above the upper deck
S = Deduction for structure in cargo space expressed as a proportion of the moulded volume of these spaces.
V_m = Volume required for machinery, tanks etc. within the volume V_h

Figure IV Deadweight (1) and Volume (2) Carrier Equations

In these equations, a balanced solution should achieve a common length (L) and beam (B) whilst the draught (T) and hull depth (D) values must conform to provide an acceptable freeboard. The block coefficient term in each equation differs (C_b for deadweight and C_{bD} for the volumetric carrier), but it has been found possible to relate C_b and C_{bd} by an empirical formula by considering typical forms. Hence, by setting an appropriate mix of cargos that is representative of a notational multi-role auxiliary, the two equations have been solved simultaneously. For a nominal mix of cargo, the three cargo types (fuel cargo as deadweight, stores as a volume and vehicles as lane-metres) have been related to a total volume and a total deadweight.

Using a spreadsheet approach, the hull has been defined by typical design ratios for L/B, T/D, C_b, C_{bD}. Formula 1 is solved for T and formula 2 is solved for D, the aim being to find a B/D value which agrees for both approaches. Parametric data was developed for deadweight carriers and capacity carriers using the respective ratios:

- R_1: cargo weight/ ship displacement
- R_2: cargo volume/ total hull volume

The model has been found to be more sensitive to cargo weight ratio R_1 than it is to the cargo volume ratio R_2. Varying R_1 will only affect the resulting B/D for the deadweight approach and vice-versa for R_2, as shown in Table I

	R_1	R_2
Change in Ratio	+1	+1
change in B/D (%)	+2.8	+2.0

Table I Effect of changing weight and volume ratios R1 and R2

Varying C_b alters the deadweight and capacity carrier B/D ratios differently. Hence a different ratio of the cargo mix (deadweight, capacity and LIM loads) is required to bring these back into agreement. For the range 0.68< Cb< 0.72 the resulting B/D is within the value of 1.7-1.9 recommended by Molland (Reference 5) 2008, as shown in Figure V. Since there is a crossover point for the two, varying C_b could be used to find a solution involving a slightly different load ratio. Solutions for various values of C_b are shown in Table II, which show that as Cb increases the proportion of deadweight can be increased. In reality values for the stores density and LIM weight per metre may be very different. However the analysis indicates that solutions can be found for other load rates.

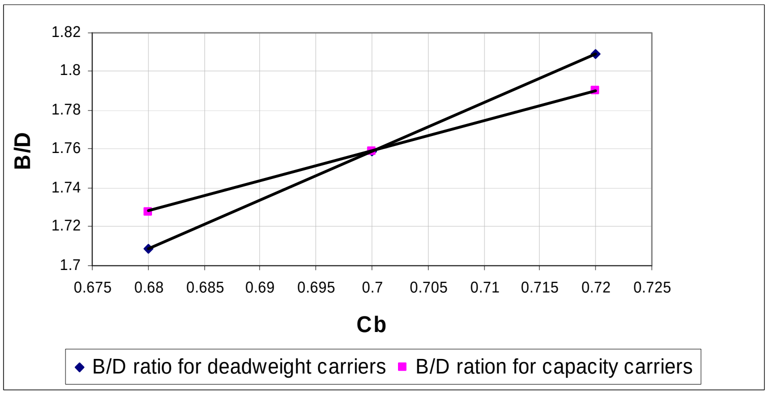


Figure V Effect of varying Cb on B/D

C_b	Load ratio (Fuel: Stores: Lane metres)
0.68	12.5 : 5 : 2
0.7	13.0 : 5 : 2
0.72	13.5 : 5 : 2

Table II Effect of Varying Cb on Load Ratio

Expanding this analysis further, the impact of the cargo mix has been explored using relative cargo ratios for fuel, stores and lane-metres. The model was investigated with the stores volume ratio R_s set to 1. The corresponding ratio value for LIMs R_l, therefore is the ratio R_l/R_s as seen in Table III. The fuel ratio R_f was then adjusted until a crossover balance point was found. It was then possible to adjust B/T by increasing the total payload now fixed at the solution ratio (see columns in Table III) until the B/T value was at a nominal 1.7 for each case.

Rf	1	1.46	3.9	7.9	10.1	11.46	12.7	22.6	35.2
Rs	1	1	1	1	1	1	1	1	1
Rl	0.2	0.3	0.5	0.82	1	1.1	1.2	2	3
LOA(m)	132	140	146	149	150	150	151	152	153

Table III Variation of Cargo Mixes and Ship Length

Figure VI shows that the resulting ratio of R_f/R_s is linearly related to R_l/R_s, i.e. they are approximately in direct proportion to each other. This means that if the LIMS (m) requirement is increased relative to the cargo volume(m^3), the fuel (te) must increase by roughly 12.5 times as much. As the LIMS was equated to 2.1 tonnes per metre, the weight fuel is increasing by roughly 6 times as much as the LIMS payload.

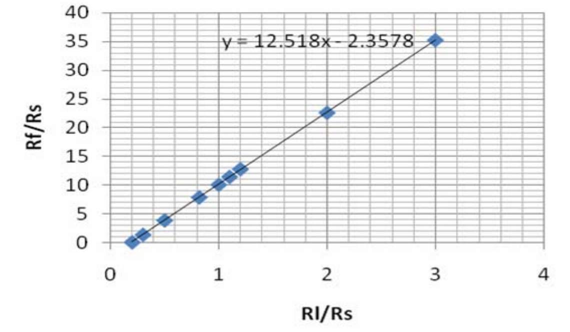


Figure VI Relative Variation of Fuel, Stores and LIM ratios

Example

Starting from a balanced design, suppose 5m of vehicle space is added to a three lane design, the ship should be designed to carry 31.5 extra tonnes of vehicle but would also increase the fuel cargo by approximately 180 tonnes to remain in balance.

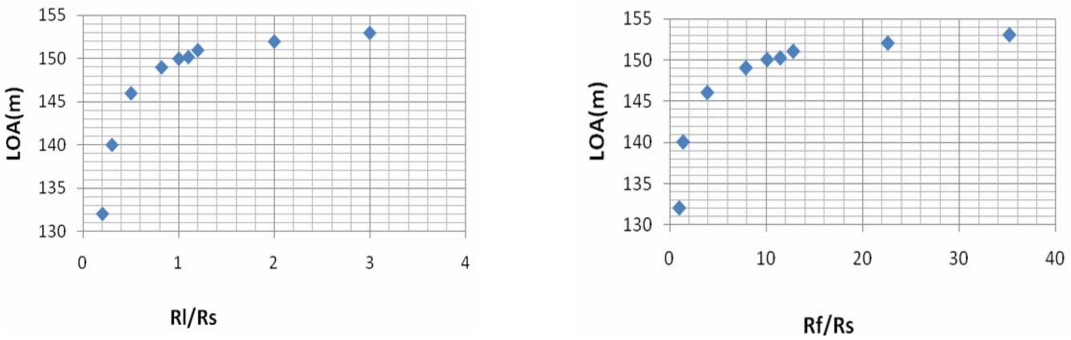


Figure VII Plots of Length Overall versus (a) ratio of LIMS to Stores and (b) Ratio of fuel to stores

Figure VII shows that length overall (LOA) increases sharply as R_l/R_s increases and then becomes less sensitive at a length of around 150m (all the points on the graph correspond to 'balanced' solution ratios). This shows that for this starting point, once the three lane design exceeds approximately 150m LOA it becomes significantly less sensitive to the relative mix of cargo. In this region the ratio R_l/R_s can vary from 1 to 3 as shown in Table III. Figure VII (a) and (b) look very similar because R_l and R_f are roughly in direct proportion but it can also be seen that R_f, and hence the fuel load, increases far more rapidly than R_l as discussed previously.

Conclusions on weight and capacity carriers

For vessels of mixed cargo types (volume, deadweight and LIMs) there are "families" of feasible designs that lead to convergence between the deadweight and capacity carrier sizing algorithms. These families are related to the specified LIM requirement and the number of "lanes" the designer chooses in the design to achieve the requirement. Convergence of the deadweight and volumetric sizing algorithms within each family was initially found to be very sensitive to the relative mix of the different cargo types selected. However, each family has a length beyond which it becomes less sensitive to the cargo mix, as in particular the deadweight of fuel becomes the dominant driver in balancing the design.

It was found that there are a number of solutions that exist for a relative mix of the cargo types. However, not all of cargo mixes have solutions; this means that for a user specified set of cargo mixes there may not necessarily result in a feasible vessel design.

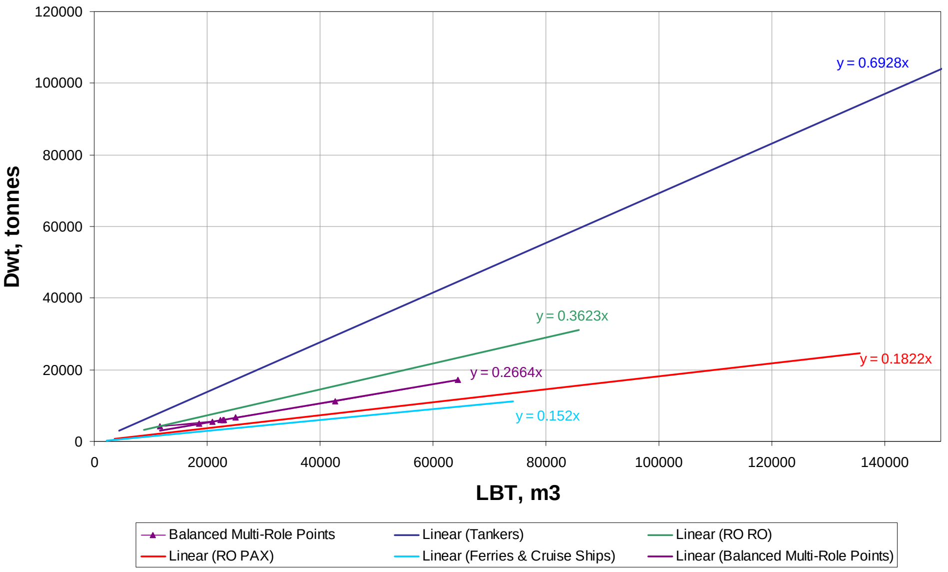


Figure VIII Balanced Deadweight - Volumetric Solutions as a function of deadweight / LBT ratio

Figure VIII shows the design values for the "balanced" multi-role points. The line lies between the Ro-Ro and Ro-Pax graphs which indicates that the results should be realistic.

Platform Arrangement Constraints

The design of the multi-role auxiliary needs to consider the competing space demands of the role and the potential conflicting standards that may apply. A principal objective for the designer must be to de-conflict the layout requirements. This allows separation of the areas for which different standards may apply and prevents individual roles impacting upon each other.

Embarking and Disembarking Logistics Payloads

A key feature of a logistics vessel and therefore a major constraint to the multi-role auxiliary is the choice of embarkation / disembarkation technique. The choice will be driven by the operational need and can be considered as a choice between strategic logistics between prepared ports under benign conditions or disembarkation at sea and without external assistance.

When operating at a port, the obvious solution is the use of ramp(s) to provide direct access to the Ro-Ro deck for vehicles. Ramps may be incorporated as either stern or side ramps. A stern ramp offers a more rapid embarkation / disembarkation as the vehicles may load in the direction of stowage but this style of ramp requires a more prepared port. A side ramp offers more flexibility as it may be deployed when the vessel is able to dock alongside in a more conventional manner, although this then requires consideration of vehicle movement internally to access the ramp opening. Additionally, the ship may also require cranege for disembarking loads.

When considering disembarkation at sea, choice of method becomes dominated by the environment under which the operation is to be conducted. A stern ramp may be used, offloading to a pontoon or directly to landing craft. This is practical and does not impose a greater impact on the design than a more conventional stern ramped Ro-Ro. However, ramp to ramp operations are limited by sea state due to the need to maintain a physical connection between landing craft and logistics vessel and the safety considerations of moving people and vehicles across the connection.

The alternative may be consideration of a dock in the logistics vessel. Moving the landing craft into a dock allows the transfer to be conducted within the controlled environment of the ship. However, incorporation of a dock into a design is a significant design driver, both in terms of the physical space for the dock and also the required ballasting system to allow the vessel to increase draught to allow sufficient depth of water in the dock.

A further complication is the carriage of transfer boats or landing craft. In the case of the dock ship these would be carried internally. When using ramps to off-load to landing craft, the landing craft themselves become cargo which has to be carried and launched either from the upper deck of suitably arranged alcoves. However, this again brings further role conflict, as the chosen position must not be at the same location as for RAS stations, cannot interfere with the material flow to the RAS stations and must still conform to boat handling standards and safety requirements (e.g. height above waterline for green seas, space for line handling etc.).

Cargo Flows for Replenishment Ships with Logistics Capability

The replenishment flow will require the cargo to be directed to the ships replenishment stations. There will be a number (typically 2, 3 or 4) of abeam positions which may be for fluid, solid or both forms of cargo. There may also be requirements for astern refuelling and VERTEP of stores. Additionally, points of embarkation for the cargo need to be considered.

Figure IX illustrates the complexity of the payload and material flow. The need to ensure the material flow routes do not constrain each other as they are moved from stowage to point of delivery is evident.

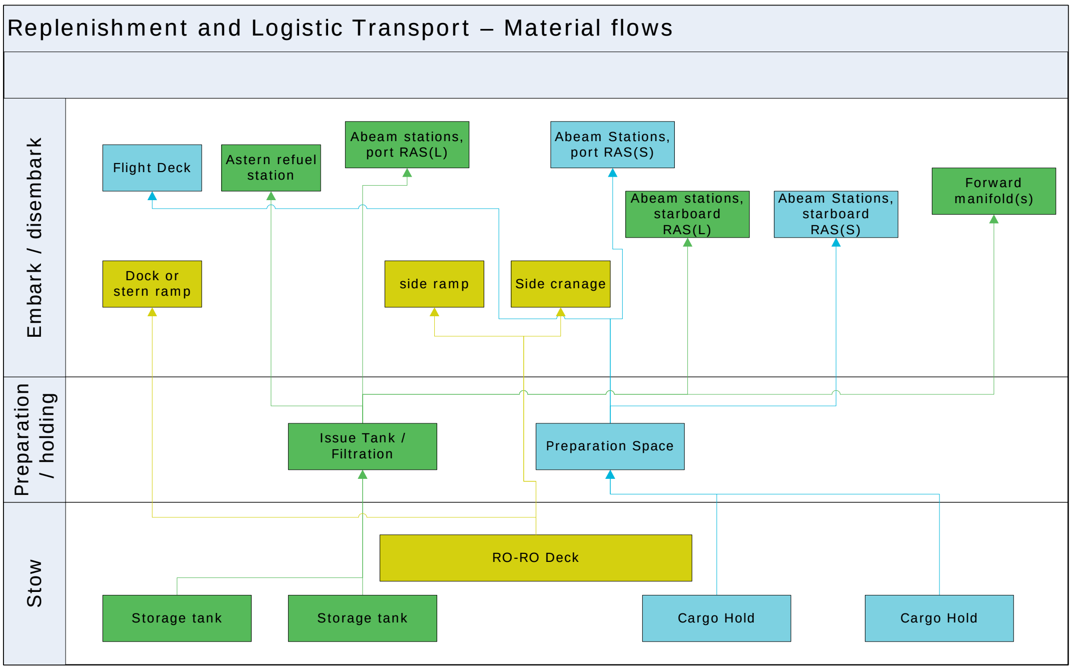


Figure IX Logistics Material Flow Superimposed with Replenishment

<u>The Possible Configurations of Multi-Role Designs</u>

Key constraints to consider in the concept are:

- Separation of hazardous cargos (fuel from ammunition);
- Maintenance of a suitable trim and bending moment (which favours a central fuel tank arrangement);
- Length of required aviation arrangements positioned aft;
- Longitudinal alignment of replenishment at sea stations to receiving vessels;
- Stores flow from holds to replenishment at sea stations;
- Personnel flow.

The overall arrangement of the design concept is in fact highly constrained by these features, and can broadly be grouped into the following configurations; aft superstructure arrangements, superstructures split fore and aft and forward superstructures. The relative merits of these configurations have been explored by Andrews in Reference 6.

Ideally, a single superstructure would reduce the cost of duplicating hotel systems forward and aft and it separates the cargo function from the accommodation, so this may be taken as a starting point. This is the basic configuration used in most single commodity cargo vessels, e.g. tankers or solid cargo.

The first complication arises from the introduction of solid cargo, munitions and fuel. Both of these cargos should be located in blocks, but whether to arrange these vertically, horizontally and in which order is less obvious (Figure X).

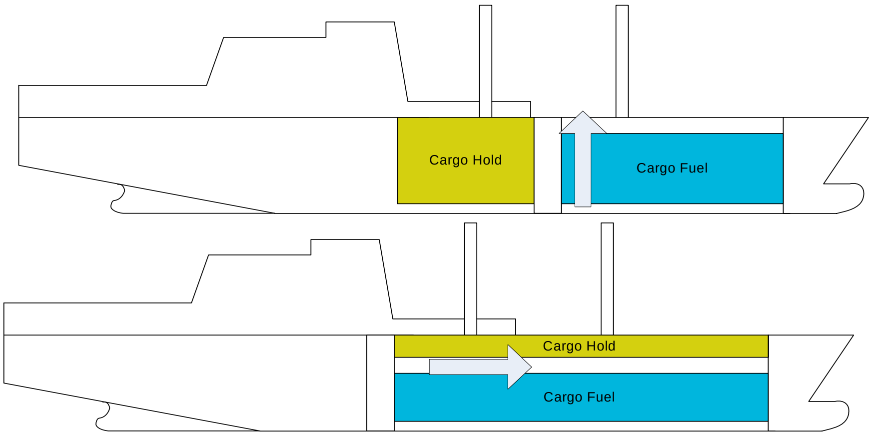


Figure X Vertically and Horizontally Arranged Ships

Clearly, where munitions are to be carried then these cannot be located adjacent to fuel cargo tanks, accommodation or other hazardous spaces, either longitudinally adjacent or above, unless a cofferdam is included. Also, from a simplistic cost perspective, reducing the number of cargo tanks and holds would be advantageous. This would suggest that where there is a significant fluid cargo a vertical arrangement is preferable.

The addition of the logistics capability requires a Ro-Ro deck for the stowage of vehicles, with suitable access arranged as previously discussed. To avoid the extensive use of vehicles ramps, which are space consuming and operationally difficult, the vehicle deck should ideally be arranged as a single deck at "main deck" level to allow direct access to the ships ramps, as in Figure XI.

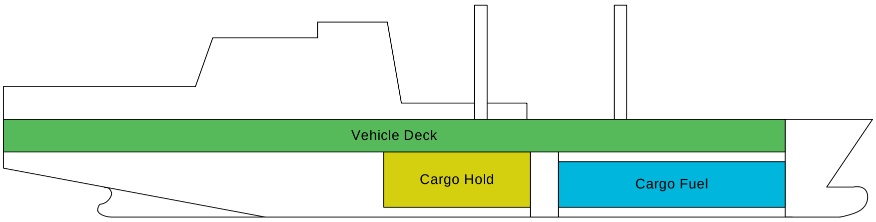


Figure XI Simple Multi-Role Ship Configuration

The resultant design becomes a mix of vertically and horizontally arranged cargo spaces. The cargo tanks and holds are arranged vertically, constrained by the watertight boundaries below the main deck. The vehicles deck has to be arranged horizontally for access. This introduces the complexity of moving cargo from the vertically arranged lower portion to the points of delivery, past the horizontally arranged vehicle deck whist not constraining the replenishment flow rates or making vehicle stowage difficult to arrange. De-conflicting this arrangement may require either a reduction in one or other or both cargo types or implies a suitably large ship to allow the de-confliction.

A further complication arises with the arrangement of superstructure. This is driven by the aviation requirements and complement levels. A major constraint of the replenishment ship is the location of the RAS stations. These must align with the receiving ship stations. Given the complexity in designing warships, the receiving ships will invariably drive the location of the delivery ship. The effect on the multi-role auxiliary is to constrain the size of the aft superstructure and length of potential flight deck. Hence, as the aviation facilities increase (e.g. more than one helicopter), so the amount of volume and length required increases and less space becomes available in the aft superstructure for accommodation as shown in Figure XII.

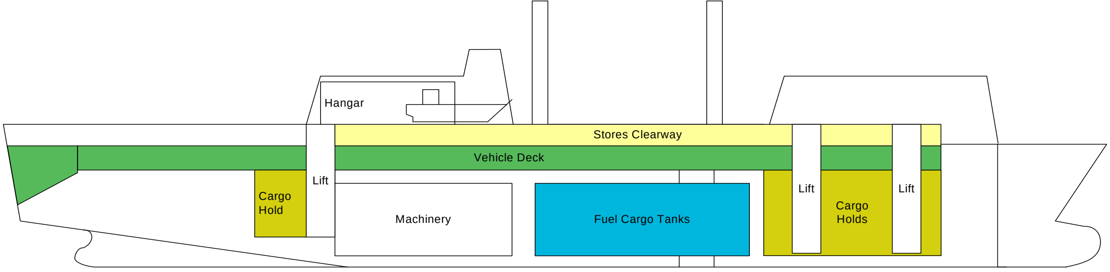


Figure XII Multi-Role Logistics, Replenishment and Aviation Capable Design

Further, as an auxiliary with a significant aviation element is also highly likely to require a lot of accommodation, so the superstructure eventually may need to be split into a fore and aft block to provide the required volume.

In addition, some of the more specialist roles are also finding their way into multi-role projects. As already mentioned the UK AOR Class provides an enhanced aviation support facility. A number of the ongoing projects have sought to add other specialist roles, notably enhanced medical facilities. The end result may be a large and highly complex ship, delivering fluid and solid replenishment at sea, sealift of vehicles and troops, medical and enhanced aviation support.

The Truly Multi-Role Ship?

From this discussion, the truly multi-role auxiliary ship requires the following attributes:

- Sufficient fuel cargo capacity to support a number of warships, with abeam and possibly astern refuelling;
- Sufficient stores cargo and munitions holds to support a number of warships, with abeam and VERTREP delivery;
- A Vehicle deck;
- A side and possibly stern ramp;
- Possibly a dock;
- Stowage for at least two landing craft;
- A flight deck and hangar, possibly for multiple helicopters.

The resultant ship has to be large, driven by:

- The internal volume for all the cargo types;
- The correct distribution and alignment of upper deck features (the flight deck and hangar aft, RAS stations at the appropriate location, sufficient superstructure for all the accommodation);
- A suitable layout to allow an efficient material flow for each role;
- Sufficient depth of hull to accommodate cargo tanks and holds beneath the vehicle deck;
- Other "multi-role" features such as a significant aviation capability, containerised cargo on the upper deck, modular repair or hospital facilities.

A good explanation of how such a ship evolves and the issues faced by the designer is given in Reference 7, which details the developments of the Canadian Joint Support Ship.

The conclusion is that the true multi-role auxiliary must either be a very large vessel, not only to carry all the payload items but to allow sufficient weather deck length and internal volume to de-conflict all the roles and internal cargo flow routes.

To reduce the ship size to an affordable naval auxiliary ship size, then some of the features must be reduce or removed. This then compromises the capability in one or more role, for example;

- Reduce the replenishment capability by reducing to a single RAS station per side and reducing the bulk stowage (fuel and / or stores);
- Reduce the logistics capability by reducing the length of the vehicle deck;
- Limit the logistics delivery capability, i.e. no dock and possibly not carrying its own craft.

The investment in a replenishment ship is significant due to the equipment and related training and therefore the capability delivered should fully meet the user’s needs. Alternatively, a vessel with only a limited logistics capability may not be able to deliver sufficient payload to support the forces ashore. In either case, it is not truly multi-role, rather capable of partially fulfilling a number of roles.

The key question therefore becomes: are all the roles to be delivered to the same level of capability expected from a single role vessel or are they only a more limited capability?

Fleet Size may ultimately determine the merits

The answer to whether a multi-role ship is cost effective is perhaps more subtle than purely the costs themselves and it is necessary to consider the fleet size to gain an appreciation of the reasoning behind the choice.

The Small Fleet

In the “small fleet”, there may only be one or very few auxiliary vessels. It is unlikely that the full range of capabilities exist. On this basis, the “multi-role vessel may offer new capabilities for modest cost increases in new vessel investment.

Whilst the multi-role vessel may not deliver the full capability of each type of single role vessel, the expectation may not require this as the multi-role vessel will provide additional capabilities in any case.

The Medium Fleet

For “medium” sized fleets, then the capabilities may be present but delivered by individual ships. This causes the obvious difficulty that when that ship is unavailable, then the capability is temporally lost. Where two roles delivered by two ships can be combined, this clearly offers the opportunity to have two ships each capable of delivering both capabilities. Now, the capability can be maintained. This argument is demonstrated in practical terms by the Canadian Joint Support Ship (JSS) project. Here, Canada is faced with the problem of not only replacing its existing replenishment ships and providing a sealift capability, but with two coasts on which to provide both capabilities. The solution was to combine the replenishment and sealift roles, providing one ship per coast plus one rotating into maintenance. The alternative would have been one replenishment ship per coast and one logistics ship covering both.

The Large Fleet

Interestingly, the largest navies do not tend to follow the multi-role route. After introducing the AOR class, the UK is now reverting to separate tanker and stores ships with the MARS programme. For these larger navies, the vessels tend to operate within task groups where there will always be a number of auxiliary vessels present. In this case, there is a more limited advantage in combining roles as the overall hull numbers are not reduced. This is because the performance in individual roles cannot be compromised and the vessels are already large such that further growth to accommodate multi-role features is not realistically practical. Hence, adoption of multi-role vessels adds complexity and cost to the vessels but does not reduce hull number requirements.

Conclusions

This paper has considered the implications for the ship designer of the current trend in naval procurement towards “multi-role” auxiliary vessels. It has explored the complexities that multiple types of cargo present and how the mixing of stores, fuel cargo and vehicle decks in one ship design leads to a blurring of the definition of the vessel. This makes the designers initial starting point for the design less obvious and this is related to the relative mix of cargo within the requirement set.

Finally, the merit of adopting multi-role auxiliary types may lie with the nature of the fleet it serves and specifically the size and expectation of performance in each individual role. Ultimately, a multi-role ship offers the ability to gain extra capabilities for a modest increase in procurement budget, provided the expectation is limited. The multi-role ship is therefore not a true replacement of single role vessels as it must always compromise some performance aspects.

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