



ONR High Speed Craft Development

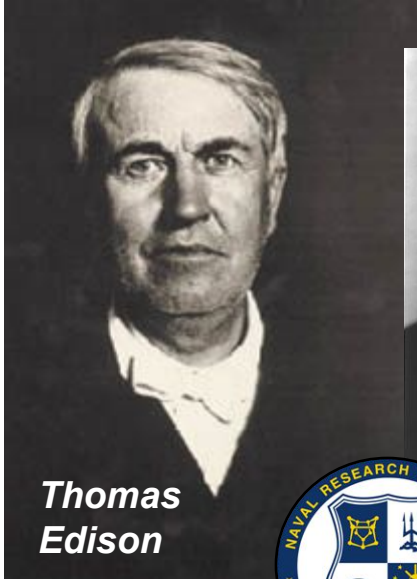
**IHS / SNAME Joint Dinner Meeting
2 Dec 2004**

**Scott Littlefield
ONR 33X
(703) 588-2358
little@onr.navy.mil**

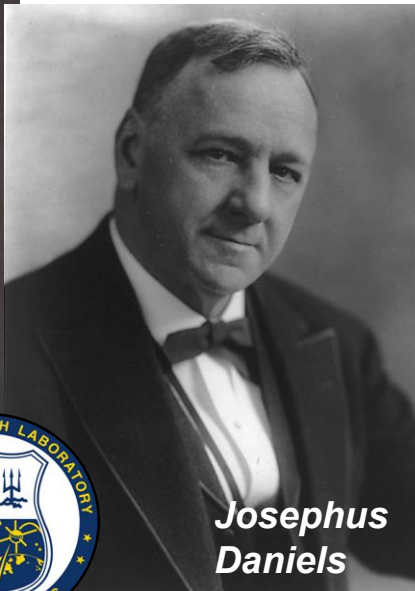
Naval Research Mission

“To plan, foster and encourage scientific research in recognition of its paramount importance as related to the maintenance of future naval power and the preservation of national security.”

Public Law 588 (1946)



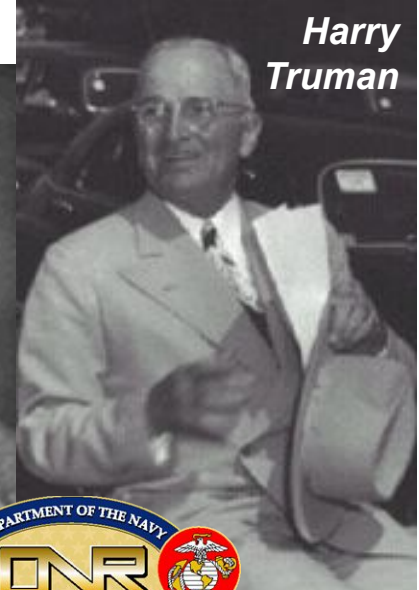
**Thomas
Edison**



**Josephus
Daniels**



**Vannevar
Bush**



**Harry
Truman**

Experimental Ship Programs



ONR Programs – Small Fast Ships and Craft

Delivering a complete vessel (from large to small):

- X-Craft (including HDV-100)
- Hybrid Small Waterplane Area Craft / Lifting body technology (Sea Flyer)
- High Speed Cargo Craft (Sea Coaster)
- Small Watercraft Demonstrator
- Unmanned Sea Surface Vessel
 - High Speed Variant
 - Low Speed Variant

Delivering designs or component technology:

- Composite High Speed Vessel
- Composite Special Operations Craft
- High Speed, Heavy Lift Shallow Draft Craft (aka V-ALT); may lead to a complete vessel demo.
- Agile Port and High Speed Ship Technology
- Project Endeavor

Other Programs: Advanced Electrical Systems (including electric propulsion), Hydrodynamics, Advanced Structural Materials, Coatings, Environmental Quality . . .

How did we get here?

Customer Pull:

- Recent Navy interest in small, fast ships
- Seabasing Concepts

Congressional Push:

- Additional funding for small, fast ships and related technology

Navy vs. Commercial

- What's the same? What's different? -

		Navy	Commercial
• High Speed	XX	X	
• Good Seakeeping	X	X	
• High Payload Fraction	X	X	
• Survivable	XX	~	
• Low Signature	XX	No	
• Shallow Draft / Beachable		XX	No
• R&D Budget	Large	Small	
• Technical Risk Tolerance		Medium	Low

Navy Investment Leading to a Commercial Sale

Lockheed Martin Awarded Contract Worth More Than \$25 Million to Deliver Two Crew Boats to Mexico

Vessels Will Be Used to Transport People and Cargo to Oil Rigs

BALTIMORE, Oct. 18 / PRNewswire-FirstCall / -- Lockheed Martin (NYSE: [LMT](#)) was recently awarded a contract valued at more than \$25 million to perform detailed design, construction, test and delivery of two Small Waterplane Area Twin Hull (SWATH) crew transport vessels that will provide service to Mexico's national oil company, PEMEX. The Lockheed Martin design is based on its SLICE(R) Small Waterplane Area hull form. The contract, awarded to Lockheed Martin by Hotelaria y Servicios Petroleros, S.A. de C.V. (HSP), calls for the delivery of two SWATH crew transport vessels that can safely and swiftly transport people and limited cargo from Ciudad del Carmen to the Campeche Basin Oil Field 90 miles offshore . . .



High Speed Craft Technical Issues

NAVY
3,000 tons
50 kts

Overarching Need

Maintain useful payload fraction and range while increasing speed

ARMY
10,000 tons
70 kts

Propulsion

Metrics:

- Power Density
- Efficiency

Technologies:

- Engine / Drive train
- Mechanical drive vs. electric drive
- Propulsor choice

Hull Forms

Metrics:

- Minimize drag (friction, form, and wave making)

Technologies:

- Optimize hull form
- Control emersion (dynamic lift)
- Fluid drag reduction

Hull Materials

Metrics:

- Strength vs. weight
- Cost
- Corrosion resistance
- Maintainability

Technologies:

- High strength steel
- Aluminum
- Composites
- Coatings

Ride Control

Metrics:

- Stable, smooth
- Controllable / adjustable

Technologies:

- Environmental sensing
- Controllers and Algorithms
- Control surfaces and actuators

Hull Form Versus Performance Features

	Speed	Seakeeping	Payload	Range
Displacement Monohulls	25-40knots	SOA	High	Trans-Ocean
Displacement Multihulls	~50 knots	Good at Speed with Ride Control	Good	Trans-Ocean
SWATH & Variants	14-30 knots	Excellent all Around	Low	Trans-Ocean
Planning Hulls	~45 knots	High Accelerations	Moderate	Short Range, Size dependent
SES	60-65 knots	Good with Ride control	Low	Short Range, Size dependent
Hovercraft	45-55 knots	Moderate with Ride control	Low	Short Range, Size dependent
Hydrofoils	30-70 knots	Excellent at High Speed	Low	Short Range, Size dependent
Lifting Body & Hybrids	30-50+ knots	Excellent	Good	TBD

X-Craft



X-Craft Delivery Spring 2005

Purpose - Support future concept development of Littoral Combat Ship by:

- Concept development for 50 kt craft.
- Evaluate one form of mission modularity.
- ABS rules development for High Speed Craft-Naval Craft.

Science & Technology:

- Hydrodynamic experimentation (experimental data suite)
 - Measure fluid flow, motions, dynamic loads, stresses, and speed/power requirements.
- At sea experimentation with advanced mission systems.

DIMENSIONS

Length (overall):	262'/79.9m
Length (at waterline):	240'/73m
Beam:	72'/21.05m
Draft (scantling):	12'/3.6m
Full Load Displacement:	1150 T
Light Ship Displacement:	820 T

PERFORMANCE

Maximum Speed (Combat Load*):	50+ kts
Maximum Speed (S/S 4):	40+ kts
Maximum Speed (Diesels only):	20+ kts
Shaft Power (ISO):	2x 33.6KHP
Range:	4000 NM



X-Craft

Elevator

Mission Modules

X-Y Crane

Launch/Recovery/RORO Ramp



X-Craft



Stern Ramp



Firescout



Waterjet

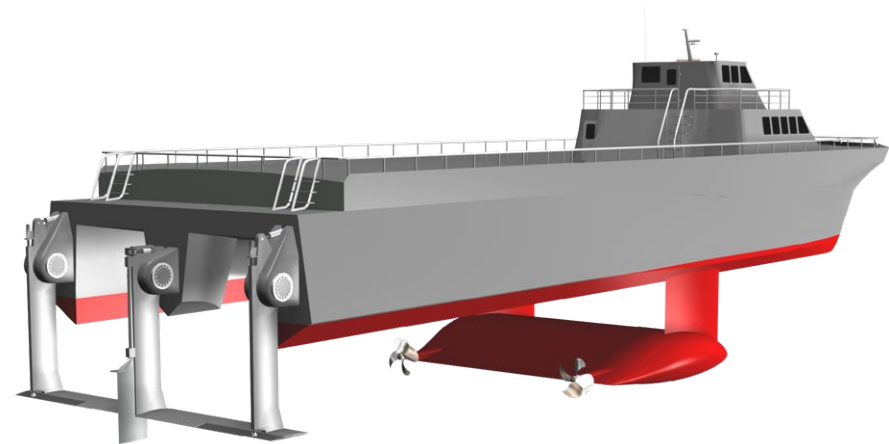


Stern View

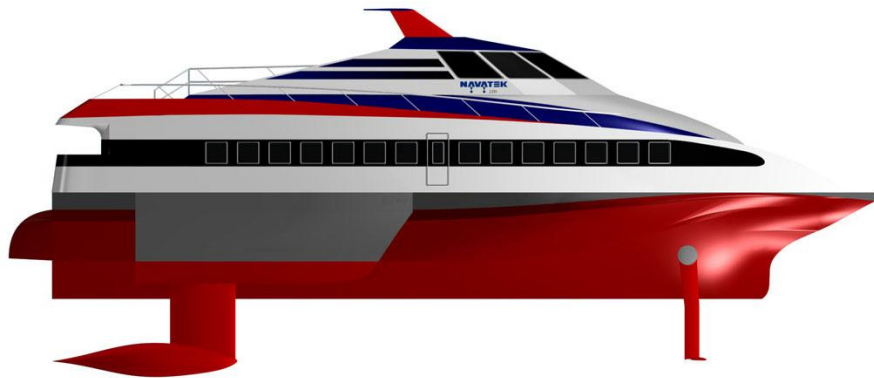
Sea Flyer

Purpose:

Large scale technology demonstration for lifting body hull forms and advanced ride control systems. Possible roles in drag reduction research, high-speed training, and operational demonstrations.



HDV- 100



Purpose:

- Demonstration platform for evaluating the commercial and military potential for high speed lifting bodies combined with Deep-V hull forms

Science & Technology:

- Test advanced ride control system at high-speed
- High speed propulsion system evaluation (surface drives and controllable pitch propeller on center line)
- Evaluate synergistic effects of “Sertter Deep-V” monohull and “Blended Wing Lifting Body”
- Drag Reduction - fluid tested on lifting body

Specifications:

Length: 100 Feet

FLD: 98 LT

Propulsion: 4 Propulsion Diesels

Propulsors: 2 Surface Drives and
1 Controllable pitch propeller

Speed: 50 knots in calm seas in
full load condition

40 knots in Sea State 4

Seakeeping: Operational through S/S 4;
survivable through S/S 5



Small Rapid Response Watercraft Demonstrator (SWD)



Purpose:

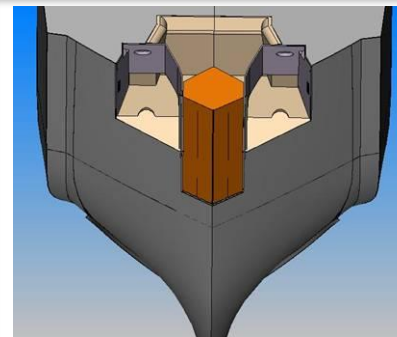
Explore hybrid lifting body and other ship hull form technologies in the smaller displacements needed for rapid response craft. Explore Hybrid propulsion.

Science & Technology:

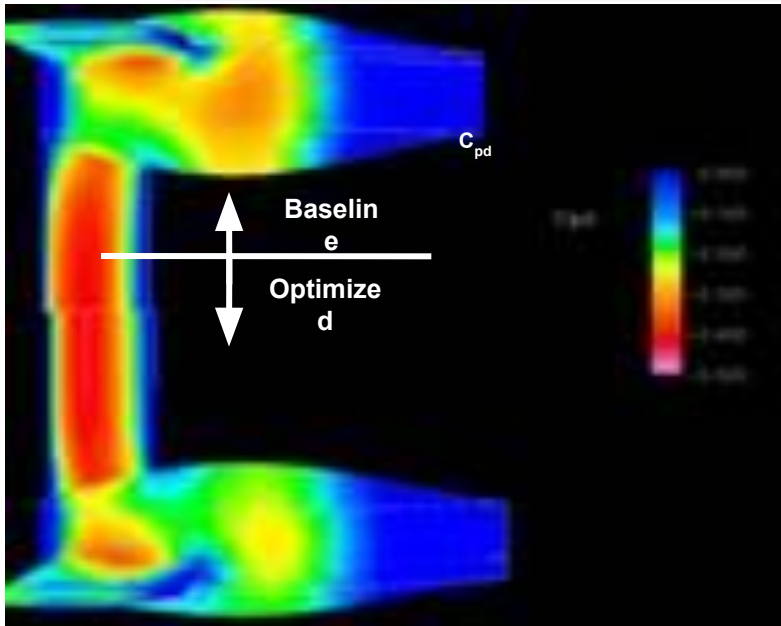
- **Practical hybrid configurations in the 34 to 50 foot length regime**
- **Speeds from 35 to 60+ knots**
- **Variety of high-performance technologies to gain insight into the hydrodynamics of small high-performance craft.**
- **Combined diesel-electric/diesel-mechanical propulsion alternatives**
- **Alternate lift augmentation devices**
- **Improved surface drive propulsors**

Specifications for SDV 45:

Length:	50	Feet
Beam:	14	Feet
Displacement:	12	LT (full load)
Draft	3.8	Feet
Propulsion:	Diesel/Elect. 2X700 HP	
Propulsor:	Surface Piercing Propellers (2)	
Speed:	45 knots in calm seas @ full load	
Seakeeping:	Superior motions from zero to full speed through SS 3	



Advanced Lifting Body Research



Purpose:

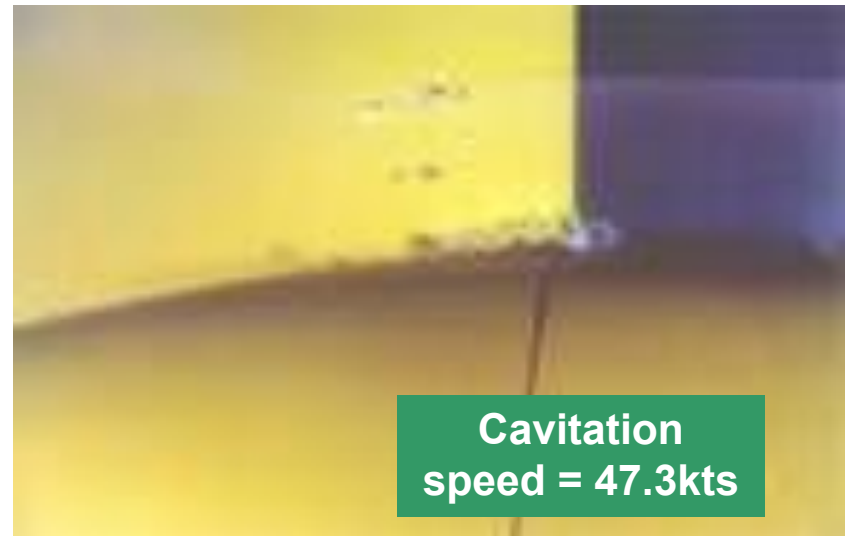
Characterize the hydrodynamic performance, structural loading, and other related features of various advanced monohulls, lifting body and monohull/lifting body hybrid hull forms

Science & Technology:

- Actual SEA FLYER loads from at-sea tests
- Innovative propulsion concepts
- Advanced ride control systems and force effectors
- Hull design paradigms for hybrid forms
- CFD predictions for realistic configurations
- Computer simulation models and tools

Plans:

- Structural analysis of lifting body, struts, attachments and impacts on parent hulls.
- Advanced hull and lifting body scientific studies.
- Innovative propulsion, drag reduction, and powering efficiency alternatives and technologies.
- Innovative ride control systems approaches, methodologies, and technologies.
- Modeling and analysis tools and methods.



Sea Coaster



Purpose:

- Investigate and validate technology to support development of a high speed cargo craft

Science & Technology:

- Speed/Power relationships
- Sea Keeping (motions & accelerations)
- Structural Response & Integrity

Approach:

- Design 100 ft air cavity test vessel
- Test & Evaluate at sea

Naval Relevance/Impact:

- Novel hull form
- High speed vessel
- Very shallow draft – potentially beachable

Status:

- Construction Complete, undergoing trials.



V-ALT Advanced Littoral Transport

VariCraft Concept (V-ALT)



Purpose:

- Demonstrate the capability of a new hull form technology to enable logistic support directly to shore
- Advanced hull form with unique contra-rotating propeller/water jet propulsion
- Adaptation of SEA SLICE hull form technology
- Variable geometry hull form: SWATH mode, landing craft mode, intermediate mode enabled by a movable payload deck
- Large-scale demonstrator craft

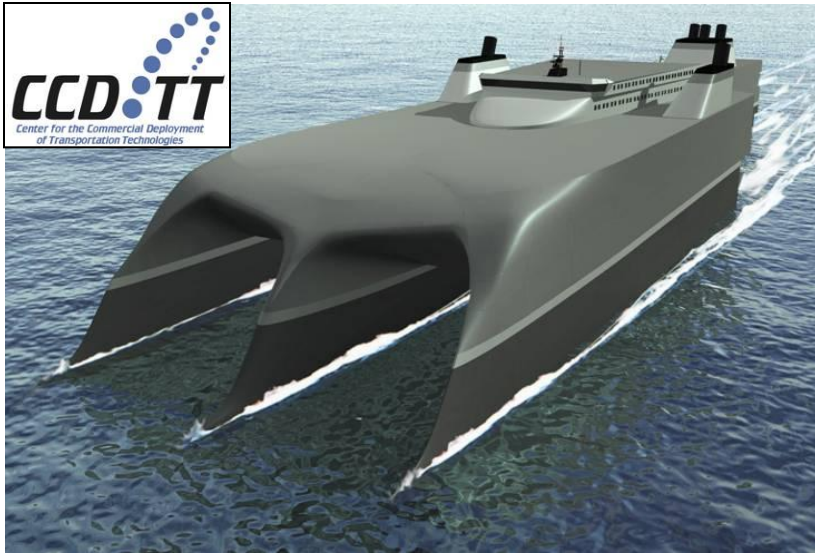
Design Features for 1/2 Scale Demonstrator:

Length:	148	Feet
Beam:	54	Feet
Displacement:	469	LT (full load)
Payload:	60	LT
Barge Draft:	3	Feet
SWATH Draft:	11.5	Feet
Speed:	20	Knots
Propulsion:	Diesel Direct	
Propulsors:	Twin Contra-rotating propellers and twin water jets	
Seakeeping:	Operable in SS 5 (SWATH mode)	



Agile Port and High Speed Ship Technologies

Center for the Commercial Development of Transportation Technologies (CCDoTT)



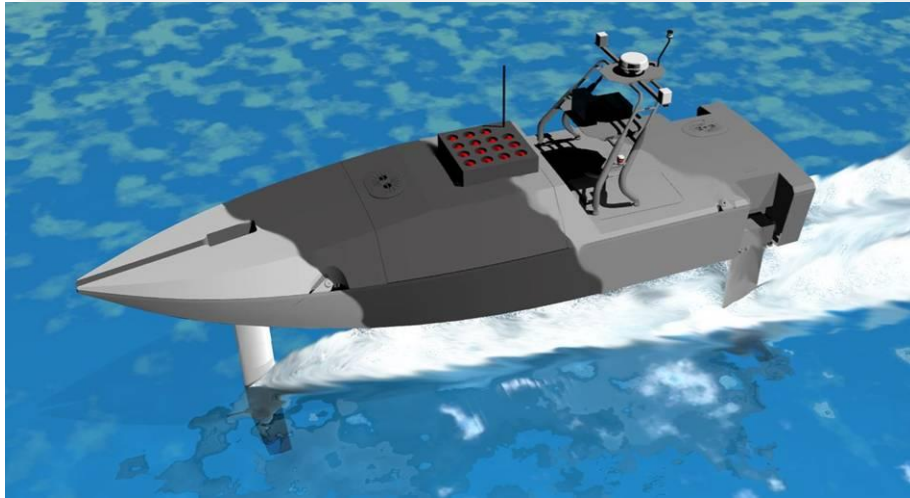
Purpose:

Develop enabling technologies for maritime related Defense Transportation Systems while improving the productivity of defense related commercial shipping and inter-modal transfer/support systems

Science & Technology:

- **Model test and evaluation of advanced axial flow water jets**
- **Automated design optimization of multi-hull vessels**
- **Large, high speed trimaran (HST) technology development**
- **Concept design development of Very Stable Mobile Ocean Platform**
- **Magnetic levitation freight transport system, port to inland port**
- **Operational Concept Document (OCD) and analysis for military deployment through Agile Port System with inland port.**

Unmanned Sea Surface Vessel [USSV]



Purpose:

- Understand and demonstrate purpose-built Unmanned Surface Vehicles, with a focus on HM&E technologies,
- Optimize speed, payload, range and seakeeping characteristics,
- Demonstrate an automated launch and retrieval system for USVs.

Science & Technology:

- Determine performance envelope of purpose-built unmanned craft

Approach:

- Evaluate trade-space for USVs
- Design, build and conduct at-sea testing of two purpose-built vehicles.

Naval Relevance/Impact:

- MCM / ASW
- Anti-Terrorism/Force Protection
- Intelligence, Surveillance & Reconnaissance

Status:

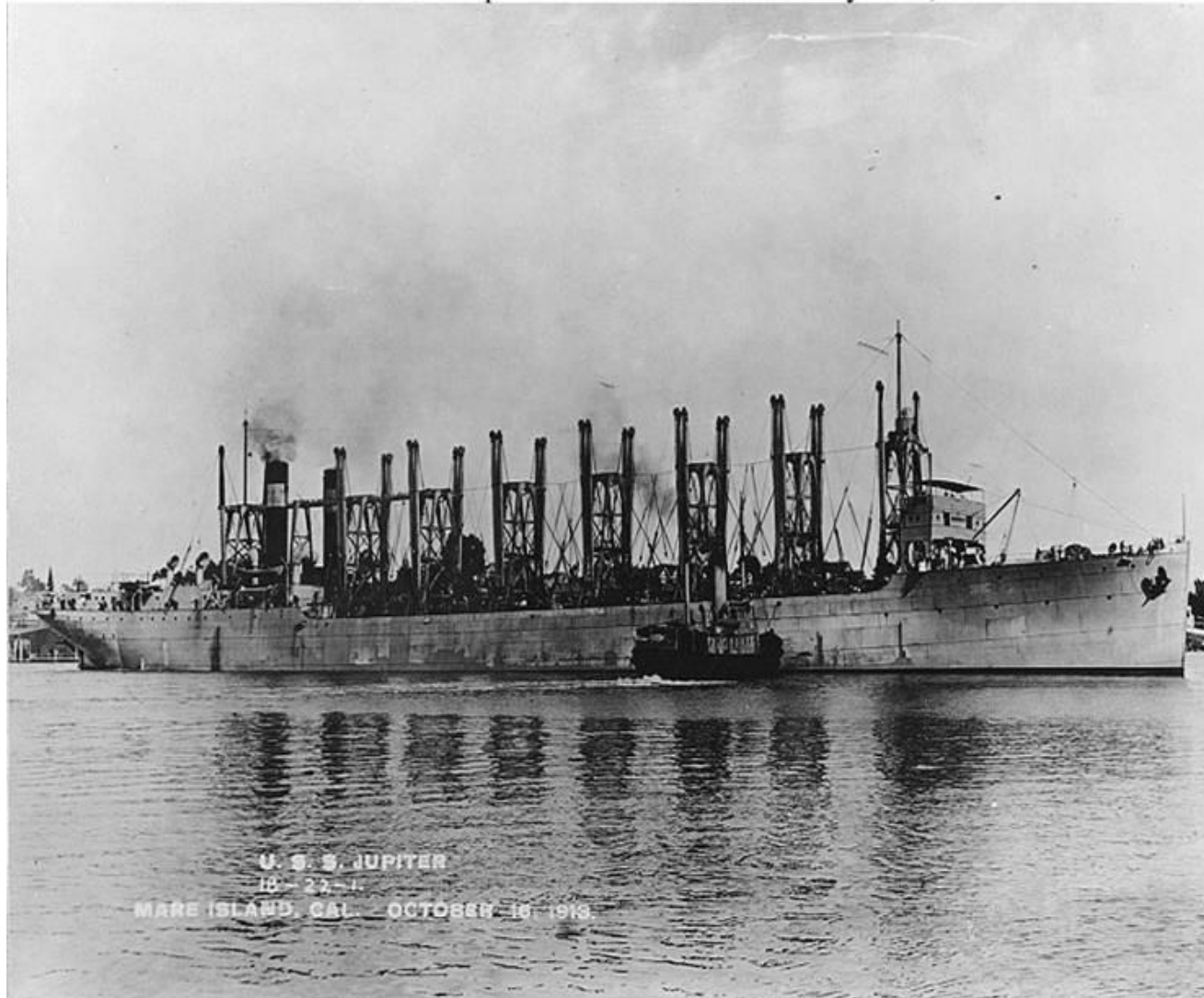
- Two prototypes under construction for testing in 2005.



Propulsion

USS Jupiter- 1913

Early example of Electric Drive

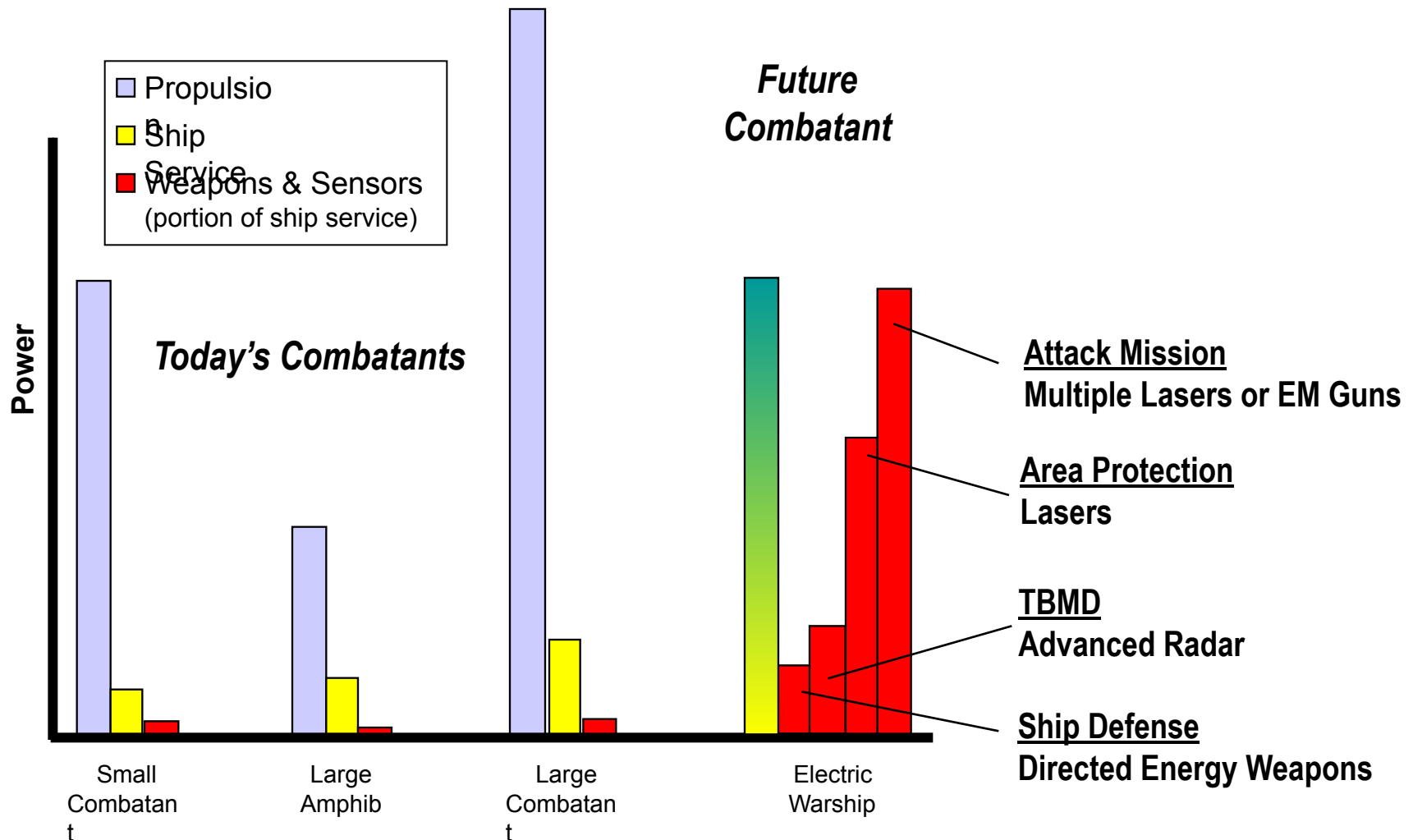


Why Is the Navy Going Electric?

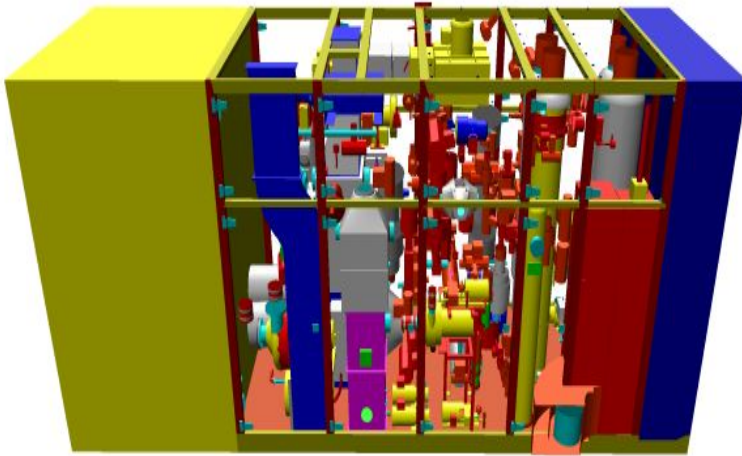
- **Enable Transformational Weapons Systems**
 - Electromagnetic Guns
 - Shipboard Laser Systems
 - Advanced Sensors
- **Improve Survivability**
 - Rapid and anticipatory Reconfiguration of Power and systems
- **Reduce Signatures**
 - Eliminates propulsion gear noise
 - Enables lower speed propellers
 - Enables silent watch capabilities
- **Reduce Life Cycle Costs**
 - Reduction in Number of Prime Movers
 - Significantly Greater Fuel Efficiency
 - Eliminate high maintenance hydraulic systems



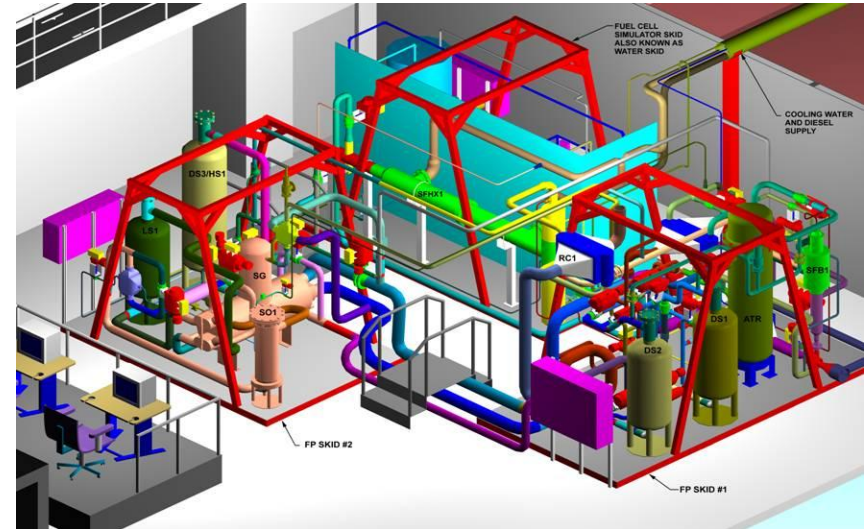
Expected Growth in Power Requirements



Ship Service Fuel Cell Programs



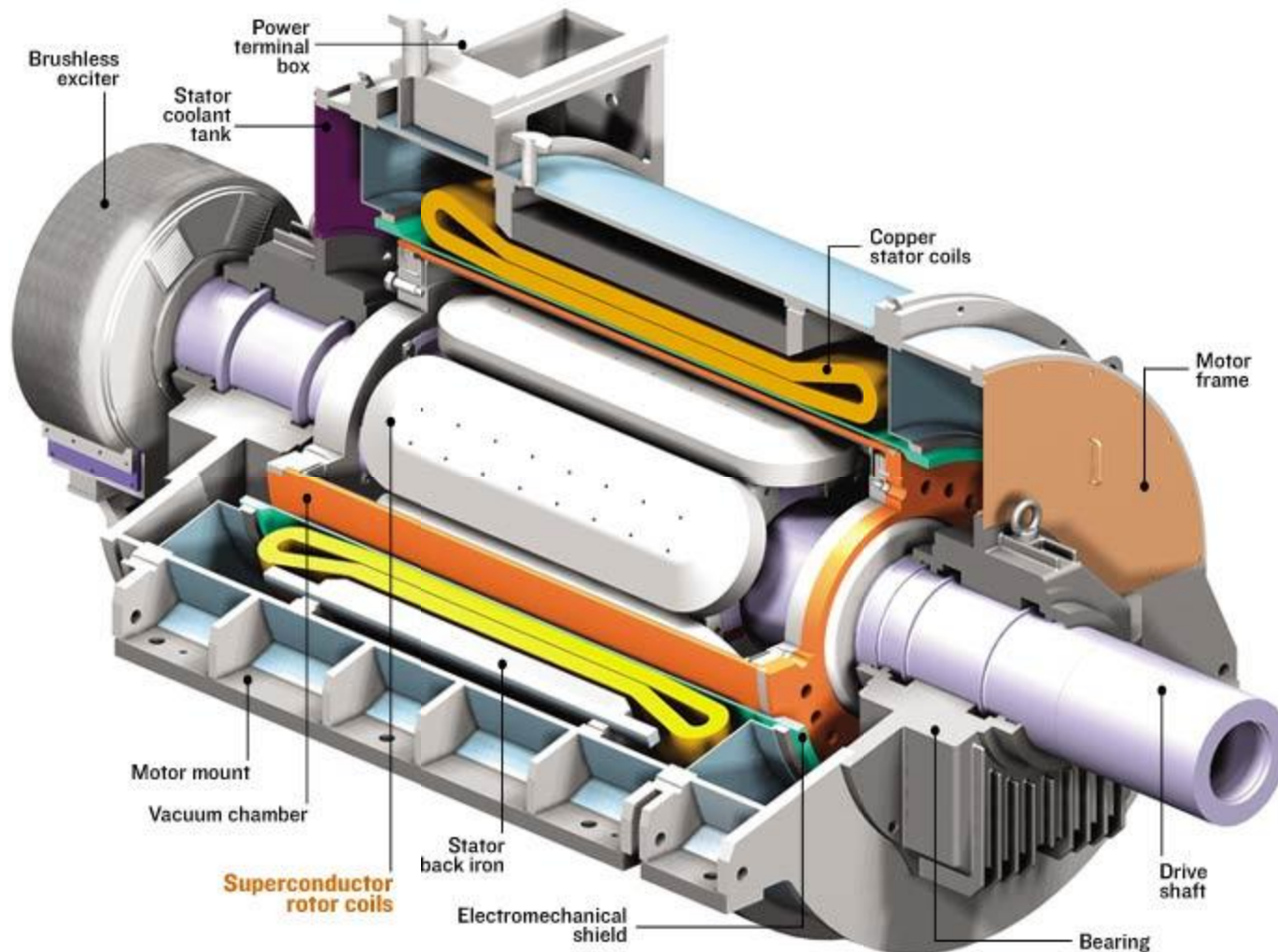
**625kW Molten Carbonate Ship Service Power
Fuel Cell System using Diesel Fuel
50% EFFICIENT**



**500kW Integrated Fuel Processor (IFP)
compatible with PEM Fuel Cell, using Diesel Fuel
37% EFFICIENT**

***37 – 50% EFFICIENT
QUIET OPERATION
LOW ATMOSPHEREIC EMISSIONS***

High Temperature Superconducting AC Synchronous Motor



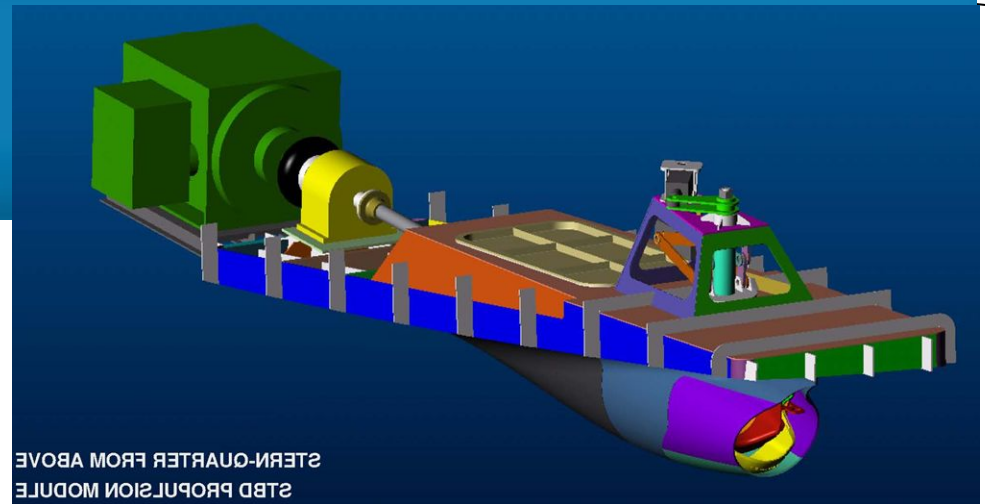
Advanced Electric Ship Demonstrator (AESD)

Rolls Royce - AWJ21 Craft Configuration



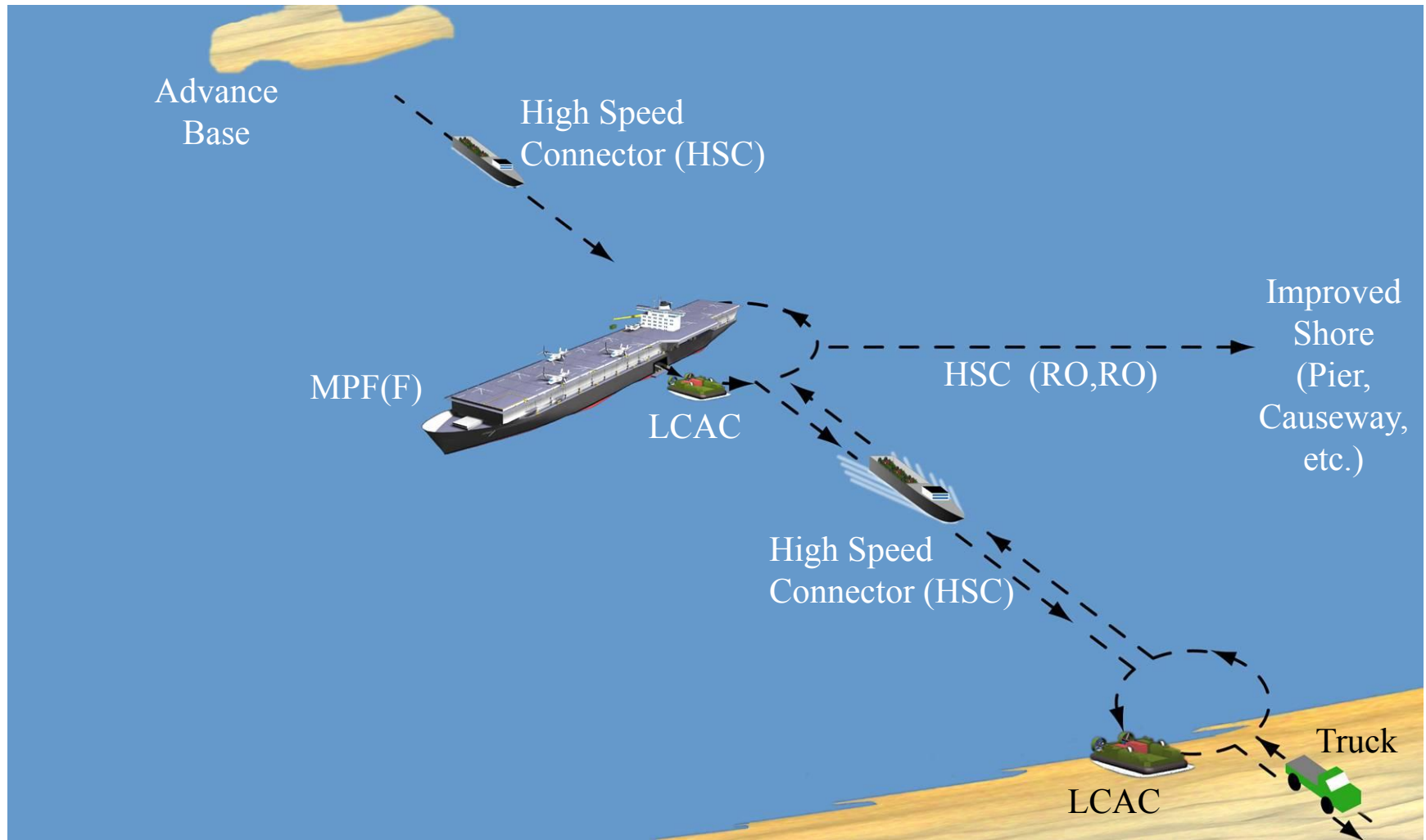
Design Parameters

LOA = 133', LWL = 130', BOA = 14.5'
Displacement = 107 LT
Diesel / Electric 500HP per Shaft x2
16 knots Required for T&E



What's Next?

Sea Basing!



“It’s all about throughput”

Questions?