Welcome

Dr. Paul Shebalin (RADM)
Professor, Systems Engineering Department, NPS
Key Takeaways

• Supply
  – Key Factors were Supply Ship Cycle Time, Basing Alternatives, and Survivability
  – Air Assets Did Not Significantly Improve Throughput and Raised Cost Substantially.

• Repair
  – Mean Supply Response Time Was the Biggest Factor.

• Force Protection
  – Current Mortar Defenses were Insufficient.
  – The Nobriza/Barge Baseline was Most Effective MOB Alternative.
  – IR Illuminators are Valuable for Point Defense
0900 – 0915  Introduction
0915 – 0945  Supply
0945 – 1000  Break
1000 – 1015  Repair
1015 – 1045  Force Protection
1100 – 1200  Break Out Sessions

(In the Bullard Labs)
SEA 11 Cohort

LCDR Mike Galli, USN
B.S. Business
Naval Flight Officer
Next Duty: CDCO, USS Ronald Reagan

LT Jim Turner, USN
B.S. Mechanical Engineering
Nuclear Submariner
Next Duty: Submarine Advanced Course

LT Kris Olson, USN
B.S. Work Force Education
Surface Warfare
Next Duty: CHENG, USS Rushmore

LT Neil Wharton, USN
B.S. Sociology
Surface Warfare
Next Duty: CHENG, Harpers Ferry

CPT Everett Williams, USA
B.S. Physics
Army Artillery
Next Duty: West Point Instructor

LT Mike Mortensen, USN
B.S. Systems Engineering
Surface Warfare (Nuclear)
Next Duty: OPSO, USS Higgins

ENS Tom Schmitz, USN
B.S. Systems Engineering
Student Naval Aviator
Next Duty: Naval Flight School

ENS Matt Mangaran, USN
B.S. Systems Engineering
Student Naval Aviator
Next Duty: Naval Flight School
TDSI Cohort

MAJ Tan Boon Leng  
LT Eric Pond  
CPT Gil Nachmani  
Ong Hsueh Min  
Ong Wing Shan  
Goh Choo Seng  
CPT Ho Chee Leong  
Cheng Hwee Kiat  
CPT Teng Choon Hon

Lim Han Leong  
CPT Yow Thiam Poh  
MAJ Mak Wai Yen  
Hui Kok Meng  
Lim Meng Hwee  
CPT Phua Poh Sim  
CPT Joshua Sundram  
Tan Kian Moh
Tasking

- From the Wayne E. Meyer Institute

Tasking: “Collaborate with the Naval Expeditionary Combat Command (NECC) to design a system of systems for performing emerging Navy missions associated with coalition operations in littoral and riverine environments.”
“Define, Analyze, and Recommend Alternatives for Supply, Repair, and Force Protection that Increase Sustainability of the Riverine Force in Riparian Environment Utilizing Technologies Currently in Use or Available for Use by 2012.”
Riverine Maritime Security Operations

Maintain Security of the River Ways by Conducting Patrol and Interdiction Operations to Slow or Disable the Flow of:

• Narcotics
• Arms
• Slavery
• Terrorists
Riverine Squadron

- Tactical Operations Center
- O-Level Repair
- Limited Medical
- Motor Transport
- Combat Service Support
- Security Forces
- Intelligence Cell

- 12 SURCs
- 65 Rolling Gear
- 224 Personnel
Riverine Mission

The primary mission of the Riverine Force is to conduct shaping and stability operations (including Theater Security Cooperation activities), to provide Maritime Security, and to carry out additional tasks specifically related to the GWOT:

– Riverine Area Control/Protect Critical Infrastructure
– Interdiction of Riverine Lines of Communication
– Fire Support
– Insertion / Extraction of Conventional Ground Forces
– Humanitarian Assistance/Disaster Relief (HADR)
Sustainment Support

• “How it Should Work”
  – DOTMLPF

• Drawn from:
  – Joint & Service Documents
  – Research Material
  – Field Reports
Field Research

- **NECC**
  - N3, N4, N7, N9
  - Riverine Group One
  - Naval Coast Warfare Group One

- **Research Groups**
  - NAVSEA Operations Logistics Study Group
  - MIT Naval Architects
  - Coalition Operating Area and Surveillance Targeting System
  - Total Ship Systems Engineering
  - Tactical Network Topology

- **Naval Special Warfare**
  - Special Boat Team Twenty-Two
  - Naval Small Craft Instruction and Technical Training School
  - Logistics Support Group One

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Introduction  Basing  Supply  Repair  Force Protection
Wants, Needs, Desires

- Sustainable Logistics System
- Higher Availability Rates
- Minimized Footprint
- Secured Support Bases
- Defense versus Mortar Attacks
- Improve Communications Between Coalition Partners.
Research Focus

• Supply
  – How to sustain a force up river in a logistically barren area?
  – What metrics are the most influential in determining the trade space?

• Repair
  – What is the Best Way to Conduct Maintenance in a logistically barren area

• Force Protection
  – What Force Protection Measures are Most Effective in Threat Denial
Systems Engineering Process

**Problem Definition**
- Determine Customers and Stakeholders
- Determine Problem Statement and Scope
- Determine Status-quo
- Perform Functional Analysis
- Create Functional Architectures

**Design & Analysis**
- Conduct Mission Analysis
- Determine System Metrics
- Develop Scenarios and Concept of Operations
- Create Physical Architectures

**Decision Making**
- Determine Modeling Approach
- Create Operational Architectures
- Perform Qualitative Modeling
- Analyze and Decide

*Adapted from Buede, Blanchard, and Fabrycky*
Riverine Force Functional Hierarchy

Riverine Force System of Systems

ENGAGE
- Weapons Employment
- Maneuver
- Decoy
- Countermeasures

DEPLOY
- Pre-Position
- Loading
- Movement
- Staging
- Extract

C4ISR
- Deliver Intent
- Exchange Tactical Data
- Direct Supporting Arms
- Exchange Intelligence, Surveillance and Reconnaissance

SUSTAIN
- Supply
- Maintain
- Protect

Introduction
Riverine Sustainment Functional Hierarchy

Sustain

SUPPLY
- Maintain
- Movement
- Bring Back

MAINTAIN
- Repair
- Service
- Replace

PROTECT
- Predict
- Deter
- Deny

Introduction
Scenario

LT Jim Turner
Operational Setting

- **Kampar River**
  - Lightly populated
  - Length: 300 nm
  - Width: 1 nm to 5 nm
  - Jungle canopy, mangroves and brackish water
  - Indonesian Army

- **Red Forces**
  - Level II threat
  - Can operate at or near company strength
    - Automatic weapons
    - RPG’s and mortars
    - Crew served weapons
    - Small boats
  - “Networked Comms”
    - Cell phones
    - PRC-117 equivalent
ENS Matthew Mangaran
Riverine Support Base

• “Riverine forces often operate in remote locations and may not be collocated with existing support facilities.” (RF CONOPS)

• Support Base functions tailored to specific mission:
  – Operational Support
  – Medical Support
  – Logistics
  – Hotel Services
  – Helicopter Support
  – Maintenance
  – Administration
  – Salvage
Riverine Support Base

- **Forward Operating Base**
  - 400 (+/- 50) person camp
  - Ashore along the River
- **Mobile Operating Base**
  - Afloat on the river
  - Ex. Nobriza, RCSS, Barge
- **Global Fleet Station**
  - Permissive environments in International water
  - Ex. LPD-17, LCS, HSV, LPD/LSD
The FOB was a configuration of the Naval Construction Battalion’s (Seabees) Tent camp design.

The RST configured the structures with considerations for force protection and ease of conducting operations.
MOB Alternative Criteria

- **Force Protection**
  - Weapons, sensors, flight deck
- **Troop Capacity**
  - RF consists of 224 plus detachments
- **Storage Capacity**
  - Fuel, water, food, ammo, repair parts
- **Ease of Movement**
  - Draft
- **Maintenance and Support**
  - Well deck, crane, ramps, causeway, facilities
## MOB Alternatives

<table>
<thead>
<tr>
<th><strong>Littoral Combat Ship (LCS)</strong></th>
<th><strong>Nobriza (Colombia)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>(Lockheed Martin)</em></td>
<td><em>(Heavily Armored)</em></td>
</tr>
<tr>
<td>Modular Weapon Zone</td>
<td><em>(Power Projection)</em></td>
</tr>
<tr>
<td>Stern Ramp and Side Door</td>
<td></td>
</tr>
<tr>
<td><em>(General Dynamics)</em></td>
<td></td>
</tr>
<tr>
<td><em>(Multiple Weapons)</em></td>
<td></td>
</tr>
<tr>
<td><em>(Large Hangar and Flight Deck)</em></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Barge (APL-40)</strong></th>
<th><strong>RSS-207 Endurance (Singapore)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>(Used in Vietnam War)</em></td>
<td><em>(Large Well Deck)</em></td>
</tr>
<tr>
<td><em>(Tailored for mission)</em></td>
<td><em>(Automated system require a crew of only 65)</em></td>
</tr>
<tr>
<td><em>(Heavily Armored)</em></td>
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</table>

<table>
<thead>
<tr>
<th><strong>High Speed Vessel</strong></th>
<th><strong>KRI-511 Teluk Bone ex-USN</strong></th>
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<tbody>
<tr>
<td><em>(Max speed 45+ knots)</em></td>
<td><em>(Bow Gate)</em></td>
</tr>
<tr>
<td><em>(Large hangar)</em></td>
<td><em>(Smaller LST)</em></td>
</tr>
<tr>
<td><em>(Large Well Deck)</em></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Logistic Support Vessel</strong></th>
<th><strong>KD-1505 Sri Inderapura ex-USN</strong></th>
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</thead>
<tbody>
<tr>
<td><em>(Semi-submersible variant)</em></td>
<td><em>(Stern Gate and Floating Causeway)</em></td>
</tr>
<tr>
<td><em>(Large Deck)</em></td>
<td><em>(Larger LST)</em></td>
</tr>
<tr>
<td><em>(Bow Gate)</em></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Riverine Combat Support Ship (RCSS)</strong></th>
<th><strong>Supply</strong></th>
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</thead>
<tbody>
<tr>
<td><em>(Additional Flight Deck)</em></td>
<td><strong>Repair</strong></td>
</tr>
<tr>
<td><em>(Stern gate and Floating Causeway)</em></td>
<td><strong>Force Protection</strong></td>
</tr>
<tr>
<td><em>(Stern Gate and Floating Causeway)</em></td>
<td><strong>Introduction</strong></td>
</tr>
<tr>
<td><em>(Additional Flight Deck)</em></td>
<td><strong>Basing</strong></td>
</tr>
</tbody>
</table>

**Shortcomings:** MOB could be a key to future force projection.
MOB Feasibility Screening

- Troop Capacity – At least 150
- Storage Capacity – 15 days for crew and RF
- Maneuverability – Shallow draft, meet with RF
- Maintenance and Support – Accommodate small boats and perform maintenance

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Troop Capacity</th>
<th>Storage Capacity</th>
<th>Maneuverability</th>
<th>Maintenance &amp; Support</th>
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<tbody>
<tr>
<td>LCS</td>
<td>NG</td>
<td>G</td>
<td>G</td>
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<tr>
<td>HSV</td>
<td>NG</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>LSV</td>
<td>NG</td>
<td>NG</td>
<td>G</td>
<td>G</td>
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<tr>
<td>RCSS</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>G</td>
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<tr>
<td>Barge</td>
<td>G</td>
<td>G</td>
<td>NG</td>
<td>G</td>
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<tr>
<td>Nobriza</td>
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<td>NG</td>
<td>G</td>
<td>NG</td>
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<tr>
<td>RSS-207 Endurance</td>
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<td>G</td>
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<tr>
<td>KRI-511 Teluk Bone</td>
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<td>KD-1505 Sri Inderapura</td>
<td>G</td>
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<td>G</td>
<td>G</td>
</tr>
<tr>
<td>Nobriza + Barge</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>Multiple Nobrizas</td>
<td>G</td>
<td>NG</td>
<td>G</td>
<td>NG</td>
</tr>
</tbody>
</table>

G: Go      NG: No Go
Key Factors of Supply Success were Supply Ship Cycle Time, Basing Alternative, and Logistics Connector Survivability.

Air Assets Did Not Significantly Improve Throughput and Raised Cost Substantially.

For a Single Connector, “Jim G” Supported the Best Supply Ship Cycle Time.
Supply System Objectives

To Move Materiel to a Forward Base in a Logistically Barren Area Via Waterways. System Must Transport, Store, Distribute Materiel as Effectively as Possible.

- **Maintain**
  - Ensure Flow of Materiel

- **Movement**
  - Minimize Time per Transport Event

- **Bring Back**
  - Minimize Time per Transport Event

**Metrics:**
- Throughput
- Percent Supply Level
- Operational Habitability
- Supply Ship Presence Duration
- Operational Availability
Alternatives

| LCAC | Speed: 40+ unloaded / 25+ loaded  
Capacity: 1,809 sq. ft. / 60 tons  
Throughput: 23 tons/hr  
Load/Unload: well deck, bow ramp, travel on land |
| LCU-1610 | Speed: 12 unloaded / 6+ loaded  
Capacity: 1,850 sq. ft. / 143 tons  
Throughput: 14.3 tons/hr  
Load/Unload: well deck, bow ramp, beach |
| LCU-2000 | Speed: 11.5 unloaded / 8+ loaded  
Capacity: 2,588 sq. ft. / 350 tons, can dispense fuel from its own tank  
Throughput: 41 tons/hr  
Load/Unload: bow ramp, beach |
| SEACOR Marine Jim G Mini Supply | Speed: 11 unloaded / 9 loaded  
Capacity: 1,825 sq. ft. / 320 tons  
separate tanks for fuel/water  
Throughput: 44 tons/hr  
Load/Unload: moor alongside |
| SEACOR Marine Sharon F Crew/Fast Support Vessel | Speed: 24 unloaded / 22 loaded  
Capacity: 1,804 sq. ft. / 296 tons  
separate tanks for fuel/water  
Throughput: 85 tons/hr  
Load/Unload: moor alongside |
| H-53E | Speed: 150 unloaded / 110 loaded  
Capacity: 16 tons  
Throughput: 25 tons/hr |
| H-60 | Speed: 160 unloaded / 110 loaded  
Capacity: 5 tons  
Throughput: 8.15 tons/hr |
| V-22 | Speed: 300+ unloaded / 110 loaded  
Capacity: 5 tons  
Throughput: 10 tons/hr |
Feasibility Screening

- Throughput: Assuming Distance of 40 nm, Re-Supply Operation of 300 Tons, and Done Within 24 Hours, Throughput Should be Greater Than 12.5 tons/hr.

- Cargo Weight: Carry One SIXCON (900 gallon container, 5 tons)

- Survivable: Low Profile, Steel Hull

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Throughput</th>
<th>Cargo Weight</th>
<th>Survivability</th>
</tr>
</thead>
<tbody>
<tr>
<td>LCAC</td>
<td>G</td>
<td>G</td>
<td>NG</td>
</tr>
<tr>
<td>LCU-1610</td>
<td>G</td>
<td>G</td>
<td>G</td>
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<tr>
<td>LCM-8</td>
<td>NG</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>LCU-2000</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>Jim G</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>Sharon F</td>
<td>G</td>
<td>G</td>
<td>NG</td>
</tr>
<tr>
<td>H-60</td>
<td>NG</td>
<td>NG</td>
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<td>H-53</td>
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<tr>
<td>MV-22</td>
<td>NG</td>
<td>NG</td>
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</tbody>
</table>

G: Go  NG: No Go
Supply Risk Analysis

Likelihood

Almost Certain

Likely

Moderate

Unlikely

Remote to None

Insignificant

Minor

Moderate

Major

Catastrophic

Consequence

O: Operational Availability
S: Survivability

1: LCU-1610
2: Jim G
3: LCU-2000
4. H-53E

Almost Certain

Likely

Moderate

Unlikely

Remote to None

Insignificant

Minor

Moderate

Major

Catastrophic

O(2)

S(2)

O(2)

S(4)

O(1,3,4)

S(1,3)

O(1,3,4)

S(1,3)
Cost Estimate Assumptions

- Procurement + 5 Year Operating and Support Cost
- Fiscal Year 2007 Dollars (FY07$)
- We assumed average OPTEMPO each year.
  - Cost from the past will be the same in the future
- Some data could not be retrieved for specific systems. Instead we found systems that are analogous to the system we were interested in and adjusted the cost.
- Commercial systems cannot be construed as a quote or offer for sale from the manufacturer.
CH-53E Most Expensive

Total 5 Year Cost for Supply Connector Alternatives

<table>
<thead>
<tr>
<th>Alternative</th>
<th>5 Year O&amp;S (FY07$M)</th>
<th>Procurement (FY07$M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LCU-1610</td>
<td>$10</td>
<td>$1</td>
</tr>
<tr>
<td>LCU-2000</td>
<td>$5</td>
<td>$1</td>
</tr>
<tr>
<td>Jim-G</td>
<td>$5</td>
<td>$1</td>
</tr>
<tr>
<td>CH-53E</td>
<td>$45</td>
<td>$40</td>
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</table>
Supply M&S

Tan Kian Moh
Modeling and Simulation

- **SIMKIT**
  - Determined Best Mix Using Two Waterborne Craft and Two Helicopters.
  - Broad Overview of Riverine Logistics Transport Using Gross Tonnage and Weather.
  - Consumption Rate is Linear
- **EXTEND**
  - Comparison of Two Best Waterborne Supply Craft from SIMKIT Between LCU-2000 and SEACOR “Jim G”
  - In Depth Look at how Crafts are Affected by Weather, Hostilities, Configuration Capacity, and Class of Supply.
  - Consumption Rate is Based on Operational Tempo and Number of Personnel at Basing Alternative.
Modeling Flow

Start

Arrival of AOR

Deployment of Supply Crafts

Loading

Demand Met?

Yes

Departure of AOR

No

Supply Request

After x days

Ingress

Arrival at Operating base

Unloading & Update Supply Level

Egress

Supply Craft arrival at Depot

Demand Met?

Departure of AOR
LCU-2000 Most Cost Effective

A Single LCU-2000 and SEACOR “Jim G” Have Same Performance.

Combination of Two CH-53 and Two River Connectors Has the Best Performance but at a Significantly Higher Cost.
“Jim G” Most Cost Effective

Connector Alternatives Cost Performance Curve for FOB 8-9 Days

- LCU-1610, LCU-2000
- Jim G
- LCU-1610, LCU-2000

LCU-1610 + LCU-2000 Has Slightly Better Performance at Higher Cost than “Jim G”

A Single LCU-2000 Has Significant Decrease in Performance Due to the Increased Supply Load.

Combination of Two CH-53 and Two River Connectors Has the Best Performance but at a Significantly Higher Cost
LCU-1610 + Jim G Most Cost Effective

Connector Alternatives Cost Performance Curve for MOB 4-7 Days

A Single “Jim G” Has Lower Performance Due to the Large Consumption Rate at the MOB.

2 “Jim G” Has Slightly Better Performance at a Higher Cost than LCU-1610 + “Jim G”

Combination of Two CH-53 and Two River Connectors Has the Best Performance but at a Significantly Higher Cost
2 Jim G Most Cost Effective

Connector Alternatives Cost Performance Curve for MOB 8-9 Days

LCU-1610 + "Jim G" Has Lower Performance Due to the Increased Supply Load.
To Maintain $0.95 \text{ Ao}_\text{fuel}$ SURCs

- **Max Supply Ship Cycle Time**

  - **FOB Low Conflict:** LCU-2000 – 10 Days  
    SEACOR “Jim G” – 12 Days
  - **FOB High Conflict:** LCU-2000 – 6 Days  
    SEACOR “Jim G” – 7 Days
  - **MOB Low Conflict:** LCU-2000 – 8 Days  
    SEACOR “Jim G” – 9 Days
  - **MOB High Conflict:** LCU-2000 – 5 Days  
    SEACOR “Jim G” – 6 Days
Findings and Conclusion

- Key Factors of Riverine Sustainment Supply Success are Supply Ship Cycle Time, Basing Alternative, Logistics Connector Survivability, Operational Availability of the SURCs and Cost
  - LCU-1610 as a single supply craft is dominated by LCU-2000 and “Jim G”
  - Combinations of supply craft perform better at long supply ship cycle time

- Air Assets Do Not Significantly Improve Throughput and Raise Cost Substantially.
  - 1% increase in utility by CH-53’s does not justify $80M in cost

- For a Single Connector, “Jim G” Supported the Best Supply Ship Cycle Time.
Questions?
Repair

LT Neil Wharton
Our model predicted:

• 13 SURCs are required to maintain an average of 9 available SURCs.
• 9 personnel produce an operational availability of 91%.
• MSRT has the greatest effect on $A_o$. 
Repair System Objectives

Repair: Conduct Both Preventive and Corrective Maintenance in a Riverine Environment

Preventive Maintenance
- Decrease Repair Time
- Increase Operational Availability

Corrective Maintenance
- Decrease Repair Time
- Increase Operational Availability

Metrics
- Operational Availability ($A_o$)
- Average Number of SURCs Available
- Mean Corrective Maintenance Time (MCMT)
- Mean Preventive Maintenance Time (MPMT)
Repair Risk Analysis

**Problem Statement**

Force Protection
Communication

**Conclusions**

Introduction
Supply
Repair
Force Protection
Communication
Conclusions

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>Insignificant</th>
<th>Minor</th>
<th>Moderate</th>
<th>Major</th>
<th>Catastrophic</th>
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<tbody>
<tr>
<td>Almost Certain</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Likely</td>
<td></td>
<td></td>
<td>E2</td>
<td>O2</td>
<td>C3</td>
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<tr>
<td>Moderate</td>
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<td>E3</td>
<td>O1</td>
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<td>Unlikely</td>
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<td></td>
<td>C1</td>
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<tr>
<td>Remote to None</td>
<td>E1</td>
<td></td>
<td>C2</td>
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</table>

C: Cost
O: Operational Availability
E: Environment
1: Add Personnel
2: Add Maint. Bays
3: Add SURCs

**Consequence**
• EXTEND v 6.0.8 Provided the Queuing Model for the RF Maintenance Function
• Basic Functional Flow Model:
No Significant Differences in Maintenance Alternatives

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Ao</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase Bays &amp; SURCs</td>
<td>0.9125</td>
</tr>
<tr>
<td>BAYS</td>
<td>0.9126</td>
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<tr>
<td>Status Quo</td>
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<tr>
<td>SURCs</td>
<td>0.9147</td>
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<tr>
<td>Personnel</td>
<td>0.9225</td>
</tr>
<tr>
<td>Increase All 3 Alternatives</td>
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<tr>
<td>Increase Personnel &amp; Bays</td>
<td>0.9242</td>
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<tr>
<td>Increase Personnel &amp; SURCs</td>
<td>0.9256</td>
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</table>
SURC Availability Decreases as MSRT Increases

Operational Availability vs. MSRT

![Graph showing Operational Availability vs. MSRT](image-url)
Repair Conclusions

• MSRT is the Biggest Driver of Ao.
• Riverine Force Needs 13 SURCs.
• Increasing Personnel and/or Maintenance Bays does Not Significantly Increase Operational Availability.
Questions?
ENS Tom Schmitz
Force Protection
Takeaways

• Current mortar defenses are insufficient. If U.S. forces cannot rely on host nation support for base defense out to expected mortar threat range, then a FOB becomes a vulnerable basing alternative.

• A water barrier and Remote Operated Small Arms Mounts (ROSAMs) are the most cost effective means of defending the FOB against a boat attack.

• The Nobriza and Barge Baseline is the most cost effective means of defending a MOB against a boat attack.

• IR Illuminators are valuable assets.
EFFECTIVE NEED: To Provide Protection for the RF at the Base of Operations by Predicting Enemy Courses of Action and Deterring and Denying Those Actions.

- Predicting: To have the correct defenses for an incoming attack.
- Deterring: To dissuade the enemy from attacking.
- Denying: To deny the enemy a successful attack.

Focus of our study

Metrics:
- Mortar Attack: Time to Detect and Hits on Base
- Commando Raid: Force Exchange Ratio and Infiltrations
- Boat Attacks: Mean Detection Distance, SURCs Destroyed, and Casualties
Threats Considered
Threats Considered
Continued
FOB Alternative Generation

**Mortar Defense**
- Baseline
- Baseline plus Mortar and UAV
- Baseline plus Mortar and LCMR
- Baseline plus Mortar, LCMR, and UAV

**Commando Raid on FOB Defense**
- Baseline
- Baseline plus Sensor Fence and Mortar
- ROSAMs

**FOB Boat Attack Defense**
- Baseline
- Baseline plus Water Barrier
- Water Barrier and ROSAMs
- Baseline plus Water Barrier and Patrol Boat
- ROSAM plus Water Barrier and Patrol Boat
MOB Boat Attack Defense

- RCSS
- RCSS plus Patrol Boat

MOB Alternative Generation

- 8 universal weapon stations
- 25mm Chain guns
- Mk-15 CIWS
- Mk 49 OSS and AN/SPS-67 Radar

- Patrol Boat

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MOB Alternative Generation

MOB Boat Attack Defense
Nobriza and Barge
plus Patrol Boats and Water Barrier

- FLIR sensor and navigation radar
- Mk 19 40mm grenade launcher
- twin barrel .50 cal
- twin barrel .50 cal
- M2 .50 cal machine guns
- Patrol Boat

MOB Alternative Generation
MOB Boat Attack Defense
Nobriza and Barge
plus Patrol Boats and Water Barrier

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## Force Protection Risk Analysis

<table>
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<td>T(1)M(1)</td>
<td>C(3)</td>
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<td>T(5)C(2)</td>
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<td>T(4)M(3)</td>
<td>T(3)C(1)</td>
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</table>

- **M**: Military Effectiveness
- **C**: Collateral Damage
- **T**: Technical
- 1: LCMR
- 2: ROSAM
- 3: Mortar
- 4: Sensor Fence
- 5: WhisprWave

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**Force Protection**
No Mortar Defense Alternative is Dominated

Mortar Defense Cost Performance Curve

- Baseline
- Mortar and LCMR
- Mortar and UAV
- Mortar, LCMR, & UAV

Cost FY07$M
Utility Score

$0.0 $0.5 $1.0 $1.5 $2.0 $2.5 $3.0 $3.5 $4.0
0 10 20 30 40 50 60 70 80 90 100
Baseline, Sensor Fence, and Mortars is the Most Cost Effective
The Baseline and Water Barrier is the Most Cost Effective
Nobriza and Barge Baseline is the Most Cost Effective
CPT Gil Nachman
MATLAB Simulation

Compared to MANA:

+ Full Control of Variables /Parameters
+ Complete Understanding of the Models

- Simplified Tactical Considerations
- Simpler Scenarios
MATLAB Simulation

Stage

Sensing and Detecting

Possible Outcomes

- Red Forces are Detected Before Combat Starts
- Red Forces Manage to Approach Surprise Range
- Blue Forces Annihilated
- Red Forces Annihilated

Variables

- Number of sensors
- Defensive Measures:
  - Machine guns
  - IR illuminators
  - Bunkers

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Effects of Defensive Measures

Expected Number of personnel killed as a function of number of blues

Number of Reds = 15

Baseline Scenario: 6 Machine guns

Expected number of Blue personnel killed
Expected number of Red personnel killed

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Effects of Defensive Measures

Expected Number of personnel killed as a function of number of blues
Number of Reds=15

- Initial number of Blues
- Personnel killed
- Expected Number of personnel killed as a function of number of blues

- 6 Machine guns
- 15 Machine guns
Effects of Defensive Measures

Expected Number of personnel killed as a function of number of blues

Number of Reds=15

No Bunkers

6 Machine guns

15 Machine guns

Initial number of Blues

Personnel killed
Expected Number of personnel killed as a function of number of blues

Number of Reds=15

No Bunkers

- Initial number of Blues
- Personnel killed
- Expected Number of personnel killed as a function of number of blues

6 Machine guns
15 Machine guns
IR illuminators

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The Effect of IR Sensors

**Graph**

**Expected number of blue forces killed**
- **Solid Line:** Expected number of blue forces killed
- **Dotted Line:** One standard deviation away

**Axes**
- **Y-axis:** Expected number of blue forces killed
- **X-axis:** Number of IR Sensors

---

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MATLAB Conclusions

- **Illuminators are the Most Valuable Measure** (recommend obtaining one for every person)
- **IR Sensors are Important, but Costly** (recommend 5-10 sensors)
- **Bunkers are Important for Small Numbers of Blue Forces** (recommended one for each machine gun post, 6 in total)
- **Additional Machine Guns are Important for Larger Numbers of Blue Forces** (recommended 6)
Questions?
For Further Questions
Break Out Session Start at 1200 in Bullard 100B