Intelligent marine transportation system: SMARTT

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Abstract

This paper addresses the need to develop a High-Speed Marine Vehicle (HSMV) which is designed for commercial urban applications as an alternative to land-based vehicle travel and to provide an economic stimulant for the U.S. maritime industry, merging intermodal issues with technology.

This paper addresses the marine transit problem which is to increase the market for and construction of high-speed marine vehicles for commercial use in the U.S. and to develop, design and prepare specifications for a prototype vehicle through an international collaborative effort to serve the high-speed transportation markets, and additional markets in the world.

This paper proposes bringing together a unique consortium which would be positioned to develop construction activity in shipyards and an integrated intermodal marine vehicle system (SMARTT: Swift Marine Advanced Response Transport Technology) which would reinvigorate the state-of-the-art in innovative high-speed marine design and applications for the 21st century.

1 SMARTT Consortium

The SMARTT (Swift Marine Advanced Response Transport Technology) Consortium is structured to advance the development of HSMV design and construction technology for current and future owner/operators and shipyards interested in building in the U.S. The
consortium would research, develop, design a prototype HSMV, through an international collaborative effort to serve high-speed marine transportation markets in the U.S. and abroad. This would be accomplished by identifying markets and developing a new vehicle design for the U.S. and export markets.

Consortium members would include, ferry operators and potential ferry operators, shipbuilders, technologists, educators, research centers, local and state governments, federal agencies, foreign experts, investment specialists, trade associations, consultants, naval architects and marine engineers, business leaders, marketing experts, economists, planners, engineers and designers. The consortium would represent the latest thinking on available innovative technology application for HSMV.

2 Background

A major portion of the world's urban development is associated with waterways including human settlements found along rivers, bays, harbors and oceans. There are more people carried over the water each day by every type of vehicle from the long-tail boats of Bangkok to the 6,000-passenger Staten Island Ferry, and the sophisticated Hong Kong Jetfoil, then there are air travelers. Ferries are an integral part of the world's intermodal transportation system, but play a minor role in the U.S.

In 1971 the U.S. Department of Transportation identified the potential for HSMV. This study estimated that 500,000 people (1970 census) in 30 cities could be expected to use HSMVs daily as their principal mode of transportation (based on the 1990 census and urban growth, this figure would double). Another 50 cities were identified as long-range markets. It also pointed out that the U.S. had led the way in the development of high-speed marine technology but that the developments had been oriented toward military application. In 1984 a follow-up study was conducted by the U.S. Department of Transportation. The study focused on the potential for high-speed service in Boston, Hawaii, Lake Michigan, New York City, Providence, Ft. Lauderdale, San Francisco, Seattle, Virgin Islands and Washington, DC. At that time, only four HSMVs operated in the U.S.

Current Situation

By better utilizing the potential capabilities of the nation's waterways, the urban centers would be better able to provide convenient and cost-effective urban transportation service and, at the same time, help to relieve some of the major gridlock on the overcrowded highways, bridges, tunnels and transit systems, all of which impairs our economic development potential.
Vehicular traffic entering the urban area is choking the highway networks, and the central business district access and parking has become impossible; private vehicular subsidies have added to the problem; public transportation is barely able to hold its own and air quality countermeasures have failed to contain high pollution levels. Added to these environmental concerns, active community groups have caused the delay and, in some cases, the abandonment of key congestion-relieving projects including highway, bridge, airport and transit improvements.

To turn things around, the urban centers have been involved in a process of reevaluating their transportation networks and capital investments in order to find better ways of meeting growing transportation demands and changes in travel patterns while meeting Federal Clean Air requirements. With these overwhelming multidirectional pressures, it has become absolutely essential to find and support alternate ways to maintain and improve access within the urban centers. Time and time again, high-speed marine transportation systems with special emphasis on the passenger mode have been proposed.

Despite this interest in marine transportation, it has experienced very slow growth. There are many reasons for this, including: continued advances in land-based transport technology, government fiscal policies and transportation programs, failure to utilize available and developing technologies, lack of a clear understanding of actual costs of development and operation and a lack of vision, and the absence of a national HSMV policy and direction.

Domestically, ferries are being reintroduced and considered as alternatives to congested bridges and tunnels, highways under construction and airport access problems, as well as avenues to coastal recreation, as a method of meeting Clear Air mandated goals as a more energy-efficient transit vehicle, and as environmentally-sound high occupancy vehicle which can travel on "self-healing roadways," the waterways. Additionally, the focus of private investment in 1,000 waterfronts as part of urban revitalization across the US has brought new interest in HSMV links to these areas. Clearly water-based transportation can bring relief to the already overtaxed land-based transportation network therefore offering a strategic method of expansion without spatial conflict.

**Market Potential**

In 1995, it is estimated that there are about 350 ferry systems in the U.S. and several thousand vessels. Of these, there are only 55 high-speed vessels operating. Approximately 150,000 persons travel by ferry in the U.S. each day. This is less than half of the 350,000 passengers who...
travel each day by ferry in Istanbul and only a small fraction of the 1971 U.S. Department of Transportation projections.

Most of the high-speed vessels in the U.S. are based on Australian and Norwegian designs, with the U.S. designed vessels principally high-speed planing monohulls. These vehicles are built in the U.S. Although there have been three or four U.S. monohull, amphibious and surface effect designs put into service in the U.S., this country is still dependent on the technology of other countries for this market.

Worldwide, the fleet of HSMV is about 1,000 (excluding the former Soviet Union fleet, estimated at 1,000). The annual delivery of new HSMVs now exceeds 100 vessels, as contrasted to 1988, when 56 vessels were delivered each year. The principal builders and designers of the world's fast ferry fleet are the Norwegians, Australians, with a significant increase in building activity and markets in Japan and China.

In the slower-speed North American ferry market in 1993, over $1 billion in passenger and car ferries were under construction. The bulk of these were for large car ferry systems. A few small U.S. shipyards were even exporting vessels, which demonstrates that price and quality already offer the marine client the best product.

Meanwhile, in San Francisco Bay, Washington State, New York Harbor, Jacksonville and Rhode Island, transportation planners are identifying new markets for HSMVs. San Francisco's ferry program anticipates $75 million in investments in shore facilities and HSMVs. New York has committed $32 million in waterfront investments, and negotiated for new services to be provided by seven to ten new vehicles, for a tentative program of $80 million. Staten Island Ferry is considering introduction of HSMVs to replace or supplement the existing operation, requiring at least 10 new vehicles. The New York City Council has approved a 12-year lease for a private company to operate HSMVs from Staten Island to midtown Manhattan. Rhode Island is investigating the potential market for HSMVs to Long Island, Newport and Martha's Vineyard. On Long Island, a $40 million car-carrying high-speed ferry is in the development stage and the Long Island Association working with the State of Connecticut are finalizing plans for a ten to fifteen HSMV service across the Long Island Sound. In the Caribbean operators are finding great success with new high-speed car-carrying Scandinavian catamarans.

With the passing of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), $100 million was provided for ferries, along with discretionary funds for San Francisco, New York City and Alaska. Ferries are also eligible for general ISTEA funds ($6 billion), should governmental agencies designate their ferry program as a candidate. There is at least a market for 20 fast ferries under existing
funded programs which would be most likely built using Australian and Norwegian technology.

Other Markets
Most marine transport experts and operators have concluded that there is a large world market for HSMVs for: commuting, city links, emergency response (police, fire, customs, emergency services, local regulatory agencies, medical), airport shuttles, coastal refrigerated cargo, river service, rural development, oil pollution cleanup, recreation, express package delivery, island community service where automobiles are prohibited or inaccessible, rough water areas, offshore oil platforms, fishing boat and cargo ship crew transfers, drug interdiction, humanitarian efforts, stabilized platforms for deep ocean research, trans-ocean traffic, transport to off-shore incineration facilities and the short-haul cruise market. Part of the consortium's work would be a world-wide marketing study to define specific HSMV opportunities on a country-by-country basis. HSMVs clearly fill a transportation niche in many market areas, with their total number representing a significant quantity.

3 Design and Construction
To establish a design program that promotes the sale and construction of HSMVs in the U.S., the consortium would develop a data base on national and international activities and technologies, conduct technology assessments, participate in technology transfer and finally design a new generation of HSMV.

The consortium would evaluate the financial feasibility of potential operations and develop the parameters for providing satisfactory service, that has low initial costs and is economical to operate and maintain; develop a program for public and private financing alternatives; set standards for intermodal terminals, intermodal connections, safety and operations, labor needs and licensing, environmental standards and conflict resolution.

4 Management
The consortium would be managed by an executive board. The management would oversee the consortium's performance through working groups that would be chaired by an executive board member. The latest operation management techniques would be applied throughout the process. The consortium would remove all obstacles to constructing an HSMV prototype in a U.S. shipyard and to promote expansion of this market; to use the interactive information highway, include establishing an international HSMV electronic forum to provide state-of-the-art products and information sharing.
The first priority of SMARTT would be the design and construction of a HSMV prototype and to make U.S. shipyards internationally competitive and efficient in this market. All working groups would utilize state-of-the-art technology and management techniques.

5 Work Groups

The consortium would establish work groups chaired by a member of the consortium's executive board in the areas of international activities, Research and technology transfer and system design and operation.

International
This group would serve as liaison to foreign participants. Determine foreign needs, relationships with foreign equipment suppliers and shipyards. Consult with foreign team members who are willing to support the concept of building HSMV in the U.S. market. Determine if the foreign market would be served as a combination of U.S. production and overseas production for hulls, components and subsystems with most of the electronics, propulsion and electromechanical components coming from U.S. sourcing or subcontracted to local suppliers.

Research and Technology Transfer
This group would seek and obtain the most recent innovative research and technological knowledge from all over the globe; seek the most appropriate engine and system packages to accommodate variation in speed requirements and other equipment needs; and obtain the best shipyard construction methods through international cooperation and implementation.

System Design and Operation
This group would design a vehicle to accommodate specific answers to specific needs and will use simulations to evaluate research and design options to determine their potential success.

6 Technical Approach

The consortium technical approach would explore the application of available technologies for the HSMV. The consortium goal would be to develop a state-of-the-art multipurpose marine vehicle. The vehicle would be designed with the flexibility of being used in various environments and configurations including passenger, vehicle, cargo, etc. The consortium will investigate hull design options on a flexible HSMV design, displacement and planning hulls, hydrofoil vessels, semi-planing, catamaran hulls and surface effect platforms will be
investigated. The ranges of applicability of each configuration will be evaluated. Factors such as hydrodynamics, hull strength, propulsion, seakeeping, survivability, passenger comfort, interface with terminal facilities, environmental impact, and construction and operating economics will be studied. The analysis of propulsion factors will include propulsors such as fixed pitch propellers, controllable pitch propellers, ducted propellers, vertical-axis propellers and water jets. Propulsion and auxiliary prime-mover investigations will include high-and medium-speed diesels, gas turbines and fuel-cells. The use of electric transmissions will be considered.

The vehicle would utilize human-centered technology. Access and egress, controls, machinery and seating would be optimized. Lighting, monitors, information displays, as well as other sensor systems would be integrated into the design. The cockpit would be evaluated for its reliability and user ability afloat. Control and display design would incorporate human-machine interface considerations to facilitate the crew's ability to perform vehicle systems operations. Crew workload would be based on the human-centered approach. The vehicle would be designed around the operator, crew and passenger needs and requirements using a client/customer satisfaction model. This HSMV is a natural off-shoot of the intelligent vehicle concepts and transfer of military technology. The maritime industry would greatly enhance its standing by emphasizing technology and human performance.

The HSMV would also enjoy the following characteristics: multi-use/multi-purpose platform, flexible design elements, designed to operate in a three-dimensional environment, employ GPS, collision-avoidance, night-vision, bridge automation, stabilization, cargo handling systems, human centered ergonomics, state-of-the-art materials, fuel efficient, advanced communications, fiber optics wiring, on-board MIS, interior and exterior custom display technology, advanced safety systems, surveillance systems, environmental restraint systems, fail-safe fire safety, joint use of external systems, innovative financing, focus groups for user input, advanced and automated maintenance systems, advanced electronic and on-board computer applications. Clearly SMARTT would represent proactive technology based leadership that is economically feasible.

7 Financing

The consortium would give special emphasis to funding with the objective of finding new sources of financial support, and minimizing owner/operator and shipyard overhead costs. The consortium will research and study the financial needs of participants and potential participants in the program; financial analysis of the products vis-à-vis market conditions and financial incentives; performance evaluation
and recommendations for improvements in the areas of construction; and identification of financial support. In this area, low-cost business loans, transit subsidies, financial incentives for construction of vehicles from equipment manufacturers and others, multi-financing innovations, cost-sharing proposals, minority program assistance, replacement alternatives, improved management of paying and billing methods and others would be identified and offered.

The consortium would be creative in determining the financial needs and sources of funds. Consideration would be given to low-cost loans, small business loans, subsidy to transit operators, financial incentives, multi-financing innovations, minority program assistance, cost sharing, replacement alternatives, improved management of paying and billing methods and others will be identified and offered.

8 International Cooperation

The consortium would initiate fast-track joint applied research with US., Russia, Ukraine, China, Australia, Scandinavia, Britain and Hong Kong, the centers for HSMV vehicles and construction, in order to explore collaborative technology development. For example, the Russians have developed high-speed passenger hull technology which can be matched with U.S. superior high-value elector-mechanical systems and propulsion systems. Working in partnership with Russian, Chinese, Australian, Scandinavian, British and Hong Kong researchers in a cooperative effort can help rebuild U.S. shipbuilding capabilities and redeploy personnel from defense to commercial activities. Overall administration and organizational leadership would remain with the U.S. representatives.

9 Training

Because of the application of new and advance technologies systems, controls and displays, the consortium would include shipyard construction management. The training would include maximum practical use of simulation and learner-centered training technologies and practices for construction.

10 Conclusion

The consortium would have a long-term impact on developing and expanding the market for U.S.-built HSMVs world-wide by positioning the U.S. shipbuilding industry and selected ports to be the center for active economic growth and proactive leadership in this market niche by the 21st century.