

FAST SEALIFT CAPABILITIES ANALYSIS USER'S GUIDE

Background

The spreadsheet described by this User's Guide is an outgrowth of a High-Speed Sealift Technology Workshop, conducted at the Naval Surface Warfare Center, Bethesda, Maryland, on October 21-23, 1997. The workshop gathered together approximately 200 experts in various technologies related to high-speed sealift. The delegates were assigned to subgroups to develop a consensus on the level of sealift enhancing technologies attainable in the near, mid and far terms. The Workshop participants discussed the potential to achieve the mission requirements through advances in:

- high-speed hullform and propulsor technology
- high density/efficiency prime mover and propulsor technology
- loads prediction, materials and structures technology
- ship/port interface technologies
- ship system concepts
- shipbuilding and manufacturing technology

A nominal mission statement focused the discussions. The sealift needs were presented as:

- Speed: 40 – 100 knots
- Range: 500 – 10,000 nautical miles
- Cargo: 500 – 5,000 short tons
10,000 – 150,000 square feet
- Draft: Shallow for amphibious assault missions, but not necessarily a requirement for Marine Corps or commercial applications.

Overview

The spreadsheet described in this User's Guide is a screening tool to explore the potential offered by new ship types and technologies to accomplish the fast sealift mission. It does not, by itself, provide "the solution" for the sealift mission. It does identify candidate ship types, which must then be further evaluated in terms of mission effectiveness and cost.

The spreadsheet contains ratings (with rationale) which define the inherent capability of each ship type to:

- carry the desired payloads
- achieve the desired speed, and operate at high speed in open ocean.
- perform cargo-handling operations, in port, off the beach, and over the beach.
- avoid detection, absorb damage, and recover from damage.
- sustain structural loads
- utilize multiple design materials and propulsion components
- be constructed in existing facilities, with state of the art manufacturing practices
- be constructed and operated at reasonable cost

The spreadsheet also contains an assessment of risk, in terms of the likelihood of a problem occurring, and the consequences associated with the problem, for each ship type. The assessment of likelihood of a problem occurring is made for each attribute of each ship type, and annotated with the rationale for the rating on that ship type's data page. The consequences of failure are rated and annotated for each attribute on a separate page of the workbook. The level of likelihood and related level of consequence for each attribute are combined to assign a risk rating of Low, Medium, or High to that attribute, for a specific ship type.

Users are given the opportunity to assign numerical weighting factors to each of the attributes, according to each attribute's relative importance to their sealift mission. Users can then explore the relationship between the ranking of candidate ship types and the relative importance assigned to the attributes. The ship types are:

- Displacement Monohull
- Slender Monohull
- Planing Monohull
- Displacement Catamaran
- Planing Catamaran
- Trimaran
- SWATH
- Semi-SWATH
- Surface Effect Ship

Some ship types, such as wing-in-ground-effect, and hydro-ski were excluded because their development extends beyond the time frame of interest.

The product of the spreadsheet is a ranking of risk vs. return for the ship types, based on the User's specification of the importance of specific sealift related attributes, through the numerical weighting values. The ranking is presented in both a rank order table, and as a bar graph. Levels of risk are displayed graphically for the range of ship types examined.

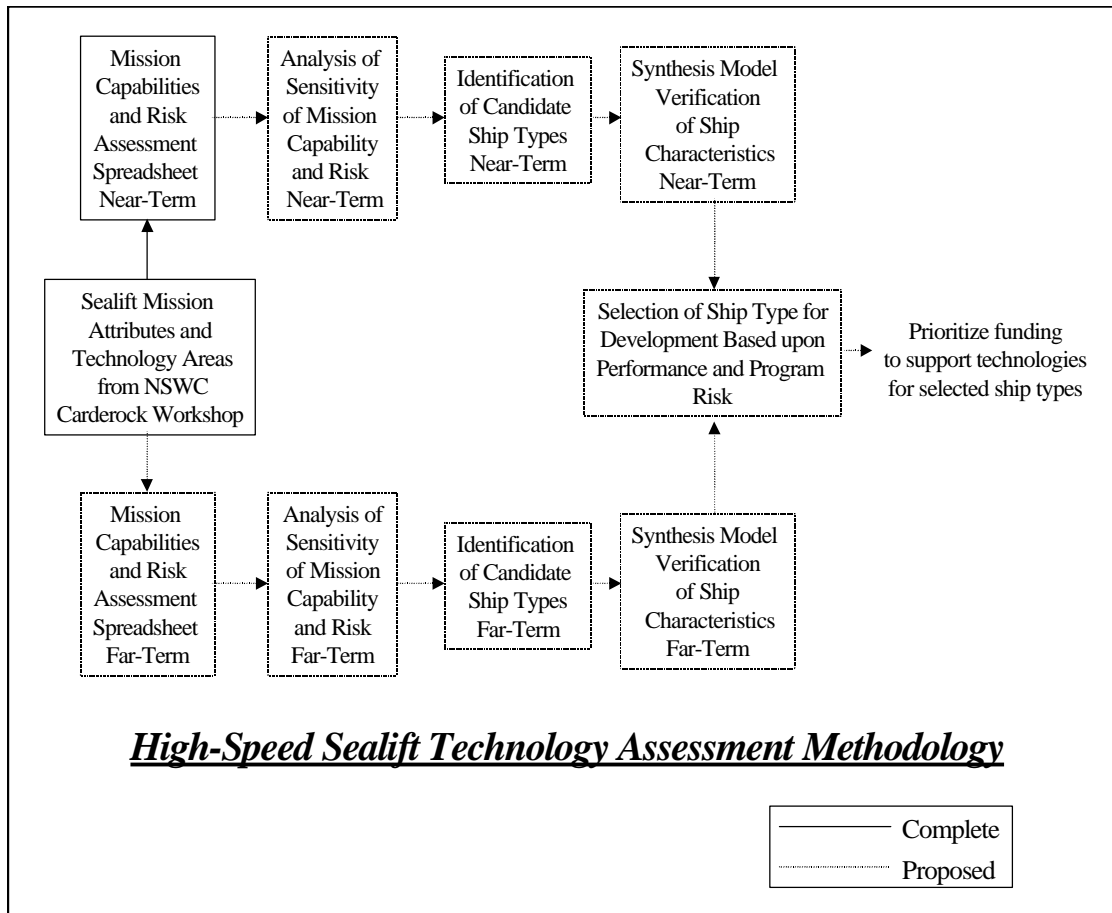
Utility of the Spreadsheet

Technical specialists have assigned the capability ratings for each attribute, for each ship type, and assigned values for likelihood of problem occurrence and consequence of a problem, based upon near-term technology. By varying the weighting of the attributes in the spreadsheet, the User can explore how those weightings affect the preferred choice of ship type, in the near term.

One additional spreadsheet could be developed, in which the attribute values for capability, likelihood of a problem occurrence and consequence of a problem are adjusted to reflect the judgement of the Workshop participants for expected Far-Term technology. Identical mission/requirement weightings applied to both spreadsheets would then indicate how the preferred choice of ship type might change over time. The results would also allow the User to identify the mission emphasis and the technology developments that created the change. This process is shown in the attached diagram.

Some caution is necessary. The spreadsheet is only a top-level screening tool. Changes in the weighting of attributes are evaluated without consideration of the cascading impacts on the ship type of a change in that attribute. For example, if great emphasis is placed on speed, there are implications for hull structural loads, material properties, structural weight, propulsion plant size and weight, fuel requirements, and human performance. These can only be evaluated through use of a design synthesis model, which does account for the related effects of changing a single mission requirement or design attribute.

Analysis to date indicates that the technology improvements identified by the Workshop participants do not contain any "breakthrough" technologies and are of insufficient magnitude to influence the ranking of ship types using the spreadsheet methodology. However, design synthesis models can more realistically assess the total ship system effects of projected improvements in technology, and those models have been utilized to refine the ranking of candidate ship types due to technology improvements.



The Hitchhiker's Guide to the Workbook

The spreadsheet is a Microsoft Excel Workbook, Version 5.

We strongly recommend that you save the initial version of the workbook for reference, and create a working copy of the workbook, with a different file name, before changing any values in the spreadsheets. The initial version will provide a ready reference to the values and rationale for the values assigned by the creators of the workbook

Page 1 *General Info* contains general administrative information about the workbook.

Page 2 *Methodology* contains a quick reference to the analysis methodology and use of the workbook

Page 3 *Analysis Results* contains the results of an analysis for a given set of User-selected weightings.

The first table on the Analysis Results page lists the ship types analyzed, and provides the unweighted and the weighted rating associated with each ship type. The table displays the rank order of each ship type based upon the weighted ranking. It also displays the number of attributes rated as high, medium and low risk for each ship type. A weighted ranking of zero appearing in this table indicates that some attribute for that ship type, identified as a “key” or “Essential Requirement” by the User, was judged incompatible with the fast sealift mission. The attribute can be identified on the Hullforms page (Page 8), as described below.

The second table on the Analysis Results page lists the ship types in rank order.

The first on the Analysis Results page bar chart displays the weighted ranking of each ship type.

The second bar chart on the Analysis Results page displays the number of low, medium and high-risk elements associated with each ship type.

The Analysis Results page contains two reference tables in columns “R” to “AL”. These tables perform intermediate calculations for the transfer of data and are of no interest to the User.

The User is cautioned that the significant result of this analysis is the relative ranking of candidate ship types, and that the spreadsheet is only a screening tool. Additional analysis using design synthesis models, in conjunction with cost and mission-related analyses, is necessary to establish a final ranking.

Page 4 *User Weightings*

The User Weightings page is the user interface page. Attributes are grouped in seven major categories:

- Payload Capacity
- Performance
- Loading Interface
- Ship Survivability
- Feasibility
- Ability to Manufacture
- Cost of Ownership

The User's first step is to establish an overall numerical weighting value for each major category. The purpose of establishing weights for the major categories is to define the relative importance of each major category to the sealift mission. This “Target Value” is entered in column F, in the “Total” row for each major category. The cells are highlighted in blue. Table 1 on this page lists the target values selected by

the User. The User should review the table to be sure the selected values provide the appropriate weighting among the major categories.

The User's next step is to assign weight values to the sub-categories under each major category. Weight values are entered in Column E, in the green highlighted cells. Replacement weight values should be adjusted until the subtotal matches the target subtotal. A bar graph displays the weight values assigned to each major category, calculated from the sub-category values. It provides a visual representation of the distribution of weight values assigned to the major categories by the User.

Users are not expected to have expertise in all attribute subject areas. A User who does not have expertise or an appreciation for the impact of a specific attribute should give that attribute a weighting value of zero. This will provide a ranking of ship types based upon the User's unique knowledge and expertise.

The User's third step is to review the sub-categories and determine which of those attributes, if any, must be provided by the ship type to have a viable concept. Those key sub-categories are identified by entering the numeral "1" in column G, labeled "Essential Requirement" in the sub-category row (red highlighted cells). Any ship type that does not have capability in a key sub-category will receive a zero total rating.

Page 5 of the spreadsheet "Weighting Ref" provides an annotated example of an assignment of weighting values.

Once the User is satisfied with the weightings assigned, the User can return to the Analysis Results page. Excel 97 users should click on cell B32 of the Analysis Results page to initiate all spreadsheet calculations and update the tables and charts of the Analysis Results page. Excel 5.0 users should click on "Tools", then on "Macro" and run the "SortHullform" macro.

The following discussion of other pages in the workbook will enable the User to analyze and interpret the data shown on the Analysis Results page.

Page 5 Weighting Ref.

Page 5 is a sample of numerical weighting values developed by a fictitious user. The purpose of this page is to provide some insight to the thought process behind the setting of weighting values. Numbers on this page are illustrative and do not impact the analysis.

Page 6 Rating Defin's

This page contains the criteria used to rate:

1. the inherent capability of each ship type, in each sub-category.
2. the likelihood of a problem occurring in each sub-category.
3. the consequence of a problem in each sub-category.

The rating assigned for likelihood is combined with the rating assigned for consequence to establish risk as "high", "medium," or "low." The risk matrix is shown on the following page.

<u>Likelihood of Occurrence:</u>					
High Level 5					
Moderately High Level 4					
Moderate Level 3					
Moderately Low Level 2					
Low Level 1					
Consequence:	Low Level 1	Moderately Low Level 2	Moderate Level 3	Moderately High Level 4	High Level 5

Page 7 Consequences

Consequence describes the impact of a problem in an individual sub-category. This page of the workbook describes the consequence rating assigned to each sub-category, and a short description of the rationale for that rating.

Page 8 Hullforms

The Hullforms page summarizes the rating assigned to each sub-category, for each ship type. It displays the weight to be assigned to that rating, and whether or not the sub-category is considered to be “key.”

If a ship type should score zero on the Summary page, the User can review the Hullform page to determine which key sub-category for the ship type caused the zero value.

Pages 9-20 (Ship Type Pages)

These pages detail the ratings assigned to the inherent capability, and likelihood of a problem, for each sub-category, for a specific ship type. A short description of the rationale for these ratings is provided. Technical specialists, experienced in the design and analysis of high performance vehicles, have assigned these ratings. The ratings are believed to be consistent, although the developers recognize that other technical experts may disagree with an individual rating value. These values are protected and may not be changed by the user. Further information on the assignment of these ratings may be obtained from Band, Lavis and Associates, Severna Park, Maryland, by telephoning (410)-544-2800 or (301)-261-1030, or by e-mail at bla@cdicorp.com.