



CPCX

Combined Patrol Combatant

**Total Ship Systems
Engineering
Capstone Design Project
December 1995**



CPCX Design Teams

Navy Variant

- Eric Anderson, LT USN
- Bob Armstrong, LT USN
- Jim Hurley, LT USCG
- Robert Jones, LT USN

Coast Guard Variant

- Jay Renken, LCDR USN
- John Comar, LT USCG
- Helen Kilty, LT USCG
- Thomas Jean, LT USN

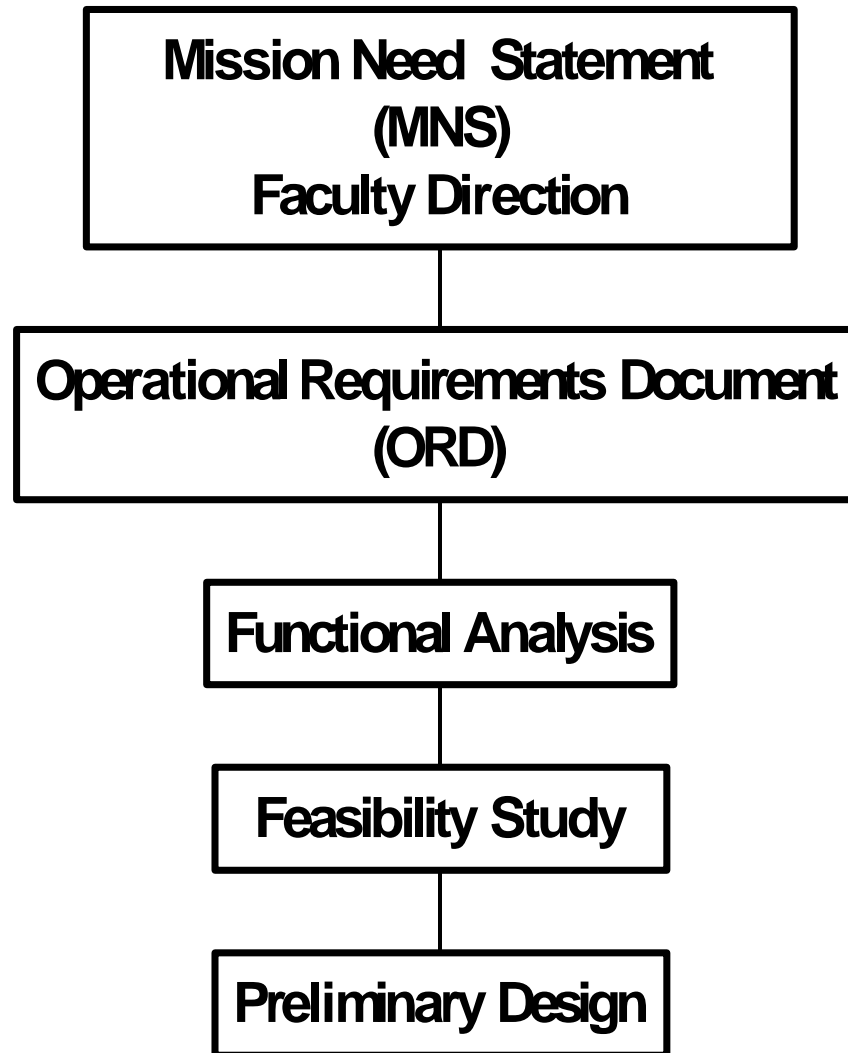


PROBLEM STATEMENT

- **Design a dual service combatant for Navy and Coast Guard use.**
- **Design two variants of one ship.**
- **Minimize cost and manning.**
- **IOC 2010**



Design Process

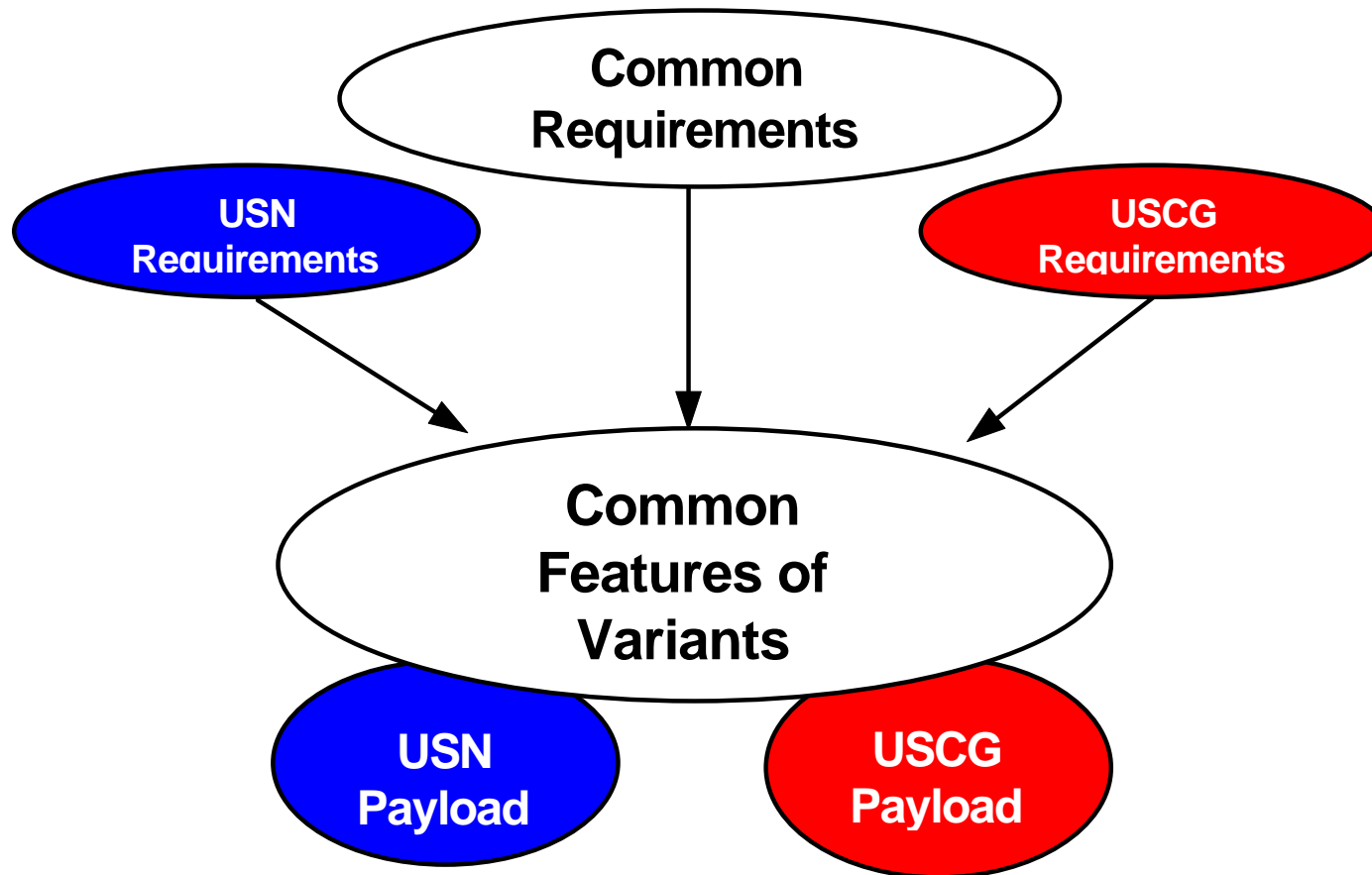


Design Philosophy

- 1. Meet or exceed ORD specifications**
- 2. High Survivability/Maximum Mission Effectiveness**
- 3. Reduced Manning/High Level of Automation**
- 4. Low Maintenance/Improved Reliability**
- 5. Improvement of Crew Habitability (Quality of Life)**



Commonality Concept





General Ship Description

Navy		Coast Guard
398 ft	Length Overall	398 ft
15ft 11in	Draft	15ft 9 in
51 ft	Beam	51 ft
3980 LT	Displacement	3934 LT
6600nm@14 kts	Endurance	8900nm@14kts
25 kts	Sustained Speed	25 kts
110	Crew	106
28,800	SHP	28,800



Payload - Navy Variant

■ AAW

- X Band Phased Array Radar (XPAR)
- **37 cell Vertical Launch System (VLS)**
- Rolling Airframe Missile (RAM) and Launcher
- 2, 40mm multi-purpose guns

■ ASW

- **Active Towed Array Sonar (ATAS)**
- **2 Surface Vessel Torpedo Tube mounts (SVTT)**

■ ASUW

- **Panther Helicopter - Combat Version of HH-65**
- **5" 54 MK 45 gun**

■ EW

- **SLQ-32 (V3)**

Payload - Navy Variant Continued

- **Mine Warfare**
 - SH-100 mine sonar
- **Communications**
 - Joint Maritime Command Information System
 - Advanced Combat Direction System
 - Cooperative Engagement Capability
 - Tactical Data Links
- **Operations Other than War**
 - 2 Davit launched small boats

Payload - Coast Guard Variant

- **AAW**
 - X Band Phased Array Radar (XPAR)
 - Rolling Airframe Missile (RAM) and Launcher
 - 2, 40mm multi-purpose guns
- **ASW**
 - Not a mission area
- **ASUW**
 - **Dolphin Helicopter HH-65**
- **EW**
 - SLQ-32 (V3)
- **Mine Warfare**
 - SH-100 mine sonar

Payload - Coast Guard Variant Continued

■ **Communications**

- **Joint Maritime Command Information System**
- **Advanced Combat Direction System**
- **Cooperative Engagement Capability**
- **Tactical Data Links**

■ **Operations Other than War**

- **2 Davit launched small boats**
- **2 Stern launched small boats**
- **Crane and buoyhandling equipment**
- **Added fuel capacity**



Mission Need Statement (Faculty Direction)

World View

Navy Guidelines

Coast Guard Guidelines



World View

(Faculty Direction)

- **Oceanic Naval warfare is unlikely**
- **Operations Other than War (OOW) are likely employments for U.S. ships**
- **Regional conflicts are likely between third world nations**
- **Tight Defense Budget**
- **Consolidation of roles of the armed forces**
- **Law Enforcement at sea will become more frequent and will be conducted against more heavily-armed criminals**

Navy Guidelines

(Faculty Direction)

- **Deployable and Fleet Compatible**
- **Operate in Littoral Environments**
- **Independent as well as Battle Group Operations**



Coast Guard Guidelines (Faculty Direction)

- **Detect, Intercept, and Defeat Well-Equipped Drug Smugglers and Pirates**
- **Interdict Illegal Immigration and Smuggling**
- **Perform Search and Rescue**





Operational Requirements Document

**Design Constraints
Specific Design Requirements
Projected Threat Summary**



Design Constraints

Cost

Displacement

Convertibility



Specific Design Requirements

- **Common**
- **Navy**
- **Coast Guard**



Projected Threat Summary

- **Law Enforcement - Independent Operations**
- **Low Intensity Conflict - Independent and Group Operations**
- **Major Regional Conflict (MRC) - Force Operations**



Functional Analysis

Functional Areas

- Detect
- Control
- Engage

Warfare Areas

- AAW
- ASuW
- ASW
- Strike
- MIW
- ELT
- OOW
- EW



Combat System Elements

- **Radars**
- **Passive Sensors**
- **Sonars**
- **Guns**
- **Missiles**
- **Small Boats**
- **Mine Hunting Devices**
- **Architecture**



Combat System Evaluation

- **Measures of Effectiveness**
- **Combat System Suite Options**
- **Payload selection**



Measures of Effectiveness

Navy

- Strike
- Air Engagement
- Sub-Surface Engagement
- NGFS
- Patrol Area
- Convertibility
- Boarding

Coast Guard

- Air Engagement
- Patrol Area
- Convertibility
- Boarding



Strike Effectiveness

$$MOE = \frac{N_m * R * P_T}{CEP * CS * N_K}$$

N_m = number of strike missiles

R = range of missile (km)

P_t = ability to target

CEP = circle error probability

CS = ship cost (M\$)

N_k = number of missiles needed for kill



Combat System Suite Selection

- **Functional Analysis & System Tradeoff Study**
- **3 Combat System Suite Options/Variant**
- **MOE Analysis**
- **Final Suite Selection**



Payload - Navy Variant

■ AAW

- X Band Phased Array Radar (XPAR)
- 37 cell Vertical Launch System (VLS)
- Standard, Enhanced Sea Sparrow, Harpoon and Tomahawk
- Rolling Airframe Missile (RAM) and Launcher
- 2, 40mm multi-purpose guns

■ ASW

- Active Towed Array Sonar (ATAS)
- 2 Surface Vessel Torpedo Tube mounts (SVTT)

■ ASUW

- Panther Helicopter - Combat Version of HH-65
- 5" 54 MK 45 gun

Payload - Navy Variant Continued

- **EW**
 - SLQ-32 (V3)
- **Mine Warfare**
 - SH-100 mine sonar
- **Communications**
 - Joint Maritime Command Information System
 - Advanced Combat Direction System
 - Cooperative Engagement Capability
 - Tactical Data Links
- **Operations Other than War**
 - 2 Davit launched small boats

Payload - Coast Guard Variant

- **AAW**
 - X Band Phased Array Radar (XPAR)
 - Rolling Airframe Missile (RAM) and Launcher
 - 2, 40mm multi-purpose guns
- **ASW**
 - Not a Mission Area
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 - **Dolphin Helicopter HH-65**
- **EW**
 - SLQ-32 (V3)
- **Mine Warfare**
 - SH-100 mine sonar

Payload - Coast Guard Variant Continued

■ **Communications**

- **Joint Maritime Command Information System**
- **Advanced Combat Direction System**
- **Cooperative Engagement Capability**
- **Tactical Data Links**

■ **Operations Other than War**

- **2 Davit launched small boats**
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- **Crane and buoyhandling equipment**
- **Added fuel capacity**

Combat Systems Architecture

- **Fiber Optic Ring BUS**
- **Distributed Data Processing**
- **MMI Modules**
 - Detect & Track
 - Correlate
 - Command & Decision
 - Weapons Control
- **Two CICs in Separate Enclaves**



Architecture Advantages

- **Survivability**
- **Automatic Readiness Assessment, Fault Detection, and Localization**
- **Embedded Training and Support Service Management**



Naval Architecture

NAVY

- LBP 380'
- Beam 51'
- Hull Depth (amidships) 30'
- Draft 15' 11'
- Prismatic Coef., Cp .576
- Max Section Coef., Cm .796
- Waterplane Coef., Cwp .733

Coast Guard

- LBP 380'
- Beam 51'
- Hull Depth (amidships) 30'
- Draft 15' 9"
- Prismatic Coef., Cp .576
- Max Section Coef., Cm .796
- Waterplane Coef., Cwp .733



Stability

USN	Parameter	USCG
7.67'	GMt	7.68'
.150	GMt/Beam	.151
18.34'	KG	18.41'
5.075' @ 45.97 deg.	Max Righting Arm	5.125' @ 46.06 deg.



Hull, Mechanical, and Electrical Options

- **Mechanical Drive Vs Electric Drive**
- **Single Shaft Vs Multi Shaft**
- **Level of Automation**
- **Type of Prime Mover (Gas Turbine or Diesel)**
- **Power Distribution (Conventional, Power off Main Bus, Propulsion Derived Ship Service)**
- **Compartmentalized Auxiliaries Vs Centralized Auxiliaries**



Hull, Mechanical, and Electrical Selection

- 2 Diesels, 2 Gas Turbine prime movers using Combination Diesel and Gas Turbine (CODAG) configuration
- Electrical Drive Transmission
- 2 Shafts
- 2 Fixed Pitch Propellers driven by Fixed Podded Propulsors
- Common Ship Service and Power Distribution System
- Remote Monitoring and Automation
- Zonal Electrical Distribution

Manning

Navy		Coast Guard	
<u>Department</u>	<u>Crew</u>	<u>Department</u>	<u>Crew</u>
Ship Support	13	Ship Support	14
Combat Sys	52	Combat Sys	31
Engineering	34	Engineering	34
Air Det.	11	Air Det.	6
		Operations	21
TOTAL	110	TOTAL	106



Convertibility

(four week shipyard availability)

Navy

1. 5 inch Gun
2. VLS launcher
3. ATAS
4. Torpedo Space
5. Missile Illuminators

Coast Guard

1. Buoy handling Crane
Environmental clean-up gear
2. Fuel Tank, Buoy Handling Equipment
3. Two Additional RHI's
4. Prisoner Containment Space



Survivability

- **Signature Reduction**
- **Redundancy**
- **Uninterruptable Power Supply**
- **CEC**



Signature Reduction

- **Radar Cross Section (RCS)**
- **Infrared**
- **Acoustic Noise**



Redundancy

- **Two Physically Separate CICs**
- **Two Engine Rooms separated by three bulkheads**
- **DC Zonal Electrical Distribution**
- **Ring Information Network with multiple redundant rings**
- **Distributed Combat System Data Processing**



Uninterruptable Power Supply

- **30 Ton Battery provides 1500 KW of hold-up power**
- **Allows for Prime Mover restarts without loss of Combat System continuity**
- **Continued Operation of Combat Systems after complete loss of Main Engineering Spaces**



Cooperative Engagement Capability

- **Common Composite “Big Picture”**
- **Queued Search**
- **Queued Engagement**
- **Fire On Remote**



Summary of Ship Characteristics

Navy	Requirement	Coast Guard
	<u>Endurance</u>	
6000nm@14kts	Required	8000nm@14kts
6600nm@14kts	Achieved	8900nm@14kts
	<u>Average Cost</u>	
\$450 million	Required	\$375 million
\$422 million	Achieved	\$309 million
	<u>Displacement</u>	
4000LT	Required	4000LT
3980LT	Achieved	3934LT

Further Study

- **Single Mast**
- **Coast Guard over buying sensors**
- **Upper limit of cost and weight margins**



Conclusion

- **Dual Service Combatant**
- **Meets the operational requirements of both Navy and Coast Guard**
- **Ease of Convertibility**
- **Not “Littorally Challenged”**





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