



Ship Design Tool Roadmap

May 28, 2008

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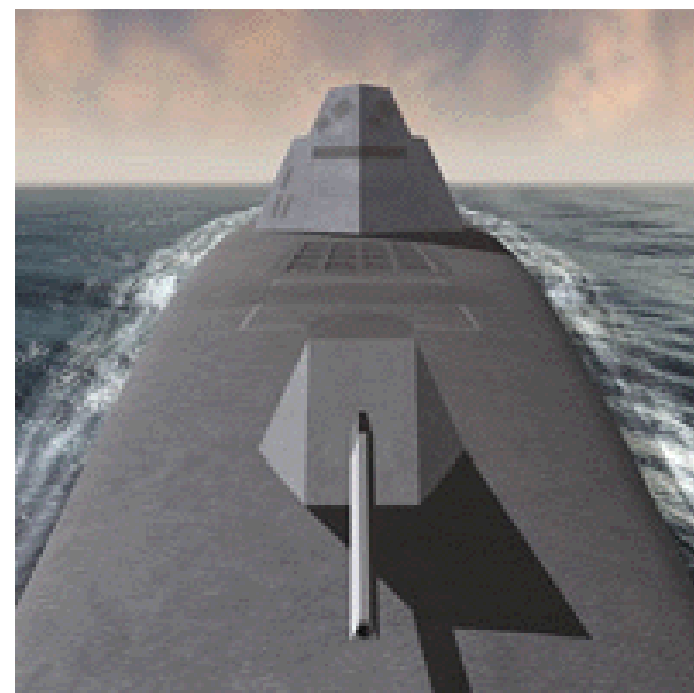
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Approved for Public Release



Agenda

- Motivation
- Track A Linkage
- Track B Linkage
- Track C Linkage





Where are we with Design Tools?

- Navy's Design Tool capability eroded significantly since the mid 1980s
 - 10+ years of minimal funding.
- Design Tool Management is decentralized and fragmented
 - Warrant Holder responsibilities
 - DADMS FAM responsibilities
 - Program Manager responsibilities
 - Program Offices have funded Industry to develop many tools
 - Ideally, these tools should be integrated into the Navy Design and Certification toolkit – transitioned to Navy custodianship
 - VV&A
 - Ship Design Manager responsibilities
- No centralized view of the health of our Design Tools
- Sources of Tool Development Funds
 - ONR (early development)
 - SEA 05 SETA
 - OSD CREATE
 - Ship Program Offices
- Many design tools incompatible with NMCI
- Design Tool Development timeline requires early investment when program dollars are not available.



Current Challenges

- Stages of Design declared complete based on schedule and not convergence of design
 - Completing activities in later stages can be very expensive
- Analysis not always timely
 - Too late to impact decisions
 - Analysis of outdated configuration
- Fidelity of analysis tools not always to level needed
- Architectures and designs not always robust to changes in requirements (that can be predicted)
 - Ships not meeting Expected Service Life
 - Expensive ECPs
- Inability to consistently predict effort and time needed to perform different stages of design
 - Do not have a good understanding of how long analysis should take during planning for a design stage
 - Do not have a good understanding of all the system interdependencies during planning for a design stage
- Cost Estimation
 - Pricing Risk and Uncertainty
 - Measuring and Pricing Complexity
 - Value of future flexibility (Real Options)
 - Understanding price causality vice price correlations
 - Pricing Non-recurring Engineering (NRE)
- Getting Tools and Processes ready in time for a ship design
- Design Processes and Tools not optimized for Set-Based Design



Motivation

COMNAVSEA Memo of 4 Feb 2008

8. My point of contact for assessing how well currently available tools meet our capability needs, and for coordinating efforts to alleviate shortfalls is Captain Norbert Doerry, Technical Director, Future Concepts and Surface Ship Design Group (NAVSEA 05DT). He will lead a team that includes the Office of Naval Research, Navy laboratories, and NAVSEA Technical Warrant Holders to draft a comprehensive Navy design tools development roadmap, with the objective of achieving the goals that I have set in this memorandum. A subset of this effort will be to document NAVSEA input to the CREATE program's ship design tool development requirements by the end of March 2008. He can be reached at (202) 781-2520 or norbert.doerry@navy.mil.



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REPLY TO

9000
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4 FEB 2008

From: Commander, Naval Sea Systems Command

Subj: SHIP DESIGN AND ANALYSIS TOOL GOALS

1. This memorandum establishes high-level capability goals for NAVSEA design synthesis and analysis tools in order to guide development efforts within the Navy and for the DoD sponsored CREATE (Computational Research and Engineering Acquisition Tools and Environments) program. Specific initiatives should be evaluated on the basis of how they contribute to achieving these goals. The targeted capabilities are aimed at specific phases of the Defense acquisition system.
2. During Joint Capabilities Integration and Development System (JCIDS) analyses prior to a Concept Decision, NAVSEA tools must inform Navy and Defense leadership on the entire trade space of ship and fleet architecture options. This requires the capability to generate and analyze hundreds of ship concepts to a rough order of magnitude level within a period of weeks or months. Synthesis tools must be compatible with Design of Experiments, Response Surface, and Set-Based Design methodologies. The analyses must accurately predict relative acquisition and life cycle costs; the impact of emerging technologies and threats; the effect of a ship concept's capabilities on the overall fleet architecture and the fleet capabilities; and the uncertainty of cost and performance predictions.
3. During the Concept Refinement Phase leading to Milestone A, NAVSEA needs tools to execute analyses of alternatives that accurately portray cost versus capability trade-offs, including uncertainty analysis, for dozens of ship concept options within a six-month period of performance. Technology risks must be defined in this phase to a level that facilitates mitigation planning, and all costs must be forecast with sufficient accuracy to develop a program budget and schedule with a known level of execution risk.
4. During the Technology Development Phase, NAVSEA needs tools for Preliminary and Contract Design efforts that allow for informed decisions on subsystem trade-offs, and for detailed



Ship Design Tool Roadmap Description

- Presents an integrated design tools architecture in the context of the ship design process.
 - A shared vision across multiple organizations.
- Evaluates our existing tools against that architecture, identifies gaps, and prioritizes those gaps.
- Guides tools development efforts of multiple organizations such as OSD, ONR, PEO-SHIPS, NAVSEA, academia and industry to ensure these independent efforts are coordinated and synergistic.
- Focuses initially on displacement mono-hull surface ships from early concept studies through Contract Design.
 - Future versions are anticipated to fully incorporate tools applicable to the other hull types and ship lifecycle stages.



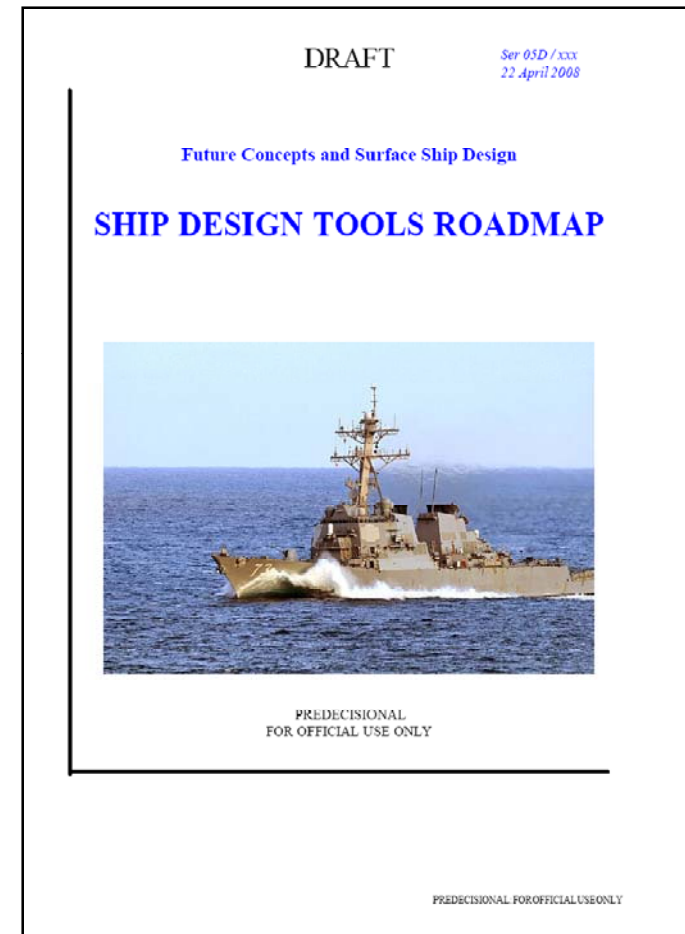
The Ship Design Tools Roadmap is NOT

- The roadmap is not an execution plan.
 - Each organization will conduct its own investment planning – ideally aligned with the roadmap.
- The roadmap is not a resource plan.
 - Each organization will conduct its own resource allocation and prioritization.
- The roadmap does not commit any participating organization to fund any particular activity.



Ship Design Tool Roadmap

- 1 Introduction / Background
- 2 The Role of Design Tools in the Ship Life Cycle
- 3 Ship Design Tools Life Cycle
- 4 Ship Design Tools Management
- 5 Ship Systems Engineering
- 6 Design Tools Characterization
- 7 Design Process Capability Measurement
- 8 Ship Program Demand for Tools
- 9 Design Tool Needs
- 10 Investment Priorities
- 11 Conclusions and Recommendations
- 12 Bibliography
- Appendix A: Tool Function Definitions
- Appendix B: Tool Data Exchange Definitions
- Appendix C: Tool Descriptions
- Appendix D: Design Tool Models
- Appendix E: Design Process Models
- Appendix F: Design Tool Interoperability with Standards
- Appendix G: Design Tool Integration with LEAPS
- Appendix H: Verification, Validation, and Accreditation
- Appendix I: Ship Design and Analysis Tool Goals





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 - Appendix H: Verification, Validation, and Accreditation
 - Appendix I: Ship Design and Analysis Tool Goals
- Establish Vision
- Describe Model
- Determine Gaps and Priority based on Need
- Supporting Information

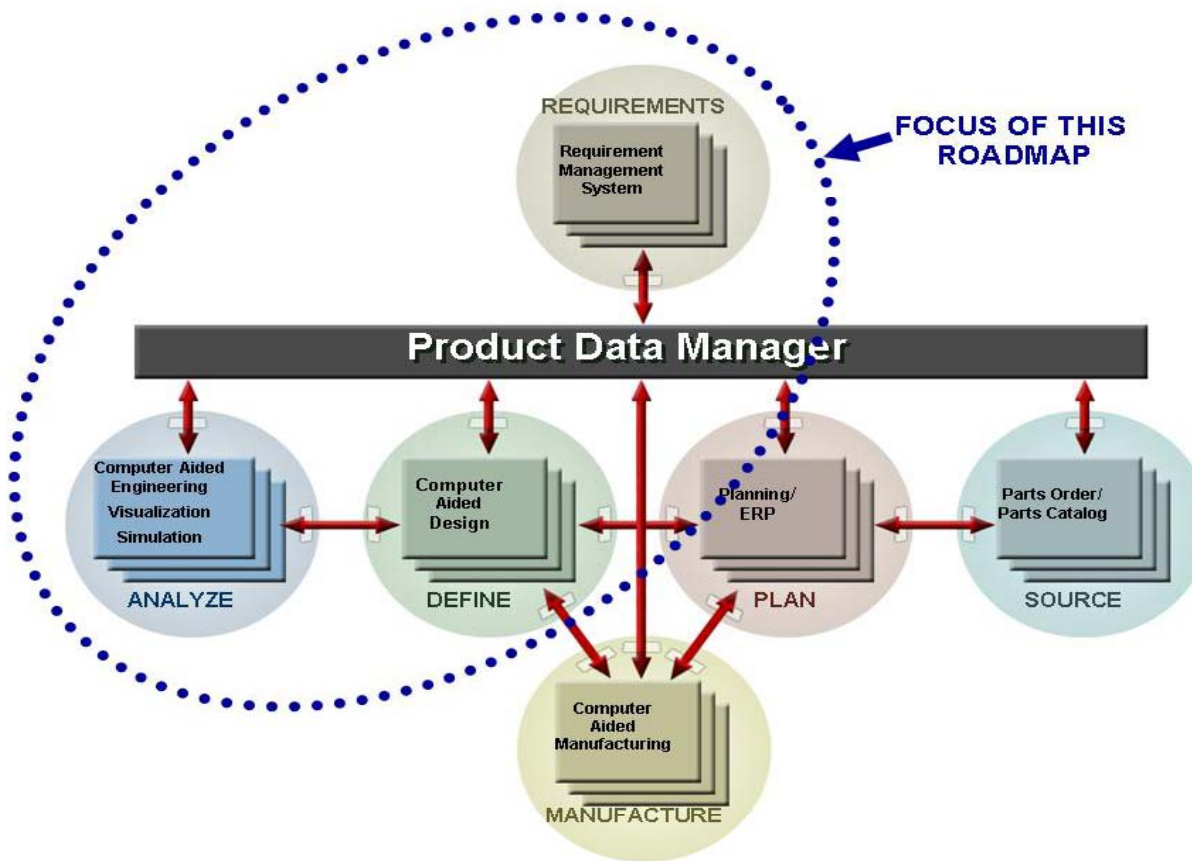


Track A Objectives

- Provide recommendations to the SHIP DESIGN TOOLS ROADMAP for achieving the SHIP DESIGN AND ANALYSIS TOOL GOALS articulated by COMNAVSEA memo of 4 Feb 2008
- Make specific recommendations for prioritizing, developing and transitioning tools and processes for use by the practicing ship design community within the next 10 years.

Design Process Reference Model Scope

The full range of ship development activity types is reflected in the following diagram with those primarily of interest to design engineers circled.





Modeling objectives of the Roadmap Team

- Assess NAVSEA's readiness (particularly from a design tools perspective) to conduct design using the current (historical) process
- Establish a baseline Design Process Reference Model (DPRM) providing quantitative information about the current process including how information is developed and flows and where engineering labor is applied
- Use metrics from the baseline Design Process Reference Model and insight into currently-available design technology to develop a Roadmap for the future.



Design Process Reference Model

Design Process Reference Model intended characteristics:

- Model information development and flow during design
- Model application of engineering labor during design
- Granularity coarse enough for human comprehension (eg < 1000 elements) yet adequately fine to provide process insight

Design Process Reference Model intended use:

- Capture current/historical process
- Identify capability gaps
- Use as design efforts planning aid for different future ship types
- Estimate cost/benefit of design process improvement investments
- Identify critical path for design development
- Use as point of departure for alternate design strategies



Design Tool / Process Transition

- Incorporate into standard process of the target engineering organizations
 - Prototype using the Center for Innovation in Ship Design (CISD)
- Train users in using the tool and integrating the tool into the design process
- Exercise the tool on a low-risk project
- Implement a problem reporting procedure

Tool Development

Academia
Government Labs
Industry



Tool Transition

CISD
Tool Developers
Tool Users



Tool Employment

SEA 05D
Support Contractors
Government Labs



Track B Objectives

- Recommend a business model.
 - Include a Governance Model.
 - Organizational Architecture.
- Recommend a model for funding and implementing VV&A.
- Recommend how to involve academia and industry.
- Identify opportunities to influence policy to enhance the ability to achieve the goals articulated in COMNAVSEA Memo of 4 Feb 2008.
- Identify and recommend policy changes associated with NMCI, HPC, DADMS, etc.



Possible Design Tools Governance Model

- A Design Tools Executive Steering Group (ESG) should be comprised of Flag/SES Stakeholders supported by Boards of Advisors in the individual critical technology/technical areas required to develop and maintain the three major Navy ship-types: Surface Ships (SEA 05D - PEO SHIPS), Aircraft Carriers (SEA 05V - PEO Carriers), Submarines (SEA 05U - PEO Subs). The ESG would be co-chaired by the Chief of Naval Research (CNR) and the NAVSEA Chief Engineer (CHENG) and comprised of SES/Flag representatives from:
 - ONR 33
 - SEA 05D, SEA 05U, SEA 05V
 - NSWCCD, NSWCDD, NUWC
 - OPNAV N85, OPNAV N86, OPNAV N87, OPNAV N88
 - PEO-SHIPS, PEO-CARRIERS, PEO-SUBS, PEO-IWS, PEO-LMW
 - ASN(RDA) CHENG
 - Chairs of each Board of Advisors
- The critical technology/technical Boards of Advisors would include:
 - Hydrodynamics (ONR, SEA 05Z, NSWCCD 50, FAM)
 - Materials, Structures and Survivability (ONR, SEA 05P, NSWCCD 60, FAM)
 - Machinery (ONR, SEA 05Z, NSWCCD 90, FAM)
 - Signatures (ONR, SEA 05T, NSWCCD 70, FAM)
 - Combat System Integration (ONR, SEA 05W, NSWCDD, FAM)
 - Human System Integration (ONR, SEA 05H, NSWCDD, FAM)
 - Cost (ONR, SEA 05C, NSWCCD 20, FAM)
 - Ship Design/Integration Tools (ONR, SEA 05DT, NSWCCD 20, FAM)

NAVAIR?
SPAWAR?

Very Complex ...
Is it workable?



Track C Objectives

- Unconstrained by the COMNAVSEA memo of 4 Feb 2008 or current acquisition policy, provide recommendations for a future requirements development process, ship design process and associated design tools for conducting design 10 to 50 years in the future.
 - Establish Stretch Goals
- Identify specific objectives for the future ship design process and associated design tools
- Identify areas of research for the next 5 years to support attainment of the recommended future processes.
- Make recommendations to the Ship Design Tools Roadmap for enabling an eventual transition to the recommended future processes.



Track C Thoughts

- Why do we have the current stages of design? Are the current stages of design serving our needs?
- What is the optimal content of design descriptions at the transition points between the different stages of design?
 - Specifications
 - CAD Product Models
 - Simulations
- In the early stages, should we model/analyze designs or specifications?
- How should requirements be derived and communicated between the customer and the ship design community?
 - How should requirements risk / market risk be evaluated and used in the context of design?
 - What is the best method for determining force / fleet requirements and allocating those requirements to individual acquisition programs?
- How can design be best used to mitigate cost and schedule risk?
- How can we change the design process to eliminate need for lengthy analysis?
 - Zonal Design.
 - Structured Distributed Systems.



Summary

- Design Tools have atrophied over the past decade.
- These workshops are an opportunity to establish and realize a vision for the future.
- Have Fun!

