A Better Basis
for Ship Acquisition Decisions
- Engineering a Solution
to Ship Acquisition Woes

Acquisition Research Symposium #8
Panel #18
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Attacking the Same Issues

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Naval Ship Acquisition Issues

Acquisition Research Program

Ship Design Community Initiatives

Navy Ship Acquisition…

…in the eyes of Congress [1]

"Our ships are simply too expensive."

and

"I believe the Navy needs to look very hard at their requirements process to determine if marginal extra capability is worth significant construction or integration costs."

[1] *The Honorable Gene Taylor (D-MS), Chairman of the Subcommittee on Seapower and Expeditionary Forces of the House Armed Services Committee on Shipbuilding Effectiveness, in his opening statement for hearings on July 30, 2009.*

Navy Ship Acquisition…

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…In the eyes of the Navy [2]

"Inarguably the underlying challenge – indeed, the pressing requirement – before us today in shipbuilding is affordability.

"The fact is that ship costs are rising faster than our topline, …. To this list I need also add performance, for on even our most mature programs, we have experienced cost growth as a result of performance shortfalls and quality escapes.

"The reality is that there is no single fix to turn around this trend, but rather a large number of initiatives, practices, and standards that we need to attack across the board."

[2] The Honorable Sean J. Stackley, Assistant Secretary of the Navy (Research, Development and Acquisition) and Vice Admiral Kevin M. McCoy, Commander, Naval Sea Systems Command, in prepared testimony for the Subcommittee on Seapower and Expeditionary Forces of the House Armed Services Committee on Shipbuilding Effectiveness on July 30, 2009.

Navy Ship Acquisition...

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...in the eyes of the Navy (cont) [2]

"We need to ensure that our requirements are balanced by our resources. .... The key here is to inform the process with realistic cost estimates and realistic risk assessments at the front end. This drives the difficult decisions early, where there are true choices, and true opportunities.

"....To meet these objectives, we must be smart buyers. The acquisition workforce has been downsized over the past decade and a half to the extent that our professional corps has been stretched too thin and we have outsourced too much of our core competencies. Accordingly, we must rebuild our Navy acquisition workforce."

Navy Ship Acquisition…

…in the eyes of the Defense Department [3]

- *"Many weapons systems are over-budget, late, and don't meet performance goals (e.g. GAO-06-391(March 2006)).*

- *"Lengthy and rigid acquisition process degrades ability to address rapidly changing irregular, catastrophic and disruptive threats.*

- *"Many of these problems can be traced to an ineffective design process.*

- *"Our present design tools are inadequate to produce an integrated design with few flaws."*

[3] Mr. Al Shaffer, Principal Deputy, Defense Research and Engineering, at the 2009 High Performance Computing (HPC) Modernization Program Users Group Conference, 17June 2009.

What were they thinking?!?

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They **thought** they knew the cost, performance, schedule and risk implications of their decisions.

In fact, *they did not*

Why not? - four Root Causes

- **Inexperienced ship design organizations**
- **Inexperienced ship design engineers**
- **Missing or inaccurate analysis software**
- **Missing or late analysis inputs**

The Design Challenge:
Precisely Balance a Host of Unknowns

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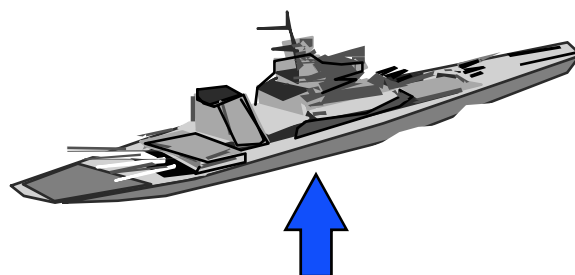
Mission Capability	>	Mission Requirement
Signatures	<	Threat Levels
Endurance	>	Mission Range & Duration
Area / Volume	>	Required Area / Volume
Buoyancy	>	Weight
Stability	>	Operating & Damage Conditions
Propulsion Power	>	Resistance
Power Production	>	Installed Loads
HVAC Capacity	>	HVAC Loads
Chilled Water Supply	>	Chilled Water Demand
Etc, Etc, Etc	>	Initial & Consequential Requirements

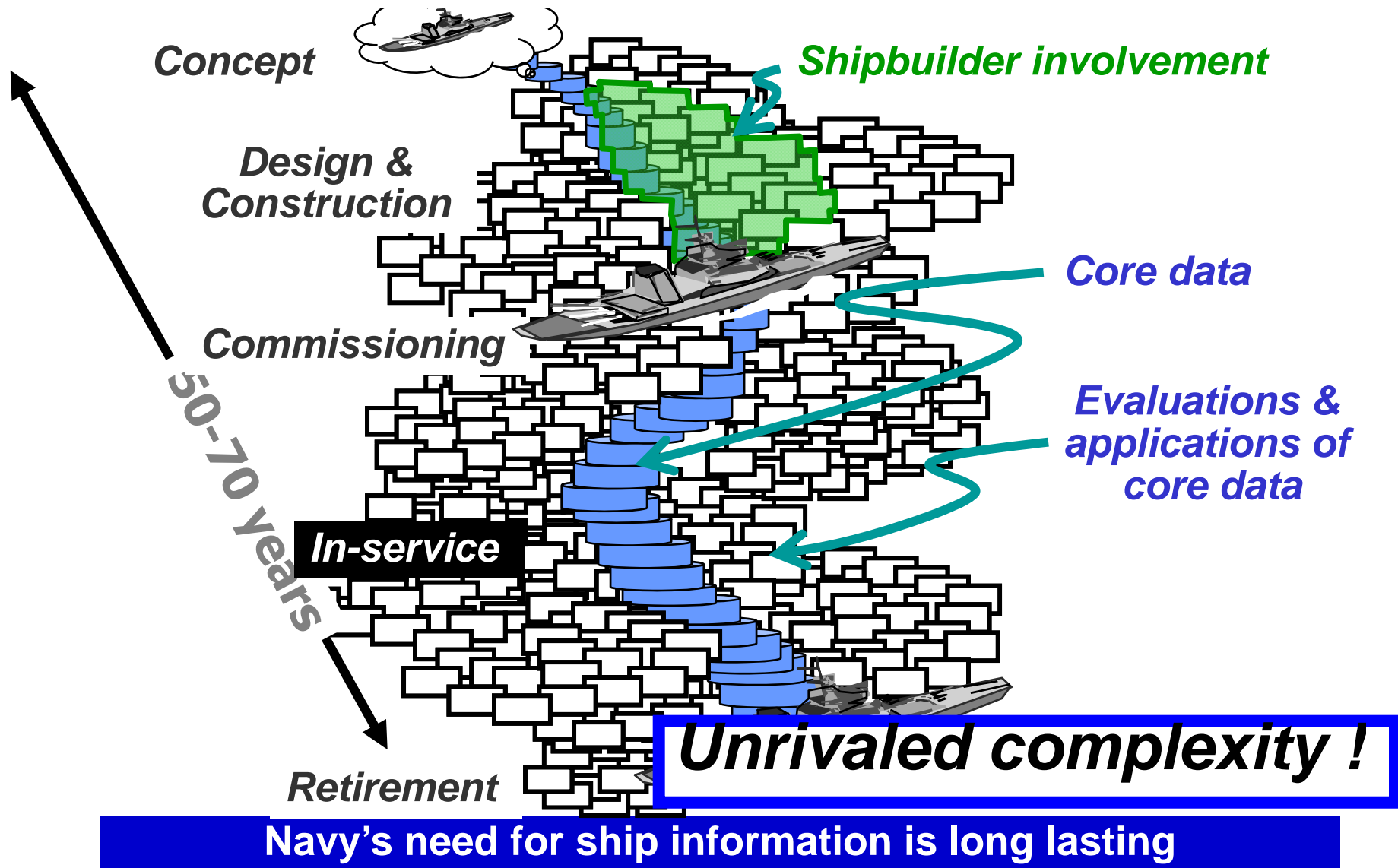**In the concept phase, the designer must correctly predict the sum of the parts before most of the parts are known!**

The Design Challenge:
Penultimate Product Complexity

- *Fluid-supported*
- *Self-contained*
- *Self-propelled*
- *Multi-mission*
- *Self-sustained*
- *System of Systems*
- *Parts count*
  - *100 x typical aircraft*
  - *1000 x typical plant*
  - *10,000 x typical vehicle*

Unrivaled complexity !

The Design Challenge:
Penultimate Process Complexity

LLC

Concept

Shipbuilder involvement

Design & Construction

Core data

Commissioning

Evaluations & applications of core data

50-70 years

In-service

Unrivaled complexity !

Retirement

Navy's need for ship information is long lasting

Root Cause #1
Inexperienced Ship Design Organizations

Since the advent of Acquisition Reform in the mid 1990's, every new ship design effort has been undertaken by a design organization formed specifically for that effort.

Stark contrast with successful approach for other complex challenges

Stark contrast with Navy's successful approach in the 70's, 80's and early 90's

Root Cause #2
Inexperienced Ship Design Engineers

Current problem with adverse demographics

Good initiatives to recruit raw talent

- **DoD SMART Scholarships**
- **ONR Naval Research Enterprise Intern Program (NREIP)**
- **NAVSEA/NSRP Engineering Education Consortium (NEEC)**
- **NAVSEA Naval Acquisition Intern Program**

One initiative to recruit raw talent and develop ship design engineers

- **ONR/NAVSEA/NSWC-CD Center for Innovation in Ship Design (CISD)**

No Navy "landing pad" for ship-design-oriented engineers

Root Cause #3
Missing or Inadequate Analysis Software

60 – 70% of ship design analysis areas have one or more of the following problems:

Evaluation software is of poor quality
- *poor algorithms inadequately represent underlying physical phenomena*
- *misleading user interface*
- *poor verification and/or validation*
- *application outside valid range*

Evaluation software is unavailable
- *new warfighting threats and/or technologies have emerged*
- *fundamental understanding of the physical phenomena involved is inadequate*
- *unconventional materials (eg, composites) have been introduced*
- *unconventional configurations (eg, multi-hulls, unprecedented electric power densities)*

13

Root Cause #4
Missing or Late Analysis Inputs

Even if quality analysis software is available, it does little good if timely and accurate input is not available. There is widespread need for

- More *rapid development* of candidate definition information

- More *rapid transfer* of definition information to analysis programs

- *Surrogate definition* from previous design efforts similar enough to the intended definition to support an estimate

- *Interoperability* within the design organization and with external contributors

Solution Vectors

	Solution Vectors	#1 – Inexp Design Orgs	#2 - Inexp Design Engrs	#3 - Poor Software	#4 - Poor Inputs
A	National Design Organization	O	O	O	O
B	Development of Design Engineers		O		
C	Mature Interim Design Products	O	O		O
D	Standard Components / Product Standards	O	O		O
E	Design Exercises	O	O		
F	Design Software Demand Signal			O	O
G	Integration and In-fill Software		O	O	O
H	Expedite Data Transfer	O			O

15

Sea Story 1 – When we <u>had</u> an NDO

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T-AGOS 19

- Urgent need – 1984 SURTASS arrays deployed in high latitudes – motions intolerable for operators & systems
- SWATH hull form of unprecedented size
- Weight critical
- High structural loads
- Strict self-generated noise requirement
- Accelerated development – 12 mo PD + CD (vs 12 mo PD + 12-18 mo CD)
- Shipbuilder participation in design
- Inexperienced builder won award (subsequently out of business)

Design accomplished IN STRIDE by experienced NDO
Resulting ship worked as-advertised & as-required by operators

Sea Story 2 – *When we <u>had</u> an NDO*

DDG 51

- PD / CD by NAVSEA-led team
- Complex multi-mission surface combatant
- Low signature design
- Cost limit
- Shipbuilder participation in design
- Externally-imposed size limit

Design accomplished IN STRIDE by experienced NDO although at greater expense ($26M) than any previous NAVSEA CD effort
62+ ship class

Sea Stories 3-6 – Since we eliminated our NDO

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DDG 1000 (aka Arsenal Ship, SC 21, DD 21, DDX)
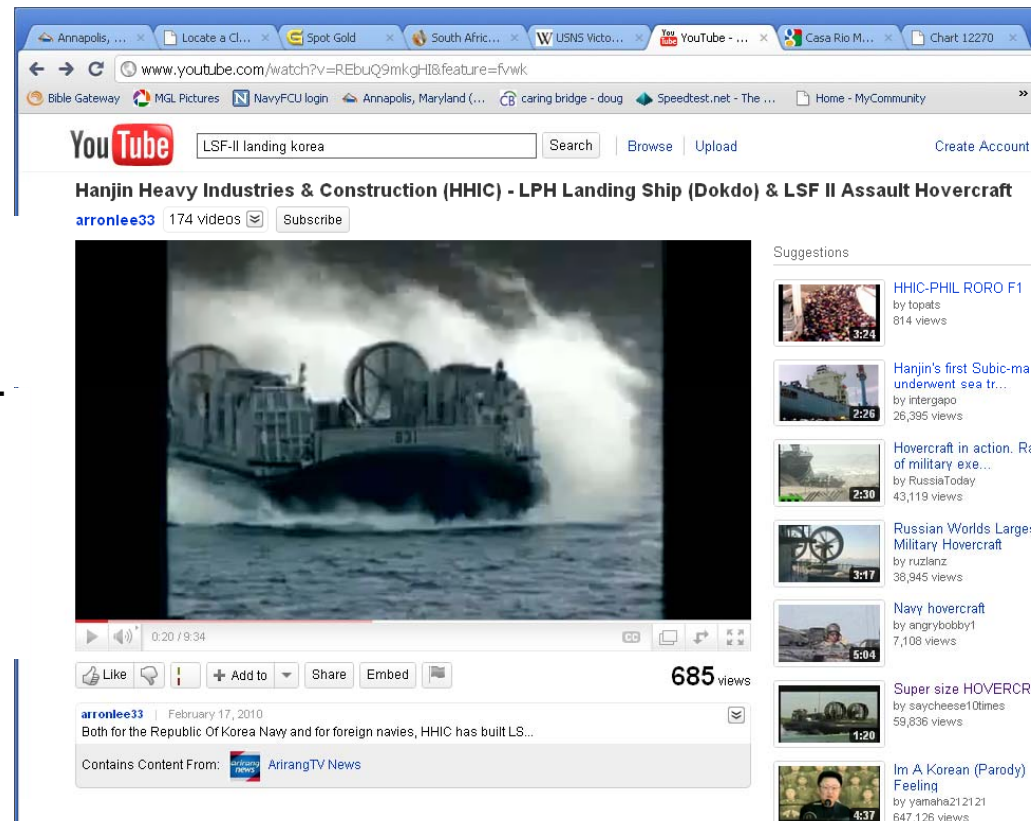
LCS 1

LCS 2

National Security Cutter

> **Designs accomplished by ad-hoc, rookie design organizations**

Sea Story 7 – art of the possible

LSF II Project (Korea)
Studies began in 2004 after
    experimentation with Russian-
    built ACVs and some
    experience with US LCACs
LSF 631 delivered in April 2007

Can we respond rapidly to emerging needs?

19

Solution Vector A
National Design Organization

Characteristics

- *Experienced, practiced and prepared in the organizational art of naval ship design.*
- *Able to provide quality cost, performance, schedule and risk estimates for decision makers.*
- *Able to provide sound designs swiftly in response to emerging needs*
- *Focused on the Navy as its customer*
- *Providing an enterprise resource for ship acquisition*
- *Process focused and oriented to continuous process improvement*

Roles of the NDO would include

- *Leadership of early stage design,*
- *Establishment of guidelines and engineering standards for all phases of design and service life support*
- *Focal point for fleet feedback.*

Solution Vector A
National Design Organization

Obstacles

- *The tyranny of the urgent*
- *Three year rotations*
- *Program-centric nature*
- *Perceived cost*
- *Over-reliance on acquisition process*

Sound Engineering is the Key to Success [for acquistion of complex systems] – RADM Wayne Meyer

"What's needed now is for Navy leadership to evaluate the alternatives, garner the required support, make a decision and move aggressively to implement the decision." – Pete Gale

Conclusions and Recommendations

Our Naval ship acquisition leaders *need and deserve* better estimates of cost, performance, schedule and risk at critical early-stage decision points

Eight relatively inexpensive *solution vectors* have been identified to provide better estimates

In particular the Navy should establish and sustain a *National Design Organization* with the requisite skill and experience to meet the design challenge

Acquisition Research Symposium participants should *strengthen ties with the ship design and engineering community* – many ASNE & SNAME events focus on similar issues