Review of
Advanced Marine Vehicles Concepts

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The final twenty years of the past century have witnessed a rapid growth of interest in the development of Fast (and Advanced) Marine Vehicles for various applications. Whereas, up to the seventies, the design of fast marine vehicles appeared to be of interest only to navy authorities, the most recent developments seem to be driven mainly by commercial applications [1]. Along these lines, in the last two decades considerable efforts have been expended, worldwide, to develop new types of fast passenger and cargo ships and to increase the share of waterborne transportation. In addition to developments in other countries with highly developed economies (e.g., USA and Japan) similar developments have been underway in Europe, which might improve the conditions for the necessary cohesion of various national economies within the European Community. It is evident, that in order to maintain or even increase the competitiveness of the European economy as a whole, it is essential to improve the efficiency of the inter-European economy and transportation network as a whole, considering that a significant portion of the final price of many products is paid for transportation.

The competitiveness of any transportation system, including Short Sea Shipping, depends on the price and quality of the offered services. The main factor characterising the quality of transportation services is *transportation time* within a "door to door" delivery concept (**J**ust **I**n **T**ime / *JIT* products), besides *safety* and *comfort*, the latter being of equal significance for passenger transport. The inherent advantage of waterborne transportation, namely its low energy consumption per ton-km suggests, that above a certain low limit for the service speed, the value of which is dependent on the transportation scenario, waterborne transportation appears to be a strong competitor to other transportation modes, particularly air- and in some cases land transport [2]. Considering also the environmental impact of road-bound transport, the huge public funds reserved for this specific transportation mode and the frequent road traffic breakdown, especially during the summer-tourist season, it seems that a further increase of land transport will be in the near future practically impossible in several areas around the world, particularly Europe. Consequently, a reduction of the road-bound transport and cross-boarder traffic is desirable and alternative transportation modes appear necessary, *even at higher cost*.

The above economical and ecological aspects, encouraging the development of efficient and competitive Open and Short Sea Shipping systems, are also supported by current 'revolutionary' developments in shipbuilding technology, particularly the use of innovative light construction materials, of innovative machinery and propulsion systems, new type navigational and system's control equipment and of innovative loading/unloading systems. Considering the time factor as one of the most important elements of any transportation mode, it is evident that developments in Short Sea Shipping are interrelated with developments in Fast Sea Transportation and to technological breakthroughs in unconventional ship designs and in innovative port facilities.

In the following, we briefly address the various types of innovative ship designs, currently under development or already implemented in practice, in the form of a comprehensive AMV development chart[1]. The chart is based on the four main physical concepts leading to the force balancing the weight of the ship, namely the *hydrostatic buoyancy force, the hydrodynamic lift force, the aerostatic, powered air-lift force and the aerodynamic lift force.* The outlined basic concepts and the derivatives thereof ('hybrids') are filed ***columnwise*** according to origin of the ***major*** physical concept balancing the ship's weight during service operation, notwithstanding the fact, that during operation more physical concepts might contribute to their weight balance, e.g. the weight of a planing craft is not entirely carried by the hydrodynamic lift force but to a certain degree, depending on the speed of operation and the planning craft hull form, also by hydrostatic forces according to the displaced water volume. Trivially, at zero speed[2], the weight balance for all outlined types is entirely accomplished by the hydrostatic buoyancy force. The outlined concepts are globally filed

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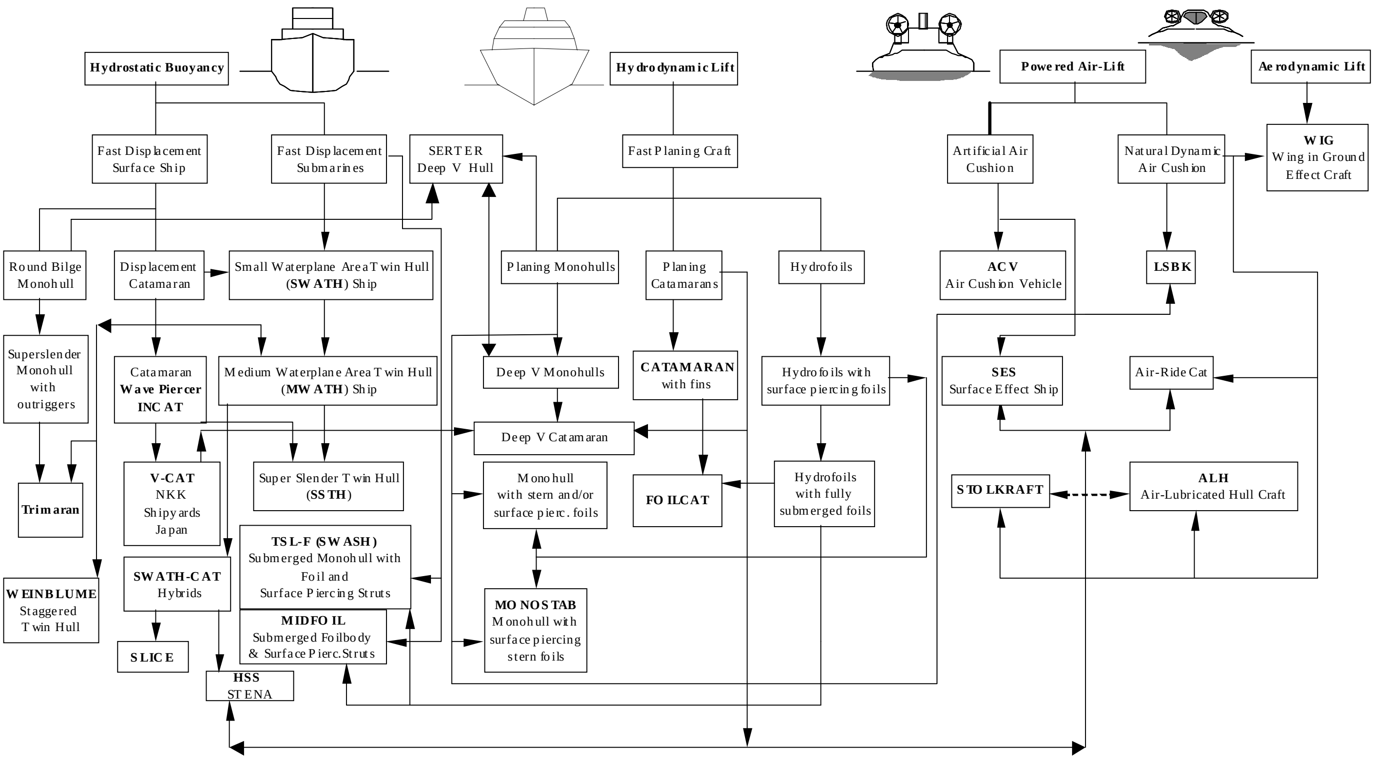
1 It is of interest to note the background history to this chart, the first version of which dates back in 1987. At that time, the introduction of AMV concepts to the Greek interisland traffic appeared practically impossible, because of the lack of proper information among the ship operators. AMV concepts, or so-called in Greece 'New Technology Ships', were 'condemned' to be 'good' or 'bad', based on the personal opinion of 'non-experts', advising interested shipowners, but little information about the great variety of concepts and their advantages/disadvantages was available to interested operators [6]. The chart reflects, in its present form developments up to about the year 1999.

2 Assuming for the air-powered lift vessels zero air-cushion pressure.

rowwise according to the degree of their development and deviation from the original main concept. Historically, technological developments are understood to have taken place from the left upper corner ('Archimedean Principle') towards the right and downwards.

From the feasibility point of view, all outlined concepts appear to have at least some of the required qualitative and partly quantitative technical and economic characteristics for possible integration within a global fast sea transportation system [2]-[5]. However, caution is necessary, when selecting a candidate AMV concept, as a variety of technical and economic aspects should be considered, especially: calm water performance (resistance and propulsion), wave-wash impact on shore, seakeeping, manoeuvring, payload capacity, flexibility of overall and of machinery/propulsion arrangements, engine emissions, noise and vibration levels, building and operational cost, links to portside facilities. Past experience has taught us, that a only a close collaboration between researchers-developers, designers, builders, operators, shippers and governmental port authorities can ensure the successful implementation of an AMV concept in practice.



ADVANCED MARINE VEHICLES

Development of Basic Types and Hybrids

acc. to A. D. Papanikolaou, 1997

Comments on Chart of Advanced Marine Vehicles and Explanation of Used Acronyms

1. ACV: **A**ir **C**ushion **V**ehicle - Hovercraft, excellent calm water and acceptable seakeeping (limiting wave height), limited payload capacity.

2. ALH: **A**ir **L**ubricated **H**ull, various concepts and patents, see type STOLKRAFT.

3. Deep V: ships with **Deep V** sections of semi-displacement type acc. to E. Serter (USA) or of more planing type, excellent calm water and payload characteristics, acceptable to good seakeeping, various concepts AQUASTRADA (RODRIQUEZ, Italy), PEGASUS (FINCANTIERI, Italy), MESTRAL (BAZAN, Spain), CORSAIR (LEROUX & LOTZ, France).

4. FOILCAT: Twin hull (catamaran) hydrofoil craft of KVAERNER (Norway), likewise MITSUBISHI (Japan), excellent seakeeping (but limiting wave height) and calm water characteristics, limited payload.

5. **L**ow **W**ash **C**atamaran (LWC): Twin hull superslender semi-displacement catamaran with low wave-wash signature of FBM Marine Ltd. (United Kingdom), employed for river and closed harbour traffic.

6. LSBK: **L**aengs**S**tufen- **B**odenkanalboot- **K**onzept, Optimized air-lubricated twin hull with stepped planing demihulls, separated by tunnel, aerodynamically generated cushion, patented in Germany (Germany)

7. MIDFOIL: Submerged Foil-body and surface piercing twin struts of NAVATEK-LOCKHEED (USA)

8. MONOSTAB: Semi-planing monohull with fully submerged stern fins of RODRIQUEZ (Italy).

9. MWATH: **M**edium **W**aterplane **A**rea **T**win **H**ull Ship, as type SWATH, however with larger waterplane area, increased payload capacity, worse seakeeping.

10. SES: **S**urface **E**ffect **S**hips, Air Cushion Catamaran Ship, similar to ACV type concept, however improved seakeeping and payload characteristics.

11. SLICE: Staggered quadruple demihulls with twin struts on each side, acc. to NAVATEK-LOCKHEED (USA), currently tested as prototype.

12. SSTH: **S**uper**s**lender **T**win **H**ull: Semi-displacement catamaran with very slender long demihulls of IHI shipyard (Japan), similar to type WAVEPIERCER.

13. STOLKRAFT: Optimized air-lubricated V-section shape catamaran, with central body, reduced frictional resistance characteristics, limited payload, questionable seakeeping in open seas, patented by **STOLKRAFT** (Australia)

14. Superslender Monohull with Outriggers: Long monohull with two small outriggers in the rear part acc. to KVAERNER-MASA (Finland), excellent calm water performance and payload characteristics, good seakeeping in head seas.

15. Superslender Monohull: excellent calm water and payload characteristics, non-validated seakeeping and structural design, EUROEXPRESS of KVAERNER-MASA Yards (Finland).

16. SWATH Hybrids: SWATH type bow section part and planing catamaran astern section (STENAs HSS, Finland, AUSTAL hybrids, Australia), derived from original type SWATH & MWATH.

17. SWATH: **S**mall **W**aterplane **A**rea **T**win **H**ull Ship, synonym to SSC (**S**emi-**S**ubmerged **C**atamaran acc. to MITSUI Ltd.), ships with excellent seakeeping characteristics, especially in short period seas, reduced payload capacity, appreciable calm water performance.

18. TRICAT: Twin hull semi-displacement catamaran with middle body above SWL of FBM Marine Ltd. (United Kingdom).

19. TRIMARAN: Long monohull with small outriggers at the center, proposed by Prof. D. Andrews - UCL London (United Kingdom), currently tested as large prototype by the UK Royal Navy (TRITON), similarities to the Superslender Monohull with outriggers concept of KVAERNER-MASA, however apparently with different calm water, seakeeping and payload characteristics.

20. TSL-F - SWASH: Techno-Superliner Foil version, submerged monohull with foils and surface piercing struts, shipyard consortium (Japan)

21. V-CAT: Semi-displacement catamaran with V section shaped demihulls of NKK shipyard (Japan), as type WAVEPIERCER.

22. WAVEPIERCER: Semi-displacement catamaran of INCAT Ltd. (Australia), good seakeeping characteristics in long period seas (swells), good calm water performance and payload characteristics.

23. WEINBLUME: Displacement catamaran with staggered demihulls, IFS Hamburg- Prof. H. Soeding (Germany), very good wave resistance characteristics, acceptable seakeeping and payload, name to the honour of late Prof. Weinblum.

24. WFK: **W**ave **F**orming **K**eel High Speed Catamaran Craft, employment of stepped planing demihulls, like type LSBK, but additionally introduction of air to the planing surfaces to form lubricating film of micro-bubbles or sea foam with the effect of reduction of frictional resistance, patented by A. Jones (USA)

25. WIG: **W**ing **I**n **G**round Effect Craft, various concepts and patents, passenger and cargo carrying, excellent calm water performance, limited payload capacity, limited operational wave height, most prominent prototypes the ECRANOPLANS of former USSR.

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