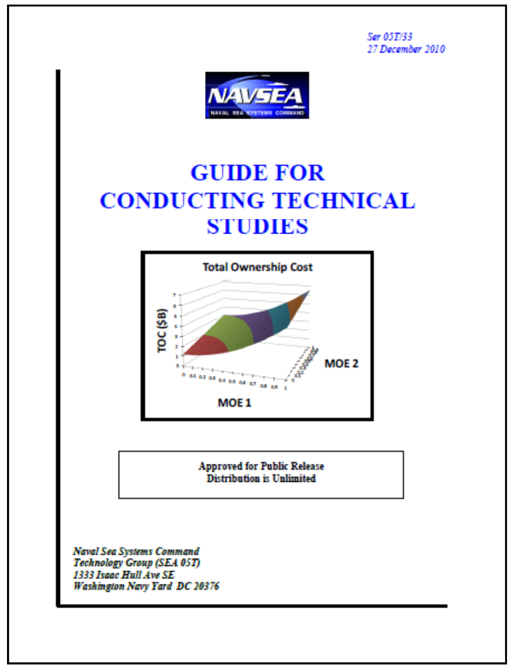
Conducting Technical Studies


Ser 05T/33
27 December 2010

GUIDE FOR
CONDUCTING TECHNICAL
STUDIES

Approved for Public Release
Distribution is Unlimited

Naval Sea Systems Command
Technology Group (SEA 05T)
1333 Isaac Hull Ave SE
Washington Navy Yard DC 20376

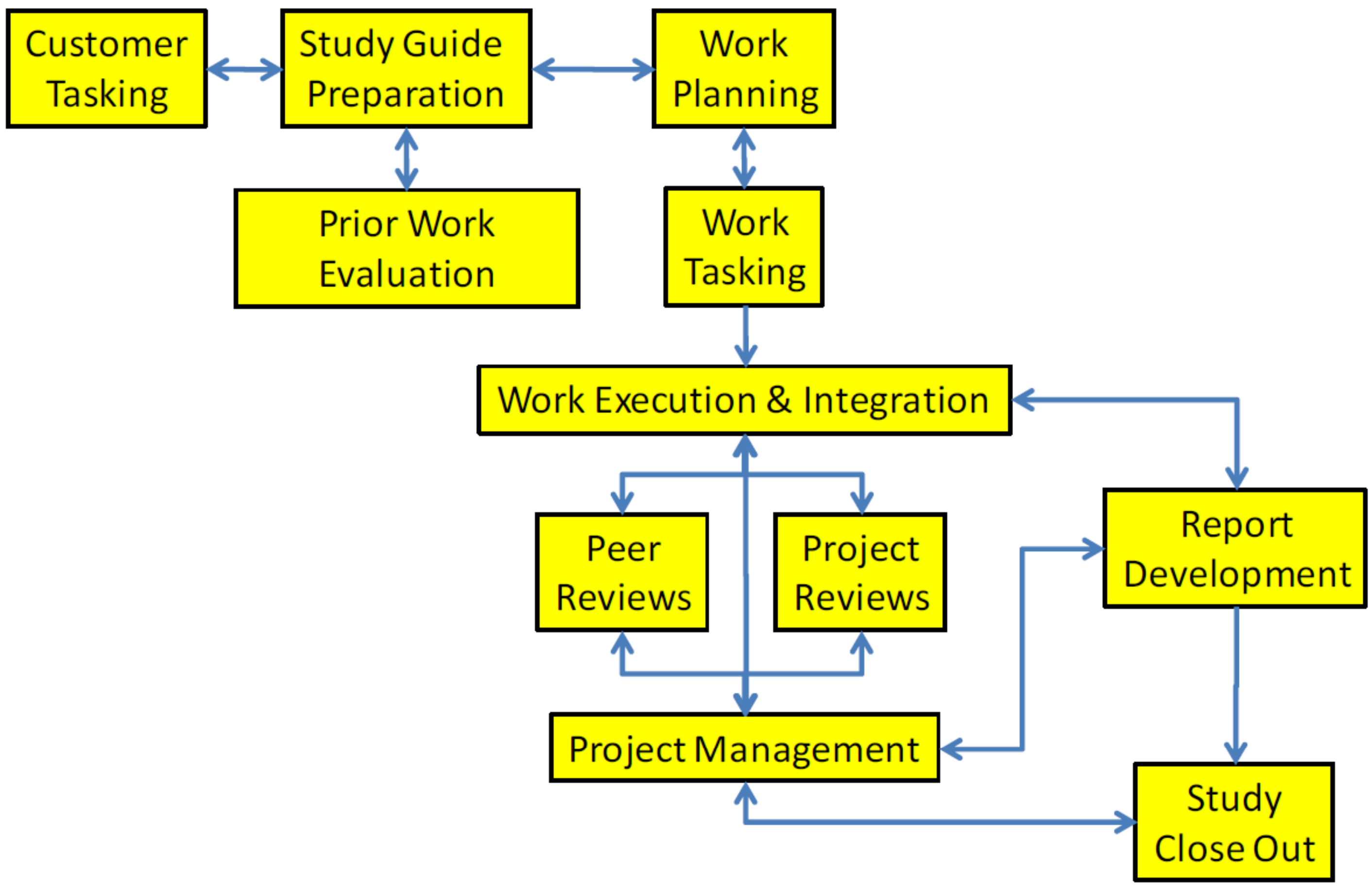
Dr. Norbert Doerry
Technical Director, SEA 05 Technology Group
SEA05TD

Approved for Public Release

Motivation

Good studies are relevant and facilitate good decisions

Process Overview



Technical Studies are both Technical and Social

Customer Tasking

- Can come in many ways ….
  - Formal Tasking Letter
  - Email
  - Hand written memo or sketch
  - Orally
- May or may not come with a source of funds
- Usually does not provide sufficient information to plan and execute a technical study

Need to spend time properly defining the problem

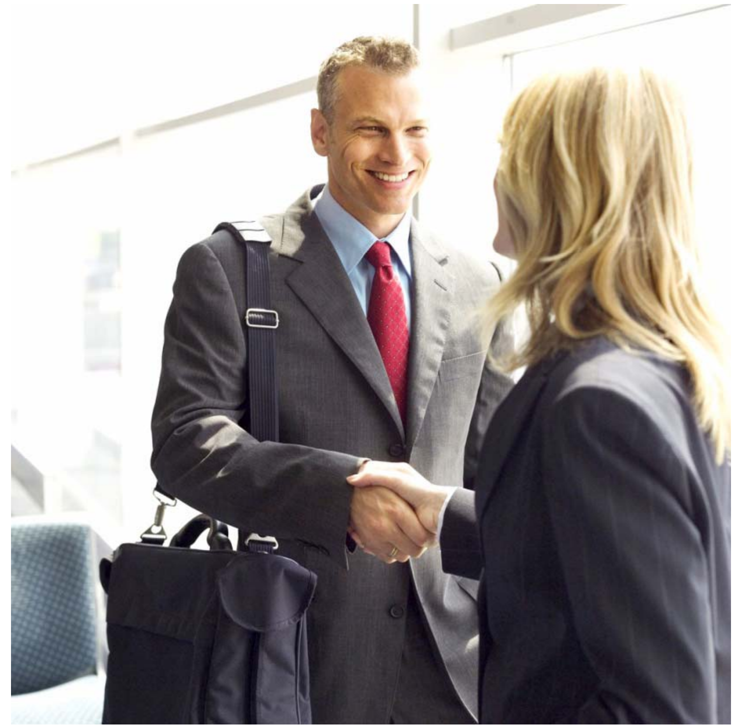
Study Guide “THE QUESTION”

- One or a few specific questions
  - If answered accurately ….
  - Will satisfy the customer
- Advantages of defining “THE QUESTION”
  - Focuses work to answer “THE QUESTION”
  - Enables conducting the study more quickly
    - Unneeded work eliminated
    - Speed improves relevance (Good Answers …. Fast!)
  - Enables discriminating between in-scope and new-scope work

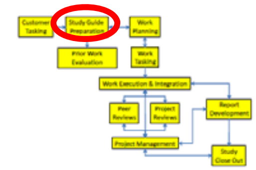
Getting “THE QUESTION” right is key to a good study

Study Guide Preparation

- Align study to Customer expectations
  - Define "THE QUESTION"
  - Identify general approach
  - Identify key participants
  - List key assumptions
  - List design and analysis tools and methods
  - Provide high level schedule
  - Document resource requirements
  - Identify deliverables
- Level of detail depends on magnitude of the study
- Must have stakeholder concurrence



Study Guide content is more important than format



Study Guide Guidelines

- Clearly articulate "THE QUESTION"
- Keep the objective in mind
- Understand what pieces are missing
- Dig to the right depth
- Parse the study into logical chunks (tasks)
- Highlight task relationships
- Be clear about who will do what
- Budget plenty of time for documentation

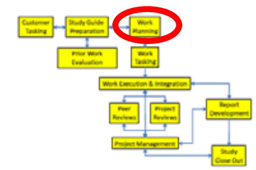
Define the path for answering "THE QUESTION"

Prior Work Evaluation

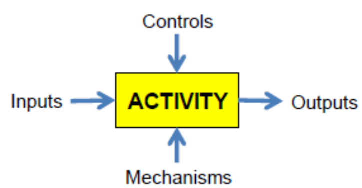
- Once you know "THE QUESTION" see if someone has already answered all or part of it.
- Where to go ….
  - Document Management Systems
  - Technical Libraries
  - Other Engineers
  - Web
    - Defense Technical Information Center (DTIC)
    - Professional Societies
- Aka Market Research
  - Department of Defense (DOD), "Market Research Gathering Information About Commercial Products and Services", SD-5, July 1997.

Customers like fast and cheap answers to "THE QUESTION"

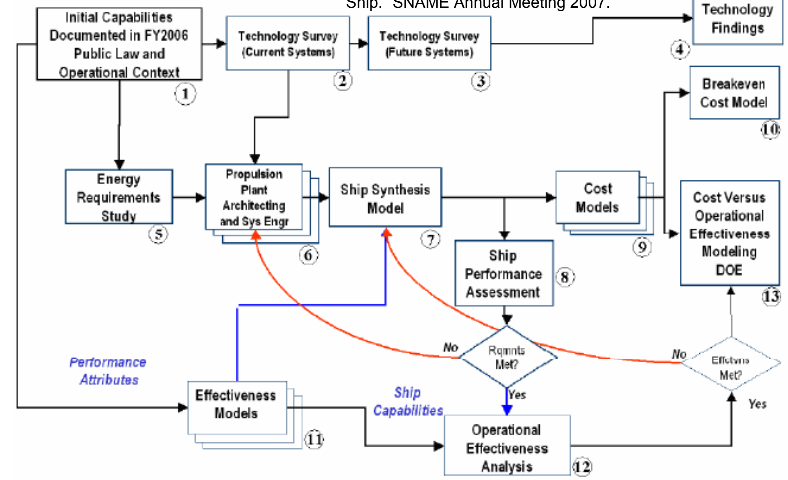
Work Planning (Defining the work)

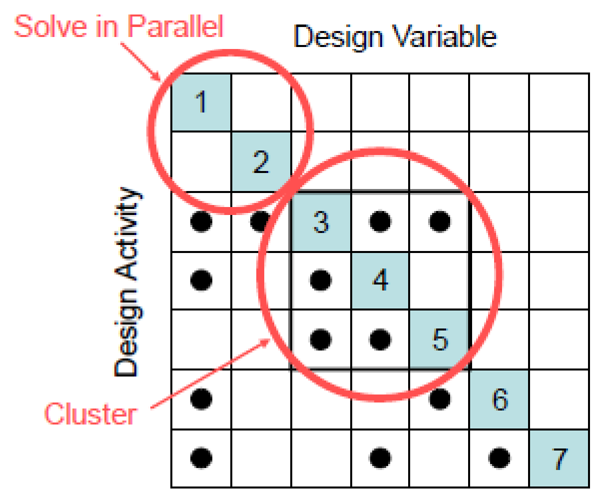


- Activity Modeling
  - Process Modeling
  - Design Structure Matrix
- Define Activities
  - Inputs
  - Outputs
  - Controls
  - Mechanisms
- Define activities …
  - To be accomplished by one organization
  - Using a defined process
  - And well defined artifacts for inputs and outputs

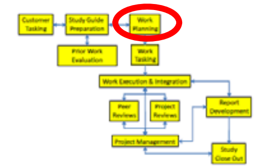


Webster, James S., Howard Fireman, Dillon A. Allen, Adrian J. Mackenna, and John C. Hootman, "Alternative Propulsion Methods for Surface Combatants and Amphibious Warfare Ship." SNAME Annual Meeting 2007.



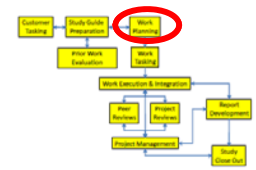


Work Planning (Cost & Schedule)

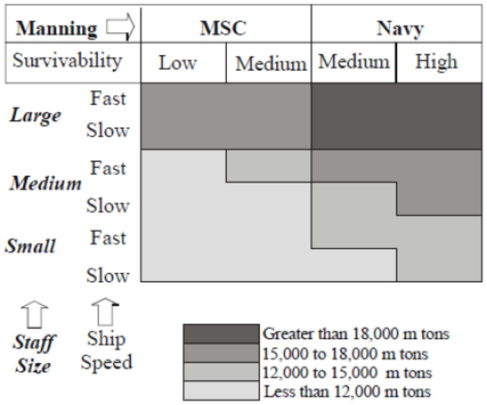


- Use the process model
- Considerations:
  - Part time work
  - Fully Burdened Cost
  - Iterations
  - Stakeholder involvement
  - Resource availability
  - New tools
  - Coordination meetings and reviews
  - Holidays and vacations
  - Contracting Process

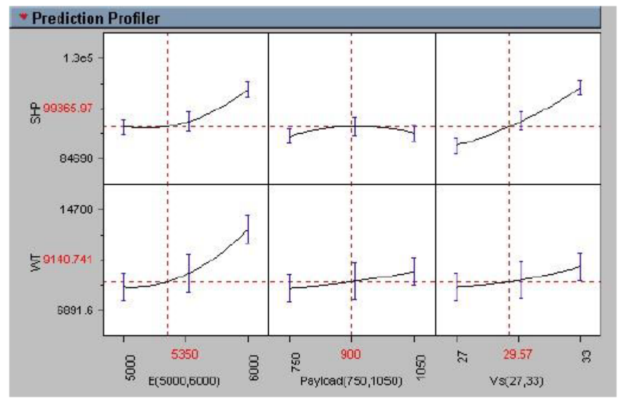
Work Planning (Study Techniques)

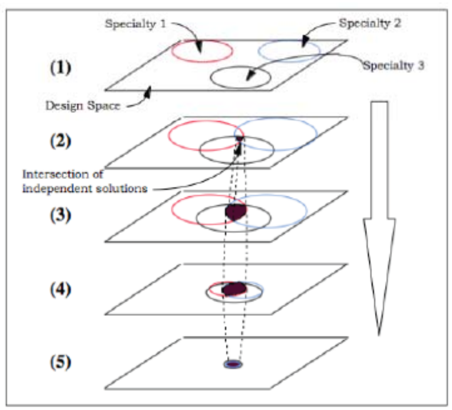


- Design Space Exploration & Design of Experiments
  - Systematically explore the trade-space
- Set Based Design
  - Systematically eliminate what is NOT the answer
  - Allows for semi-independent teams
- Decision Oriented Systems Engineering
  - Plan work to support the scheduling of decisions.

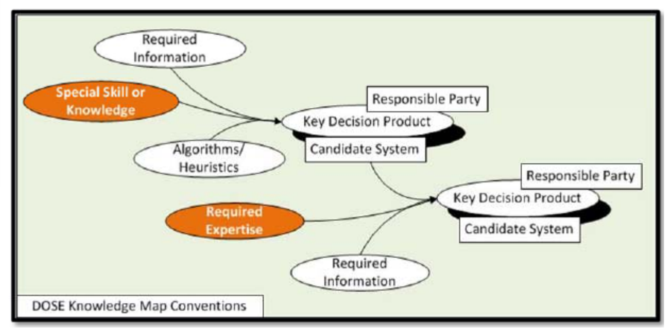


Whitcomb, Dr. Cliff, "Sea Connector Family and Seabase Architecture Systems Engineering and Systems Architecture," Presentation to Naval Postgraduate School SI4000 Fall AY2005, Project Seminar, October 21, 2004.



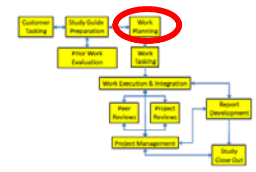


Bernstein, Joshua I. (1998), —Design Methods in the Aerospace Industry: Looking for Evidence of Set-Based Practices,‖ Master of Science Thesis, Massachusetts Institute of Technology, 1998.

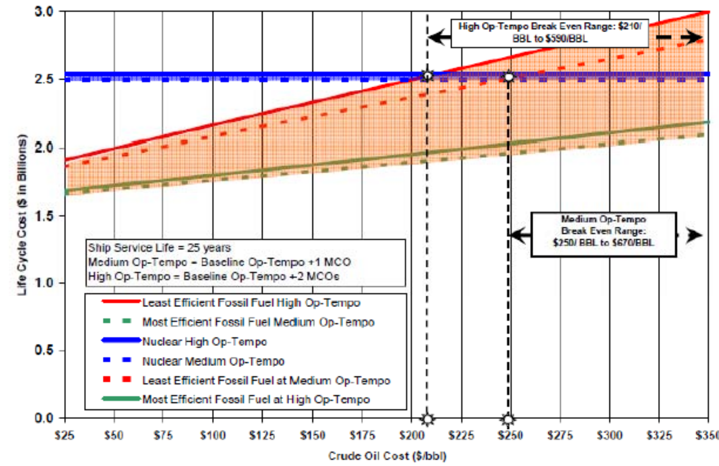


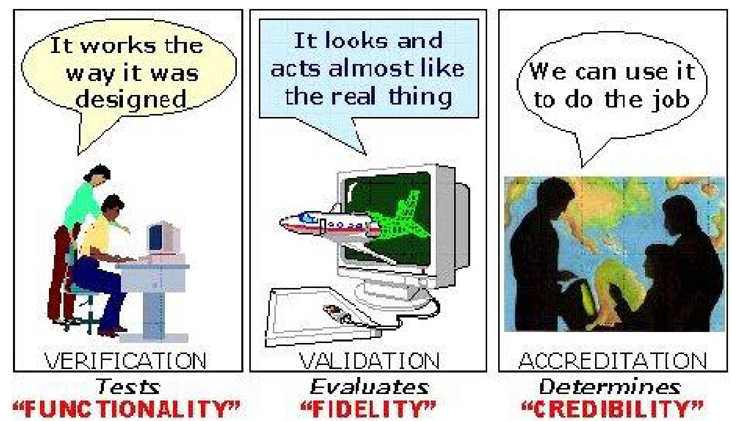
Buckley, Michael E. and Volker Stammnitz, —Decision Oriented Systems Engineering (DOSE) – A Structured, Systematic Approach to Function Allocation,‖ Proceedings of the 14th Annual International Symposium for INCOSE, 2004.

Work Planning (other considerations)

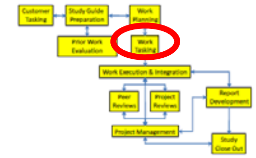


- Study Phasing
- Classified, Sensitive and Proprietary Data
- Dealing with Uncertainty
- Concept Cost Estimates
- Risk Evaluation and Readiness Metrics
- Data Certification
- Organizational Structure Considerations
- Dispersed Workforce
- Verification, Validation, and Accreditation
- Generalizing Results
- Intermediate Final Products

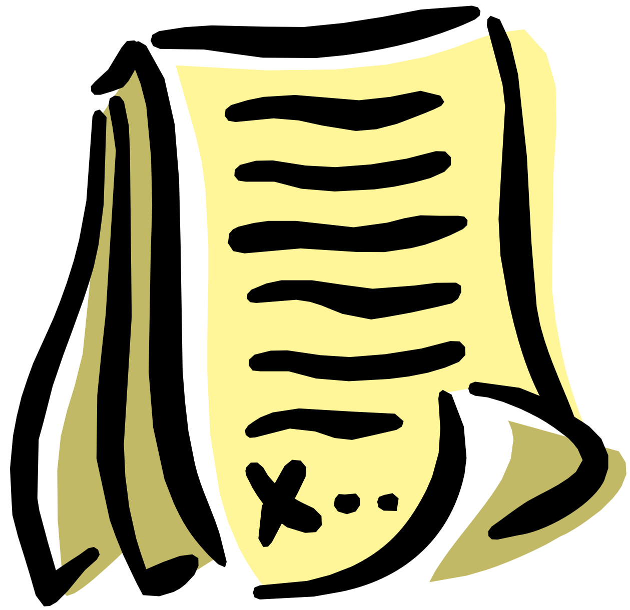




Work Tasking



- Multiple ways to fund participants
- Considerations
  - Activity definitions
  - Intellectual Property
  - Participation in integration meetings and peer & project reviews
  - Deliverables
  - Options



Work Execution & Integration

- Study Integration
  - Route information to and from study teams
  - Resolve issues
  - Ensure consistency in assumptions across teams
  - Find and fill gaps
- Study Guide Maintenance
  - No plan stays intact during execution

Peer Review

- Independent Technical Evaluation
  - Assumptions
  - Methods
  - Data
  - Results
- Midpoint Peer Review
  - Mid-course guidance correction
  - "Argue Early"
- 90% Peer Review
  - Identify critical issues before funding runs out
  - Help formulate generalized conclusions

Effective Peer Reviews enable completing studies on schedule

Project Review

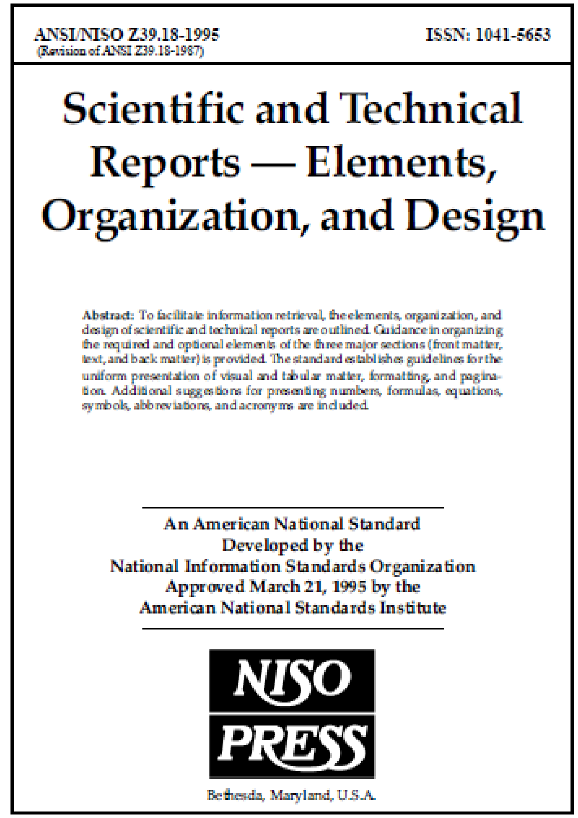
- Purpose
  - Communicate study plans, progress, issues and risks to customer and stakeholders
  - Ensure the customer and stakeholders buy into the process, assumptions, and by extension, the results
  - Make decisions or eliminate options
  - Aide in free-flow of information
  - Solicit ideas and feedback from outside the study team
- Typical timing
  - Kickoff Meeting
  - Midpoint review (optional for short studies)
  - 90% review

Project Management

- Cost Schedule and Performance
  - Track performance of study teams
  - Take corrective action as necessary
- Risk Management
  - Identify and mitigate risks associated with successfully completing the study
- Reporting and Metrics
  - Provide periodic feedback to management on status of study
- Growth within Scope
  - Carefully apply contingency resources to additional unplanned work needed to answer "THE QUESTION"
- Growth in Scope
  - Try to defer growth in scope (new QUESTIONS) to a follow on study

Report Development

- Formal Report Advantages
  - "Certified" via signature
  - Can be referenced (serialized)
  - Aide future studies
- Format
  - ANSI/NISO Z39.18-2005
  - Letter Report
  - Distribution Statements
  - ITAR statements
- Schedule
  - Start work on the report immediately after the kickoff meeting



ANSI/NISO Z39.18-1995 ISSN: 1041-5653
(Revision of ANSI Z39.18-1987)

Scientific and Technical Reports — Elements, Organization, and Design

Abstract: To facilitate information retrieval, the elements, organization, and design of scientific and technical reports are outlined. Guidance in organizing the required and optional elements of the three major sections (front matter, text, and back matter) is provided. The standard establishes guidelines for the uniform presentation of visual and tabular matter, formatting, and pagination. Additional suggestions for presenting numbers, formulas, equations, symbols, abbreviations, and acronyms are included.

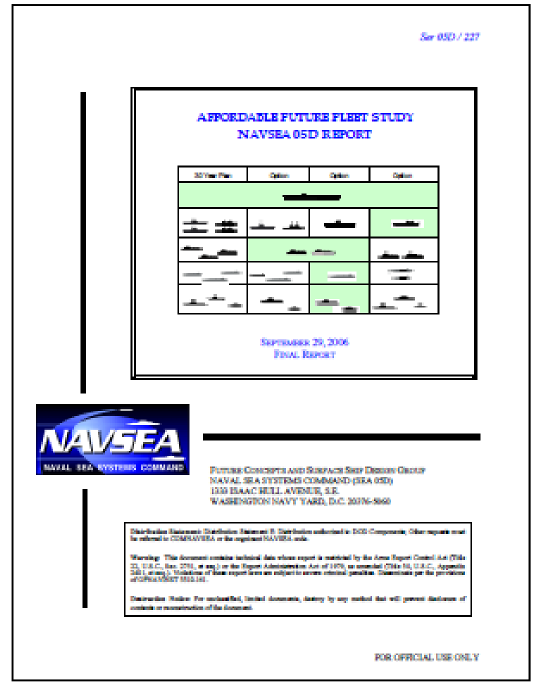
An American National Standard
Developed by the
National Information Standards Organization
Approved March 21, 1995 by the
American National Standards Institute

NISO PRESS
Bethesda, Maryland, U.S.A.

The Study Report usually represents the organization, not just the study team

Report Contents

- State and answer “THE QUESTION” in a one or two page Executive Summary.
- Identify the customer and articulate the subject context and importance
- Demonstrate the study results answer “THE QUESTION”
- List key assumptions
- Identify tools and methods used
- Include if applicable:
  - Technical and other Programmatic Risks
  - Insights gained and recommendations for further study
  - Assessment of risk of study methodology
- Consider including the Study Guide as an appendix or by reference.
- Consider including a “minority opinion” if applicable


Ser 05D / 227

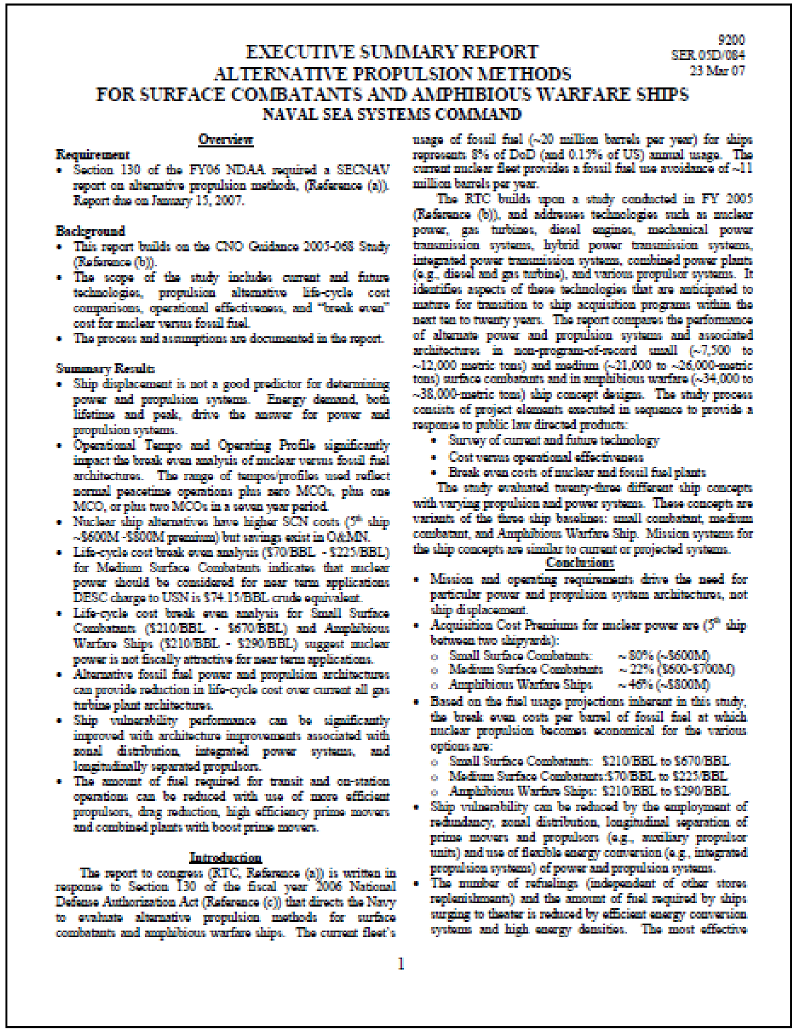
AFFORDABLE FUTURE FLEET STUDY
NAVSEA 05D REPORT

September 29, 2006
Final Report

FOR OFFICIAL USE ONLY

Study Close Out

- Formal review of the Study Report by stakeholders
  - Ensure conclusions are supported
  - Ensure "THE QUESTION" is adequately answered
- Presenting to the Customer
  - Consider using "Tufte-style" 4 page paper
  - Otherwise use PowerPoint
  - Seek feedback from the Customer



9200
SER 05D/084
23 Mar 07

EXECUTIVE SUMMARY REPORT
ALTERNATIVE PROPULSION METHODS
FOR SURFACE COMBATANTS AND AMPHIBIOUS WARFARE SHIPS
NAVAL SEA SYSTEMS COMMAND

Overview

Requirement
- Section 130 of the FY06 NDAA required a SECNAV report on alternative propulsion methods, (Reference (a)). Report due on January 15, 2007.

Background
- This report builds on the CNO Guidance 2005-068 Study (Reference (b)).
- The scope of the study includes current and future technologies, propulsion alternative life-cycle cost comparisons, operational effectiveness, and "break even" cost for nuclear versus fossil fuel.
- The process and assumptions are documented in the report.

Summary Results
- Ship displacement is not a good predictor for determining power and propulsion systems. Energy demand, both lifetime and peak, drive the answer for power and propulsion systems.
- Operational Tempo and Operating Profile significantly impact the break even analysis of nuclear versus fossil fuel architectures. The range of tempos/profiles used reflect normal peacetime operations plus zero MCOs, plus one MCO, or plus two MCOs in a seven year period.
- Nuclear ship alternatives have higher SCN costs (5th ship ~$600M -$800M premium) but savings exist in O&MN.
- Life-cycle cost break even analysis ($70/BBL - $225/BBL) for Medium Surface Combatants indicates that nuclear power should be considered for near term applications DESC charge to USN is $74.15/BBL crude equivalent.
- Life-cycle cost break even analysis for Small Surface Combatants ($210/BBL - $670/BBL) and Amphibious Warfare Ships ($210/BBL - $290/BBL) suggest nuclear power is not fiscally attractive for near term applications.
- Alternative fossil fuel power and propulsion architectures can provide reduction in life-cycle cost over current all gas turbine plant architectures.
- Ship vulnerability performance can be significantly improved with architecture improvements associated with zonal distribution, integrated power systems, and longitudinally separated propulsors.
- The amount of fuel required for transit and on-station operations can be reduced with use of more efficient propulsors, drag reduction, high efficiency prime movers and combined plants with boost prime movers.

Introduction

The report to congress (RTC, Reference (a)) is written in response to Section 130 of the fiscal year 2006 National Defense Authorization Act (Reference (c)) that directs the Navy to evaluate alternative propulsion methods for surface combatants and amphibious warfare ships. The current fleet's usage of fossil fuel (~20 million barrels per year) for ships represents 8% of DoD (and 0.15% of US) annual usage. The current nuclear fleet provides a fossil fuel use avoidance of ~11 million barrels per year.

The RTC builds upon a study conducted in FY 2005 (Reference (b)), and addresses technologies such as nuclear power, gas turbines, diesel engines, mechanical power transmission systems, hybrid power transmission systems, integrated power transmission systems, combined power plants (e.g., diesel and gas turbine), and various propulsor systems. It identifies aspects of these technologies that are anticipated to mature for transition to ship acquisition programs within the next ten to twenty years. The report compares the performance of alternate power and propulsion systems and associated architectures in non-program-of-record small (~7,500 to ~12,000 metric tons) and medium (~21,000 to ~26,000-metric tons) surface combatants and in amphibious warfare (~34,000 to ~38,000-metric tons) ship concept designs. The study process consists of project elements executed in sequence to provide a response to public law directed products:
- Survey of current and future technology
- Cost versus operational effectiveness
- Break even costs of nuclear and fossil fuel plants

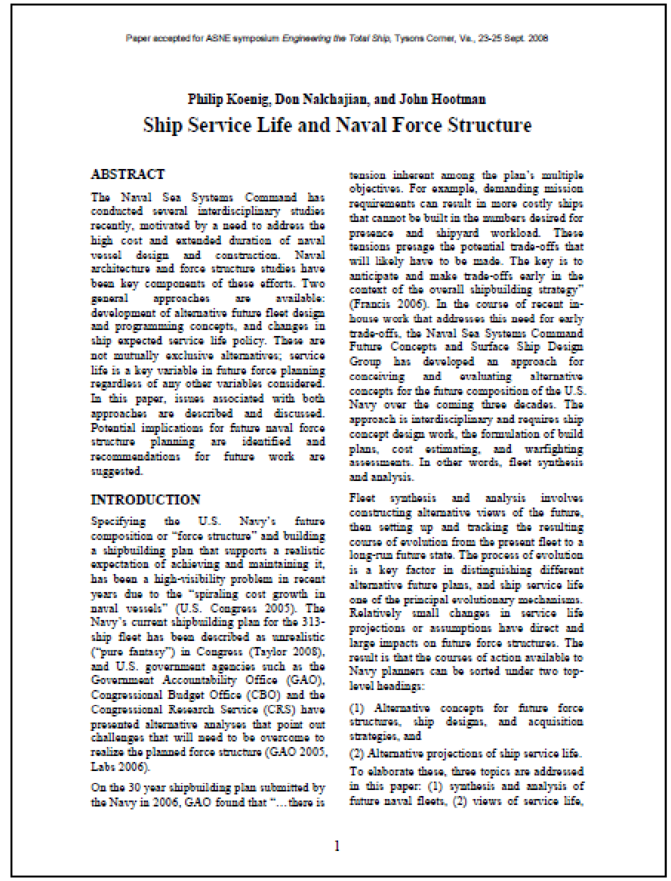
The study evaluated twenty-three different ship concepts with varying propulsion and power systems. These concepts are variants of the three ship baselines: small combatant, medium combatant, and Amphibious Warfare Ship. Mission systems for the ship concepts are similar to current or projected systems.

Conclusions
- Mission and operating requirements drive the need for particular power and propulsion system architectures, not ship displacement.
- Acquisition Cost Premiums for nuclear power are (5th ship between two shipyards):
  - Small Surface Combatants: ~ 80% (~$600M)
  - Medium Surface Combatants ~ 22% ($600-$700M)
  - Amphibious Warfare Ships ~ 46% (~$800M)
- Based on the fuel usage projections inherent in this study, the break even costs per barrel of fossil fuel at which nuclear propulsion becomes economical for the various options are:
  - Small Surface Combatants: $210/BBL to $670/BBL
  - Medium Surface Combatants:$70/BBL to $225/BBL
  - Amphibious Warfare Ships: $210/BBL to $290/BBL
- Ship vulnerability can be reduced by the employment of redundancy, zonal distribution, longitudinal separation of prime movers and propulsors (e.g., auxiliary propulsor units) and use of flexible energy conversion (e.g., integrated propulsion systems) of power and propulsion systems.
- The number of refuelings (independent of other stores replenishments) and the amount of fuel required by ships surging to theater is reduced by efficient energy conversion systems and high energy densities. The most effective

1

Study Close Out (continued)

- Dispositioning and archiving data
  - Retain and archive data for use …
    - as a reference for current / future questions or studies
    - in reproducing results
    - in presentations
    - by future historians
  - How
    - write memos / memos for the record
      - retain in Document Management Systems
    - submit documents to DTIC
    - present at conferences
    - publish in professional society journals.
- Lessons Learned
  - Consider capturing in a serialized memo to improve future studies and facilitate updating process documentation
  - Include feedback from the Customer



Paper accepted for ASNE symposium *Engineering the Total Ship*, Tysons Corner, Va., 23-25 Sept. 2008

Philip Koenig, Don Nalchajian, and John Hootman

Ship Service Life and Naval Force Structure

ABSTRACT

The Naval Sea Systems Command has conducted several interdisciplinary studies recently, motivated by a need to address the high cost and extended duration of naval vessel design and construction. Naval architecture and force structure studies have been key components of these efforts. Two general approaches are available: development of alternative future fleet design and programming concepts, and changes in ship expected service life policy. These are not mutually exclusive alternatives; service life is a key variable in future force planning regardless of any other variables considered. In this paper, issues associated with both approaches are described and discussed. Potential implications for future naval force structure planning are identified and recommendations for future work are suggested.

INTRODUCTION

Specifying the U.S. Navy's future composition or "force structure" and building a shipbuilding plan that supports a realistic expectation of achieving and maintaining it, has been a high-visibility problem in recent years due to the "spiraling cost growth in naval vessels" (U.S. Congress 2005). The Navy's current shipbuilding plan for the 313-ship fleet has been described as unrealistic ("pure fantasy") in Congress (Taylor 2008), and U.S. government agencies such as the Government Accountability Office (GAO), Congressional Budget Office (CBO) and the Congressional Research Service (CRS) have presented alternative analyses that point out challenges that will need to be overcome to realize the planned force structure (GAO 2005, Labs 2006).

On the 30 year shipbuilding plan submitted by the Navy in 2006, GAO found that "…there is tension inherent among the plan's multiple objectives. For example, demanding mission requirements can result in more costly ships that cannot be built in the numbers desired for presence and shipyard workload. These tensions presage the potential trade-offs that will likely have to be made. The key is to anticipate and make trade-offs early in the context of the overall shipbuilding strategy" (Francis 2006). In the course of recent in-house work that addresses this need for early trade-offs, the Naval Sea Systems Command Future Concepts and Surface Ship Design Group has developed an approach for conceiving and evaluating alternative concepts for the future composition of the U.S. Navy over the coming three decades. The approach is interdisciplinary and requires ship concept design work, the formulation of build plans, cost estimating, and warfighting assessments. In other words, fleet synthesis and analysis.

Fleet synthesis and analysis involves constructing alternative views of the future, then setting up and tracking the resulting course of evolution from the present fleet to a long-run future state. The process of evolution is a key factor in distinguishing different alternative future plans, and ship service life one of the principal evolutionary mechanisms. Relatively small changes in service life projections or assumptions have direct and large impacts on future force structures. The result is that the courses of action available to Navy planners can be sorted under two top-level headings:

(1) Alternative concepts for future force structures, ship designs, and acquisition strategies, and

(2) Alternative projections of ship service life.

To elaborate these, three topics are addressed in this paper: (1) synthesis and analysis of future naval fleets, (2) views of service life,

1

Summary

Customer Tasking		1								
	Prior Work Eval	1								
1	1	Study Guide Prep	1							
		1	Work Planning	1						
			1	Work Tasking						
				1	Work Execution & Integration	1	1	1	1	
					1	Peer Reviews		1		
					1		Project Reviews	1		
					1	1	1	Project Management	1	1
					1			1	Report Development	
								1	1	Study Closeout

Work Definition

Work Execution