Network Surface Combatant
RSDE Pilot Study

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Code: 823

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Distribution Statement A: Approved for public release, distribution is unlimited.
Study Objectives

- Inform the setup of Future Surface Combatant AoA studies.
  - Baseline designs from FSC wargame studies, trading reduced sensing capabilities for weapon systems
- Familiarize NSWCCD Code 824 Future Ship and Submarines Concepts Branch with the use of RSDE for future studies and provide feedback to improve the software.
Designers provide **Baseline + Ranges** of inputs, Requirements, etc. \{min,max\}

Design Space Exploration

Run RSDE

**Sample Point**

**Included Analyses:**
- IHDE
- SHCP-L
- Etc…

Automatically Re-samples for additional design points

**Visualizations & Behavior Models**

**Set of Points**

Output **Designs & Analyses** In LEAPS

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Operational Design Space

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Major Study Trade-offs

• **Combat System Major Trade-offs:**
  • Fixed array vs. rotating array radar
  • Number of VLS cells (16 to 96)
  • Main gun size
  • Sonobouy system

• **Embarked Systems Trade-offs:**
  • Number of manned and unmanned aviation units
  • Number and size of small boats/equivalent USV & UUVs
  • Boat launch location

• **Naval Architecture Trade-offs:**
  • Length
  • Propulsion system type – mechanical vs. IPES
  • Engine separation – survivability
  • Auxiliary propulsion unit – survivability
# Low Magnitude DSE Concepts

<table>
<thead>
<tr>
<th>Description</th>
<th>Length</th>
<th>Propulsion</th>
<th>Engine Room Separation</th>
<th>VLS Cells</th>
<th>Relative CSEL Weight/Elec</th>
<th>Helo</th>
<th>UAV</th>
<th>Boats/USV/UUV</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NSC Analog</strong></td>
<td>130m</td>
<td>2 shaft CODAG</td>
<td>No</td>
<td>32</td>
<td>Baseline</td>
<td>1</td>
<td>2x TERN UAV</td>
<td>2x 11m RHIB equivalent, stern launch</td>
</tr>
<tr>
<td>Patrol 1 Combatant</td>
<td></td>
<td></td>
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<tr>
<td><strong>Euro Style Combatant</strong></td>
<td>123m</td>
<td>2 shaft CODAG</td>
<td>Yes</td>
<td>16</td>
<td>0.91 / 1.02</td>
<td>1</td>
<td>2x TERN UAV</td>
<td>2x 11m RHIB equivalent, side launch</td>
</tr>
<tr>
<td>Patrol 2 Combatant</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>IPES Small Surface Combatant</strong></td>
<td>117m</td>
<td>1 Shaft IPES + APU</td>
<td>No</td>
<td>16</td>
<td>0.91 / 1.02</td>
<td>1</td>
<td>2x TERN UAV</td>
<td>2x 7m RHIB equivalents, side launch</td>
</tr>
<tr>
<td>Patrol 2 Combatant</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Small Destroyer</strong></td>
<td>148m</td>
<td>2 shaft, 4 COGAG</td>
<td>Yes</td>
<td>96</td>
<td>1.71 / 3.04</td>
<td>1 or 2</td>
<td>3x TERN UAV</td>
<td>2x 11m RHIB equivalent, side launch</td>
</tr>
<tr>
<td>Battle Group Escort Variant 5 w/ downsized radar</td>
<td></td>
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<tr>
<td><strong>APU Destroyer</strong></td>
<td>155m</td>
<td>2 shaft IPES + APU</td>
<td>No</td>
<td>96</td>
<td>1.73 / 3.17</td>
<td>2</td>
<td>3x TERN UAV</td>
<td>2x 11m RHIB equivalent, launch method under evaluation</td>
</tr>
<tr>
<td>Battle Group Escort Variant 6</td>
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</tr>
<tr>
<td><strong>IPES Surface Combatant</strong></td>
<td>136m</td>
<td>2 shaft IPES</td>
<td>No</td>
<td>32</td>
<td>1 / 1</td>
<td>1</td>
<td>2x Tern UAV</td>
<td>2x 7m RHIB equivalents, side launch</td>
</tr>
<tr>
<td>Patrol 1 Combatant</td>
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</tr>
<tr>
<td><strong>1 Shaft Destroyer</strong></td>
<td>141m</td>
<td>1 shaft GT + APU</td>
<td>No</td>
<td>96</td>
<td>1.71 / 3.04</td>
<td>2</td>
<td>3x TERN UAV</td>
<td>2x 11m RHIB equivalent, side launch</td>
</tr>
<tr>
<td>Battle Group Escort Variant 5 w/ downsized radar</td>
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</tbody>
</table>
National Security Cutter Analog

<table>
<thead>
<tr>
<th>FAST Study Design Variant</th>
<th>Length Waterline</th>
<th>Propulsion</th>
<th>Engine Room Separation</th>
<th>VLS Cells</th>
<th>Helo</th>
<th>UAV</th>
<th>Boats/USV/UUV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patrol 1 Combatant</td>
<td>130m</td>
<td>2 shaft CODAG</td>
<td>1 bulkhead separation</td>
<td>32</td>
<td>1</td>
<td>2x TERN UAV</td>
<td>2x 11m RHIB equivalent, stern launch</td>
</tr>
</tbody>
</table>

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Automated Damage Stability

ASSET 6.3

RSDE 3.0

Automated 15% LBP Damage Scenario Analysis
- Deckhouses created based on constraint points
- Constraint points tied to design features e.g. the intersection of a deck and bulkhead or other constraint points
- Constraint points will be variables in RSDE 3.1 Design Space Explorations
Machinery arrangement shown above is **NOT** representative of actual engine room arrangement

- Developing & documenting process for modeling machinery arrangements that are beyond scope of RSDE machinery theory
- Large set of machinery components are represented in model
- Increased control over placement of components
Structural Arrangement Flexibility

Simplified placement and removal of transverse and longitudinal bulkheads

Ability to remove hull shell structural members to model stern launch areas
3D structural models are now used for weight estimation

Structural theory assumes linear stiffeners, leading to gaps
Findings: Design Perspective

- Mission requirements as defined in capability concept wheel appear to be feasible
  - Modeling mission systems to the level of detail that is necessary for mission effectiveness analysis is challenging
  - Traditional Naval Architectural disciplines are strengths of RSDE
- Initial damage stability analysis shows smaller hulls will have issues with meeting damage stability flooding criteria due to large engine room and weapons systems spaces within the hull
  - Embedded SHCP-L damage stability module allows designers to design to damage stability requirements at beginning of design rather than test against requirements at end of design
- Adding unmanned vehicles has a significant impact on manning
  - 1 UAV can require up to 7 additional crew
- Impact of different RHIB launch locations has not be studied yet, but can be analyzed using embedded Ship Motions Program module

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Findings: Tool Perspective

- The initial learning curve of using the new RSDE software was steep but as new training materials and software updates have become available the process has rapidly improved.
- Near term updates to RSDE allow for reuse of information between models streamlining the model development process.
- The study has familiarized members of NSWCCD Code 824 Future Ship and Submarines Concept Branch with RSDE for use in future studies and has provided the RSDE Development Team (Code 823) useful feedback for improving the software.
  - Dr. Alexander Gray (823) – RSDE Product Lead
  - Pedro Muslera (823) – RSDE Implementation Team
  - Drake Platenberg (824) – FSC Baseline Development Task
  - James Lovenbury (824) – UUV Design Tool Development
  - Nick Mullican (823) – RSDE Development Team
  - Mark A. Parsons (823) – Ph.D. Student at Virginia Tech researching Concept Effectiveness and Vulnerability Analyses with Dr. Alan Brown

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The Future of RSDE

DoD 5000 Acquisition Phases

Material Solutions Analysis
Technology Development
Engineering & Manufacturing Development

Pre-Systems Acquisition
Systems Acquisition

Concept Design, Technology Assessment
Analysis of Alternatives (AoA) & Feasibility Studies
Preliminary Design (PD) & Contract Design (CD)
Detail Design & Construction (DD & C)

Exploratory Design
Engineering Design
Production Design

Navy Led
Navy Performed
Navy or Shipbuilder Performed
Shipbuilder Led
Shipbuilder Performed

Current domain for RSDE
Future Expansion of RSDE Domain

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The Future of RSDE: Near Term

RSDE v3.1 - Release Dec. 2017

• **Improved, High Magnitude DSE (monohull)**
  • Rapidly generate 1000’s of ship concepts
  • Now with *SHCP & IHDE* integrated

• **Multi-hull hullform study DSE**
  • Rapidly generate and analyze resistance & seakeeping of multi-hull hullforms (catamaran & trimaran)

High Magnitude

White space shows feasible region

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RSDE: Long Term

• Roadmap developed to 2025, planned development:
  • Submarine Design Space Exploration
  • Systems Design (Machinery, Distribution, CPES)
  • Topside Design
  • Automated Costing
  • Arrangements (Manual & Automated)
  • Damage Stability Enhancements (Downflooding)
  • Predictive Structural Loads
  • Generative Structures

• Constant emphasis on Decision Support, Visualization, and Data Analysis Capabilities and Tool Flexibility Improvements
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