



Department of Defense High Performance Computing Modernization Program



CREATE

Computational Research & Engineering Acquisition Tools & Environments



Rapid Design and Integration (RDI)

**Distribution Statement A: Approved for public
release, distribution is unlimited**



Product Description

The vision for the CREATE-SHIPS Rapid Design and Integration (RDI) effort is to create a high-end toolset that integrates ship design generation tools with physics-based analysis tools that enables the user to:

- DESIGN – hundreds of ships by running ship design generation tools to create a rich design space
- ANALYZE – hundreds of ship designs using physics based analysis tools, adding to the knowledge captured in the design space.
- OPTIMIZE – using the knowledge in design space, cost benefit trades are performed to find a low cost, low risk, robust design solution.

RDI will use high performance computing resources to reduce the time required to perform these activities, so that they can be completed within the decision cycle of early stage design or mid-life upgrade studies.

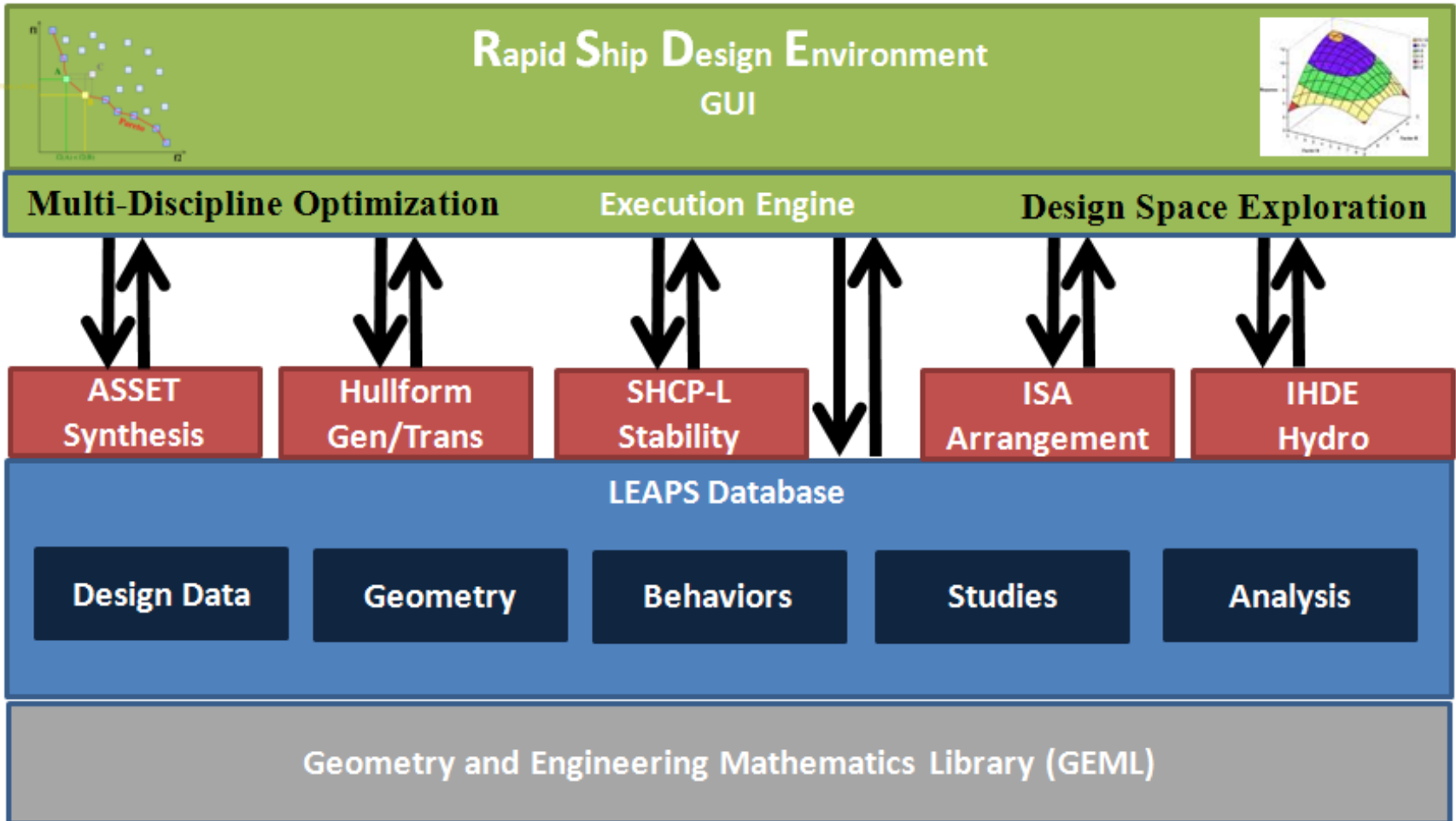


Product Architecture

- The CREATE-Ships RDI effort produces 1 Product:
 - Rapid Ship Design Environment (RSDE)
 - New Design Space Exploration capability
 - New Multi-Disciplinary Synthesis capability
- The use cases envisioned for RSDE require development of new capabilities in the existing tools:
 - Advanced Ship and Submarine Evaluation Tool (ASSET)
 - New Hull Transformation and Generation capability
 - New Structural Design Definition capability
 - Leading Edge Architecture for Prototyping Systems (LEAPS)
 - New Parallel Queries capability
- The use cases envisioned for RSDE require development of a new tool:
 - Intelligent Ship Arrangements (ISA)
 - New Ship Arrangement capability

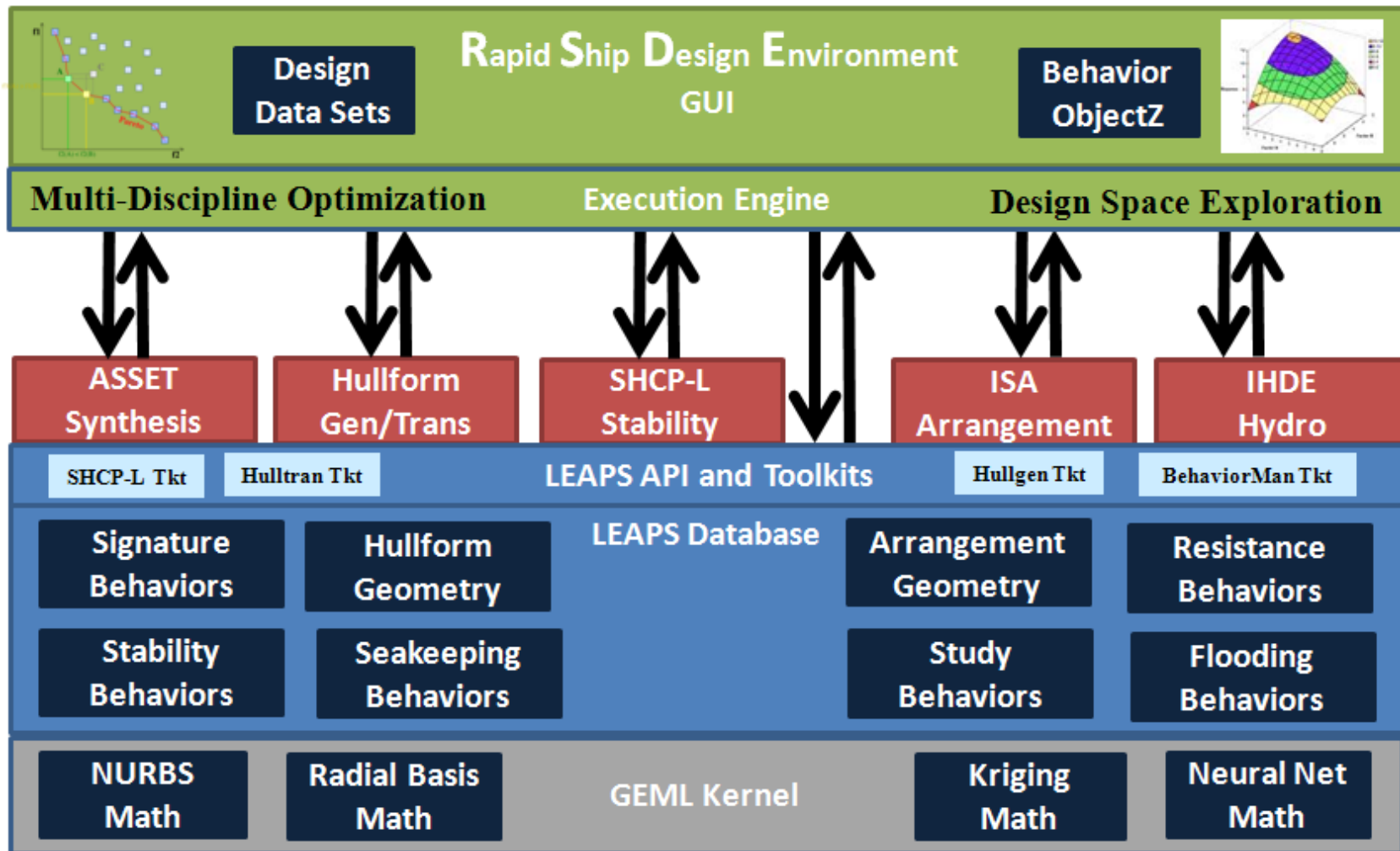


RSDE - Product Architecture





RSDE - Product Architecture





Description of the Rapid Ship Design Environment



1. RSDE will generate and interrogate design space data through....
 - 1.1 Generation of design space data through remote execution of tools.
 - 1.2 Aggregation of trade space data into larger sets.
 - 1.3 Evaluation and data extraction for downstream design and/or analysis tools.
2. RSDE will serve as a decision aid through visualization of trade space.
3. RSDE will be used by a naval architect needing higher fidelity design definition and physics based analysis during early stage design.
4. The output of this process will be a trade space. This trade space will be composed of discrete sets of design data and/or design data represented as interpolated behavior models.



Users



- Rapid Ship Design Environment- planned 1st release date: Early CY 2012.
- ASSET
 - Has been used in the early stages of design by most major ship acquisition programs in recent history: DDG-1000, LCS, CVN-78, LPD-17, CG(X), DDG-51 flight upgrade.
 - Currently has 86 org/users on distribution.
 - Currently there are an estimated 40 heavy users.
- LEAPS
 - Has been used by the following ship acquisition programs: DDG-1000, SSC (Ship to Shore Connector – LCAC replacement)
 - Used by all ASSET users as the database for ASSET models
 - *Has promise, but is currently underutilized – most users are computer programmers developing applications.*
 - Currently has 129 org/users on distribution.
 - Currently there are an estimated 30 heavy users.



Potential Ship Programs

- DDG-51 Flight III Destroyer (FY 16 award)
 - currently using ASSET/LEAPS toolset
- LHA-8 Amphibious ship (FY 16 award)
- T-AO(X) Tanker (FY 17 award)
 - currently using ASSET/LEAPS toolset
- LSD(X) Amphibious ship (FY 17 award)
 - currently using ASSET/LEAPS toolset
- Ohio Replacement (FY 19 award)
- Sub Tender replacement (FY 23 timeframe)
 - Good option for RSDE use
- DDG(X) Future Surface Combatant (FY 25 timeframe)
 - Good option for RSDE use
- LCS(X) replacement (FY 25 timeframe)
 - Good option for RSDE use
- Virginia class submarine replacement (???)



Ship Synthesis (using ASSET)

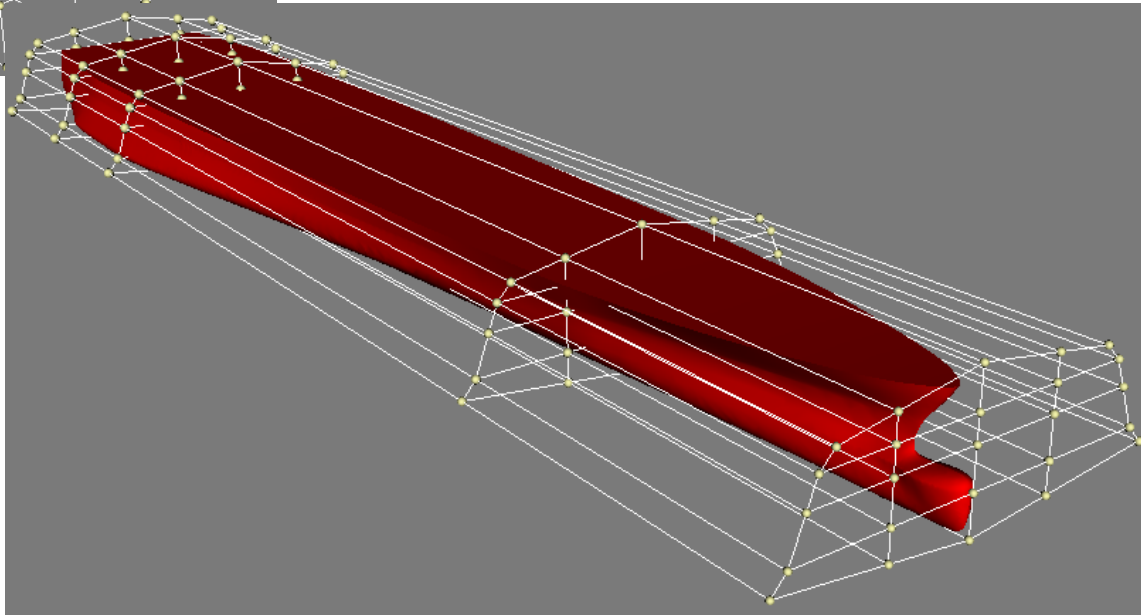
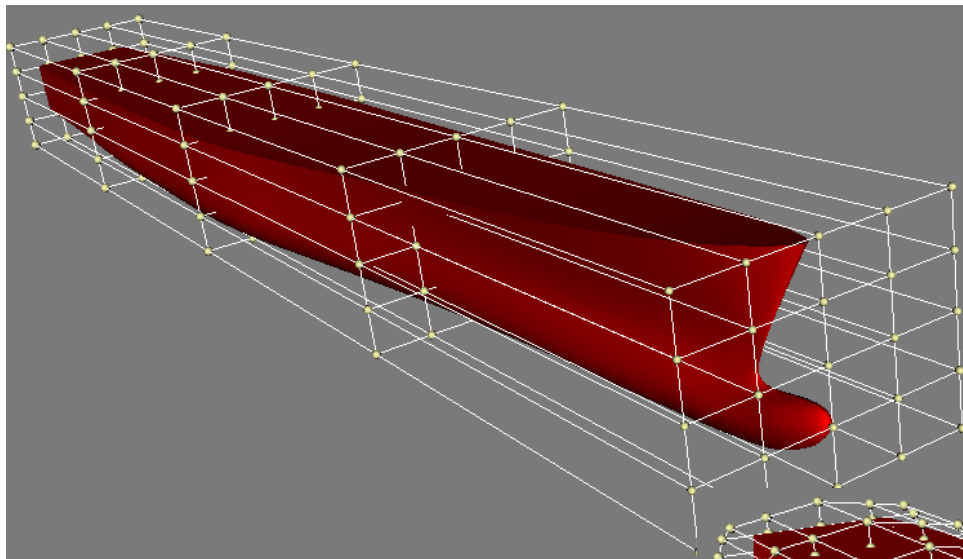


The screenshot displays the LEAPS Editor software interface. At the top, the title bar reads "LEAPS Editor - [DDGX_Baseline]". Below it is a menu bar with "File", "Edit", "View", "Display", "Tools", "Window", and "Help". A "Messages" pane on the left is currently empty. The main workspace shows a 3D CAD model of a ship's hull and deckhouse structure, rendered in yellow and blue. A coordinate system with X, Y, and Z axes is visible in the lower-left corner of the workspace. On the left side, there is a hierarchical tree view under "PM | LDB |". The tree includes categories like "Views Of Bulkhead 00", "Watertight Bulkheads", "Views Of Deckhouses", "Deckhouses", "Views Of Decks", "Views Of Hulls", "Hulls", and "Transom Of Hulls". The "Starboard Hull 00" item is currently selected. A toolbar with various icons is located below the tree view. At the bottom of the window, there is a status bar with "CAP | NUM | SCRL" and a system tray showing the time "1:10 PM" and date "10/25/2011".





Hull Transformation Approach





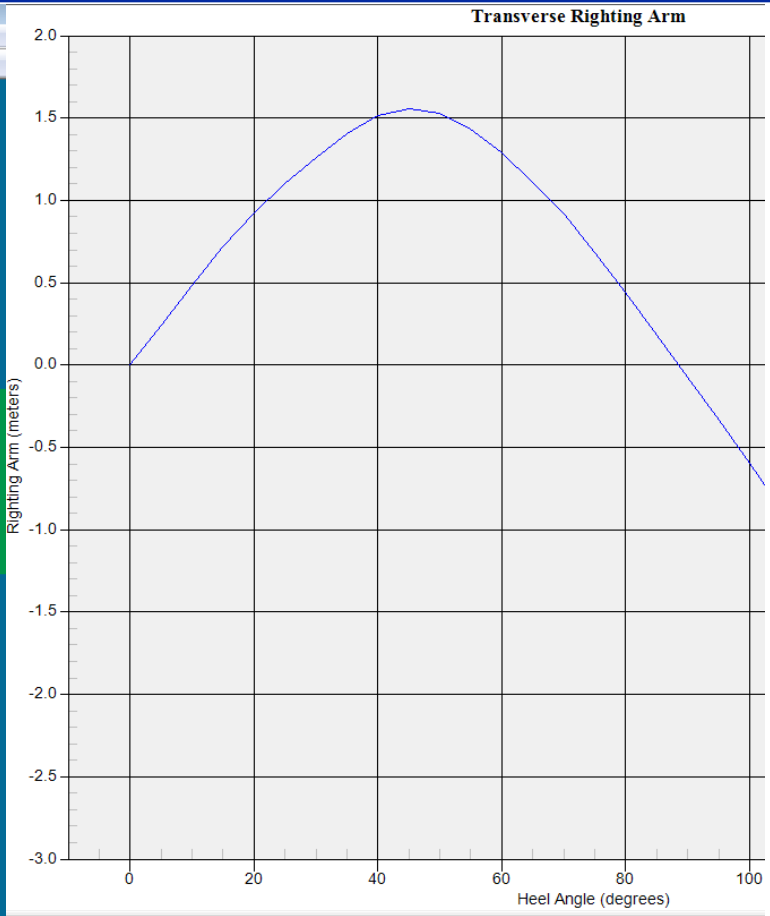
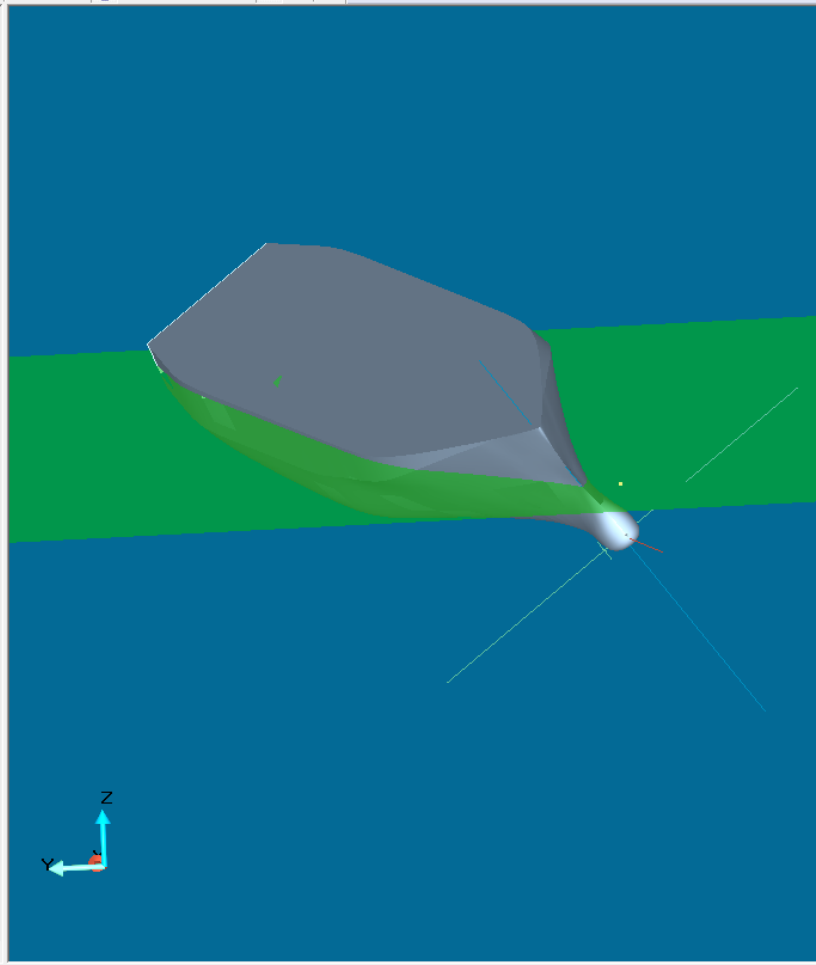
Intact Stability using SHCP-L



LeapsSHCP - [DDGXBaseline[ship_0000001-1]]

File Edit View Window Help

- Input Data
- Report
- Watertight Envelope Analyses
 - Hydrostatics
 - Hydrostatics Analysis #1
 - Input Data
 - Results
 - Plots
 - Report
 - Trim Lines
 - Limiting Drafts
 - Floodable Length
 - Floodable Length Analysis
 - Input Data
 - Results
 - Plots
 - Report
 - Damageable Length
 - Longitudinal Strength
 - Watertight Zone Analyses
 - Intact Cross Curves
 - Intact Transverse Stability
 - Intact Stability Analysis #1
 - Input Data
 - Results
 - Equilibrium Condition
 - Waterplane
 - Flooding
 - Liquid Loads
 - Plots
 - Report
 - Intact Transverse Stability on Damage Cross Curves
 - Damage Transverse Stability
 - Damage Transverse Stability Analysis #1
 - Input Data
 - Results
 - Equilibrium Condition
 - Waterplane
 - Flooding
 - Liquid Loads
 - Plots
 - Report



INTACTTS: Calculations Complete
INTACTTS: Saving Results
INTACTTS: Calculations Complete
Found Hull Length Between Perpendiculars = 159.997





Damage Stability using SHCP-L



LeapsSHCP - [DDGXBaseline[ship_0000001-1]]

File Edit View Window Help

SHCP

- Ship Geometry
 - Ship Particulars
 - Hull & Solid Appendages
 - Watertight Envelope 0000
 - Propulsion Shaft Section
 - Propulsion Shaft Section
 - Propulsion Shaft Section
 - Propulsion Shaft Section
 - Propeller 0000001-1
 - Propeller 0000000-1
 - Skeg 0000001-1
 - Bilge Keel 0000001-1
 - Bilge Keel 0000002-1
 - Line Appendages
 - Watertight Zones
 - Zone Properties
 - 2-FPK-0
 - HB-FPK-0
 - 2-8-0
 - 3-8-0
 - HB-8-0
 - 2-22-0
 - 3-22-0
 - HB-22-0
 - 2-31-1
 - 2-31-2
 - 3-31-1
 - 3-31-2
 - 4-31-0
 - 4-31-1
 - 4-31-2
 - 5-31-0
 - HB-31-0
 - 2-40-0
 - 3-40-0
 - 4-40-0
 - 5-40-0
 - HB-40-0
 - 2-50-0
 - 3-50-0
 - 5-50-0
 - HB-50-0
 - 2-50-0

Iteration 8, Volume Difference = 0.003, LCG Difference = 0
 DAMTS: Balance Achieved
 DAMTS: Equilibrium Calculations Complete
 DAMTS: Total Iteration 26, Total No Balances 0

For Help, press F1

SHCP

Hide Back Forward Print

Contents Index Search

Type in the keyword to find:

Damage Transverse Stability

Allowable KG
 Bulkhead
 Transverse Watertight Bulkhead
 Damage Longitudinal Stability
 Damage Stability Cross Curves
 Damage Transverse Stability
 Damageable length
 Design Condition
 Edit Menu
 File Menu
 Floodable Length
 Flooding Scenario
 Getting Started
 Heeling Arm
 Transverse Stability Evaluation

Damage Transverse Stability

Description

The Damage Transverse Stability module computes transverse righting arms over a range of heel angles. These calculations include the effects of flooding and liquid load movement. The vessel is balanced in displacement and LCG during the

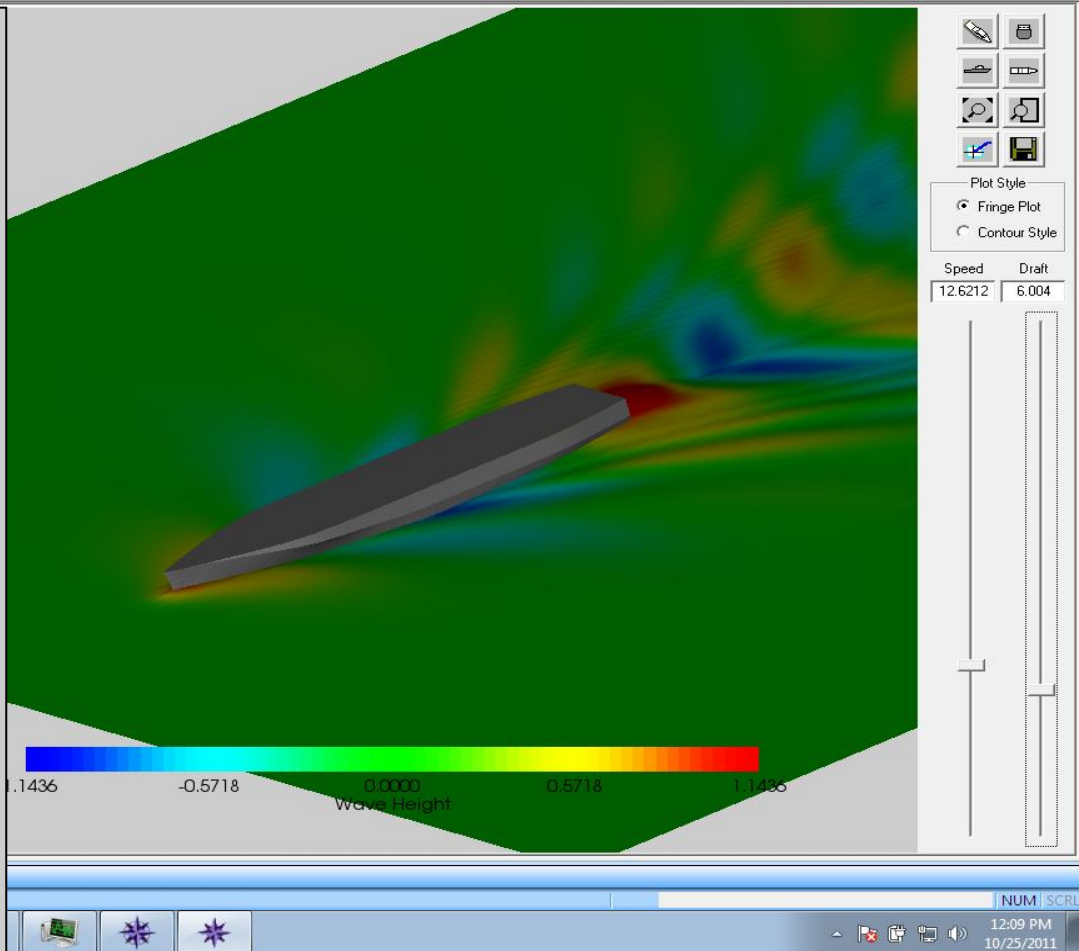
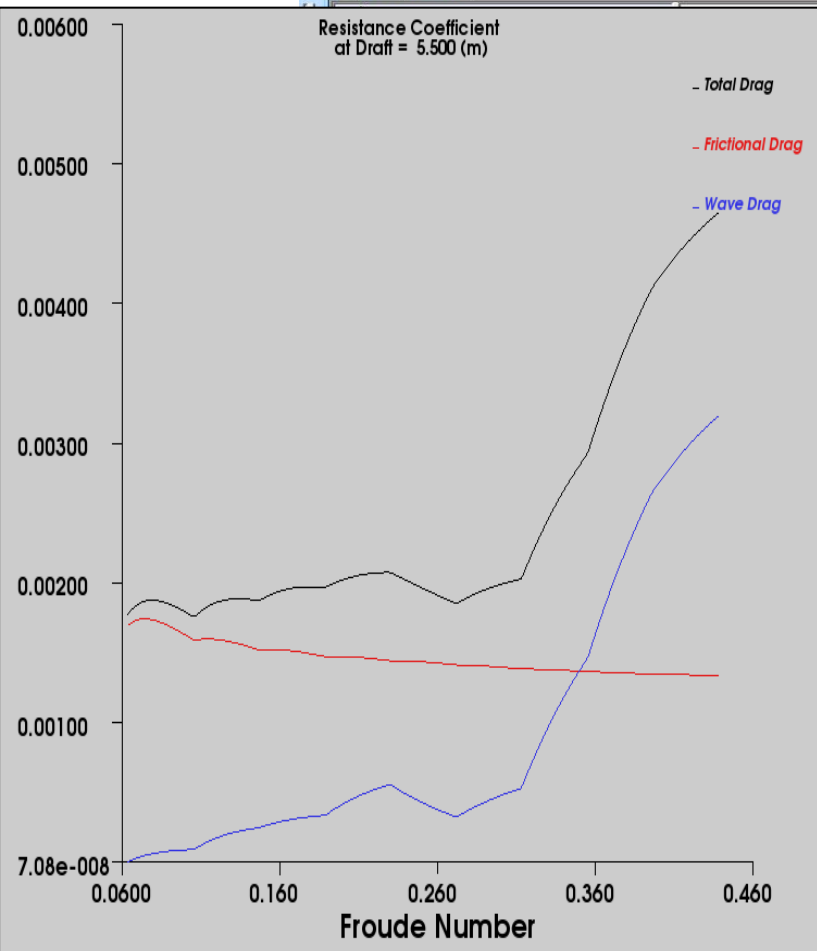
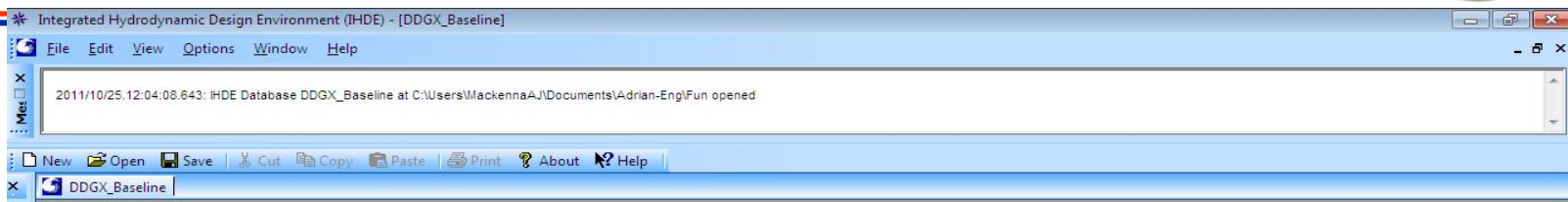
- Damage Transverse Stability
 - Input Data
 - Beam Winds Analysis
 - High Speed Turn An
 - Results
 - Equilibrium Condition
 - Waterplane
 - Flooding
 - Liquid Loads

Transverse Righting Arm

Floodable Length

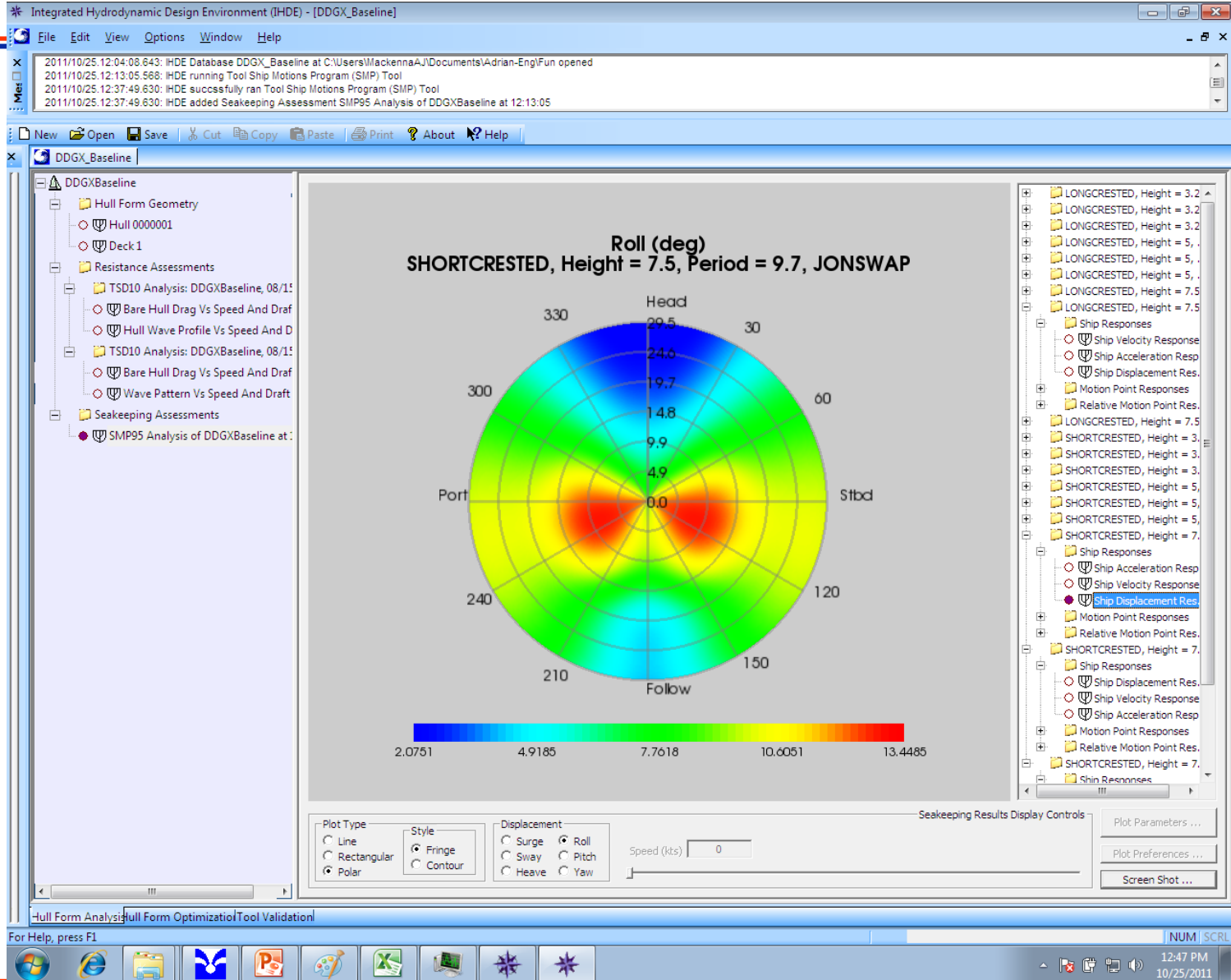


Resistance Analysis using IHDE





Seakeeping Analysis using IHDE



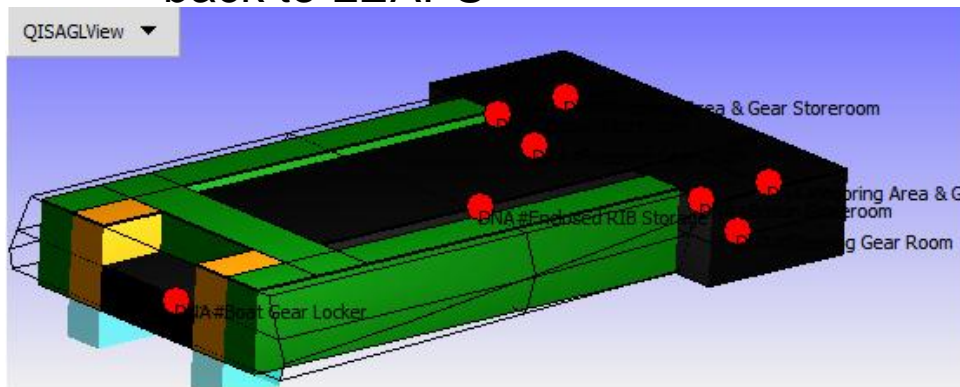
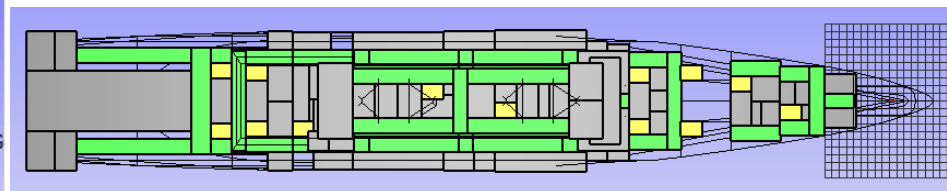
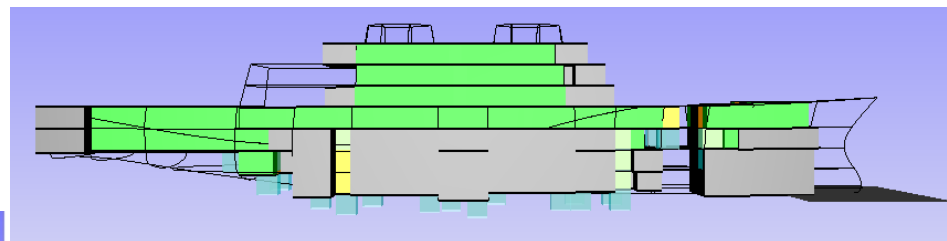
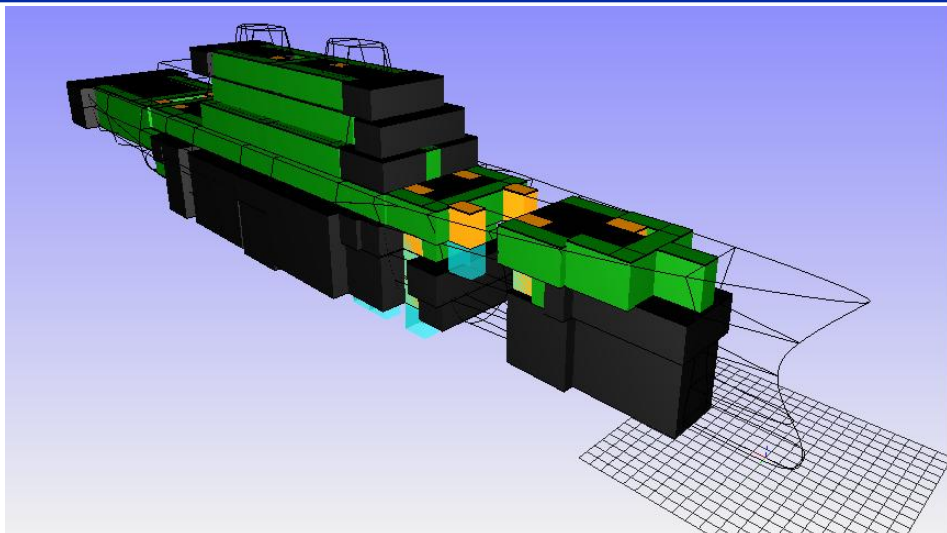


Intelligent Ship Arrangements (ISA)



- **Capabilities of ISA:**

- LEAPS database as input for ship geometry and requirements
- Arrangement requirements are input as a constraints database
- Passageways are laid out using an initial lattice network
- ISA performs allocation and arrangement of ship compartments
- Fuzzy logic is used to lay out and optimize arrangement
- 3D arrangements model is populated back to LEAPS

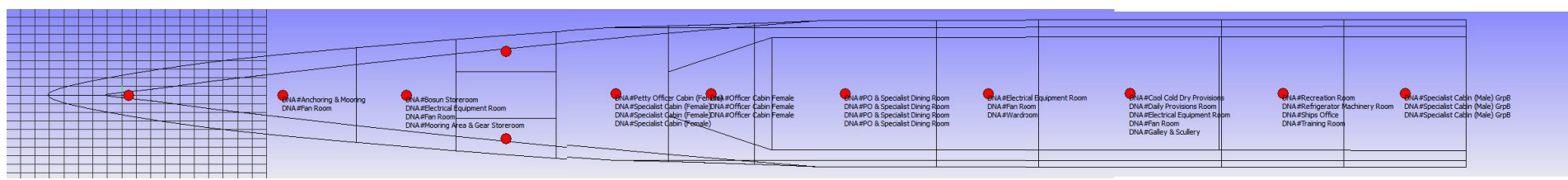




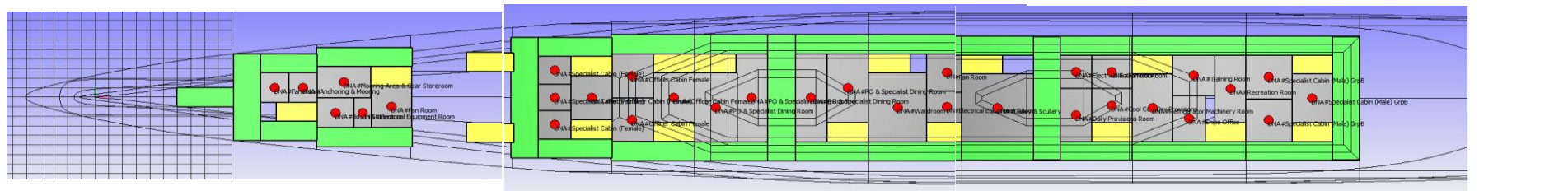
Intelligent Ship Arrangements (ISA)



Allocation Step



Arrangement Step

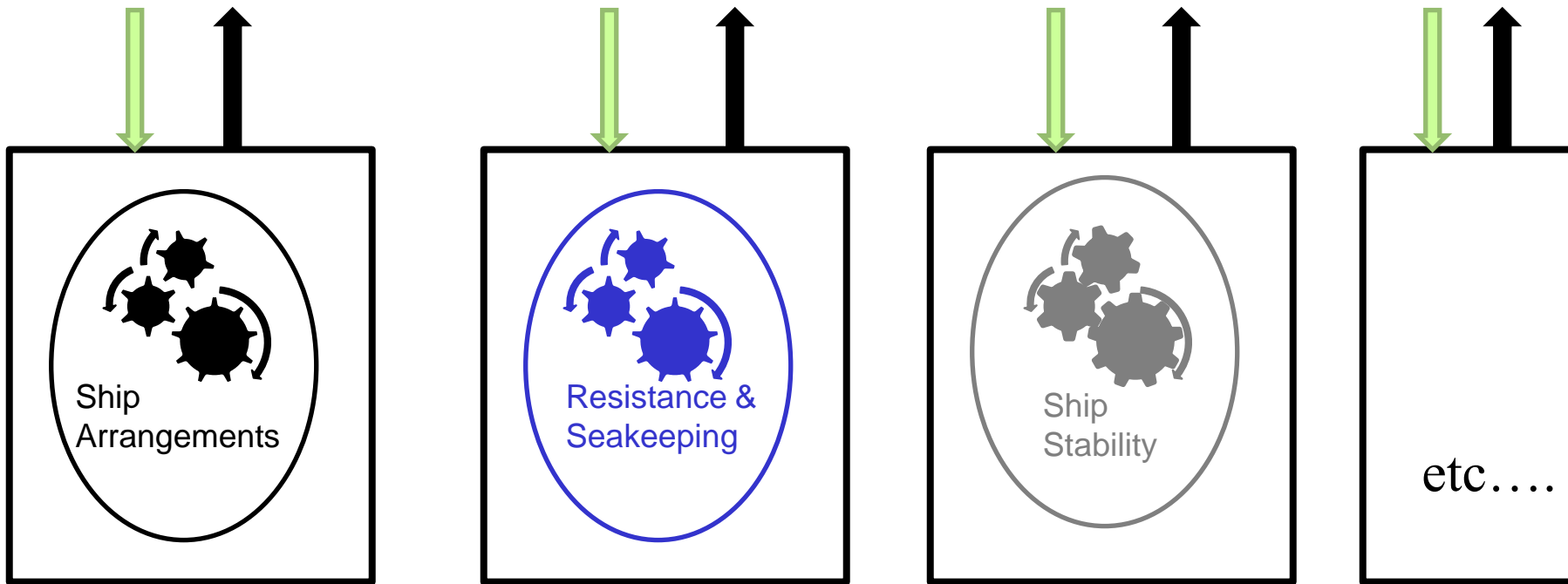




Multi-Disciplinary Synthesis

MDS (Multi-Discipline hierarchical Systems engineering)

Coordinate decision making process among ship design generation tools and physics-based analysis tools



Exchange of information and interaction among disciplines; effects of uncertainty; sharing of design variables; coordination of mutually competing objectives and constraints.



Multi-Disciplinary Synthesis

