CONCEPT EXPLORATION LESSONS LEARNED

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Agenda

- Introduction
- New Ship Studies
- Modified Repeat / Conversion Studies
- Systems Engineering
- Future Research Opportunities

Introduction - What is JCC(X)?

- **Mobile, self-sustaining sea based battle management capability**
- **An in-theater command and control headquarters should land-based facilities become unavailable, constrained or threatened**
- **A replacement for existing maritime command and control ships**

Command Ships Today ... At A Glance

USS CORONADO
(AGF-11)

- 3rd Fleet, San Diego
- CREW: 25 OFF / 31 CPO & 389 ENL
- CJTF/MCC: 263 OFF/77 CPO & 420 ENL

USS MOUNT WHITNEY
(LCC-20)

- 2nd Fleet, Norfolk
- CREW: 42 OFF / 42 CPO & 605 ENL
- CJTF/MCC: 362 OFF/45 CPO & 321 ENL

COMFIFTHFLT COMPOUND BAHRAIN

- 5th Fleet, Bahrain
- Staff: 80 Off/110 ENL/20 CIV

USS LASALLE-
(AGF-3)

- 6th Fleet, Gaeta
- CREW: 24 OFF / 32 CPO & 404 ENL
- CJTF/MCC: 193 OFF/ 27 CPO & 365 ENL

USS BLUE RIDGE-
(LCC-19)

- 7th Fleet, Yokosuka
- CREW: 40 OFF / 44CPO & 650 ENL
- CJTF/MCC: 358 0FF/36 CPO & 499 ENL

What are the Required Capabilities?

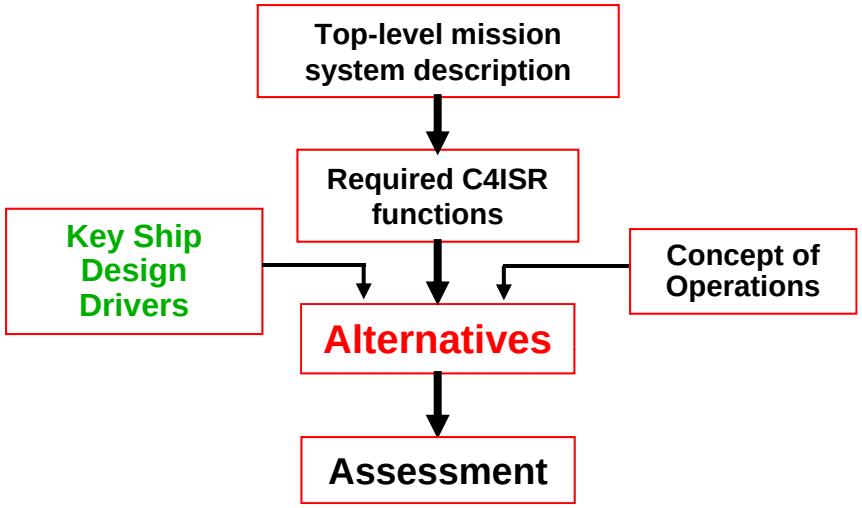
- **Capable of hosting an embarked Combined Joint Task Force (CJTF) Commander and component staffs**
  - **Hotel Services**
  - **Flexible Mission Space**
  - **Robust C4ISR Suite based on Commercial Off-The-Shelf (COTS) technology**
- **Mobile**
  - **Speed**
  - **Range**
- **Survivable**
- **Interoperable with Joint services, allied and coalition forces, and Non-Government Organizations (NGO) as needed**

Concept Exploration Activities

- **Conduct an Analysis of Alternatives**
  - **Find out what the product should do**
- **Develop Operational Requirements (ORD)**
  - **Precisely define user's expectations**
- **Develop Acquisition Documentation**
  - **Gain approval to proceed into development**
- **Develop System Requirements and Procurement Documentation**
  - **Includes P-SPEC, RFP, SOW, etc**
  - **Place next development stage under contract**
- **Develop Cost Estimates**
  - **Support Budgeting Process (PPBS)**

A ship design is no longer a product of Concept Exploration

Ship Studies
A tool for Developing Requirements



Key Ship Design Drivers

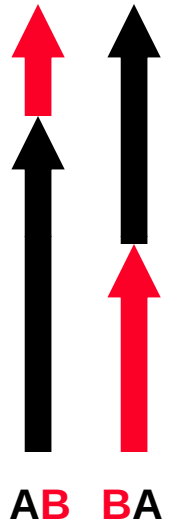
- Size of Staff
- MSC vs Navy Crew
- Survivability
- Speed

Alternatives

- Type of Platform
  - Ù New Design Ships
  - Ù Modified Repeats
  - Ù Conversions
  - Ù SLEPS
- C^2 Capability
  - Ù Dedicated Command Ship
  - Ù Part of a Distributed Option

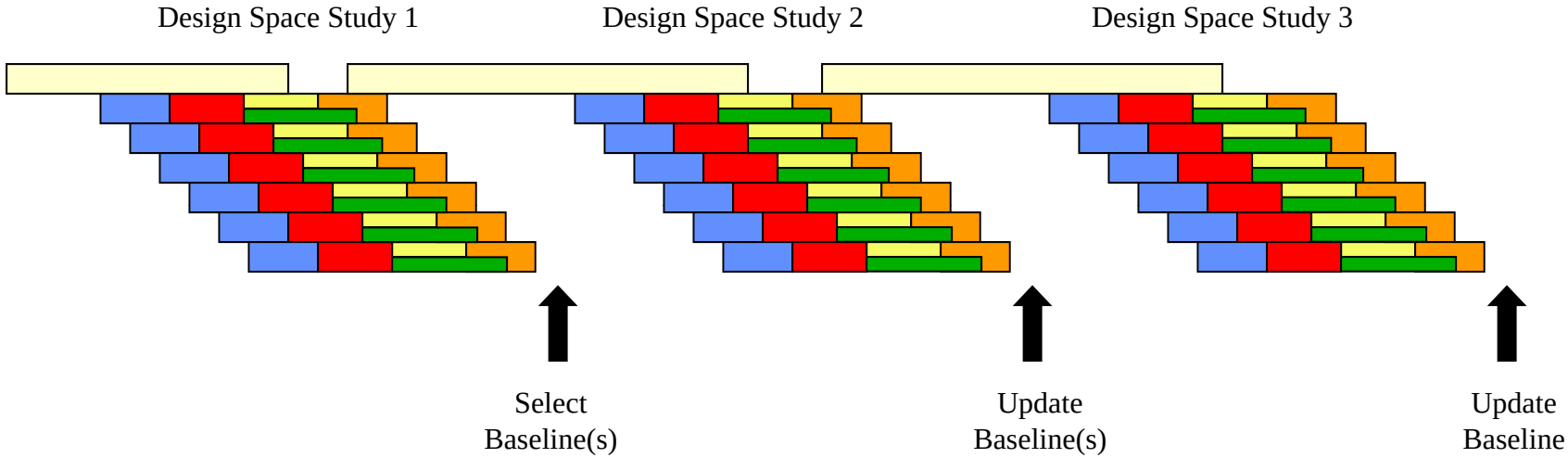
New Ship Studies - Design Space

- AOA is interested in Cost vs Capability
- The incremental cost of a particular capability depends on the order in which capabilities are added
- Averaging cost of adding a capability across multiple ship concepts provides a better metric
- JCC(X) new ship studies employed a systematic examination of the impact of design variables under study



Planning New Ship Studies

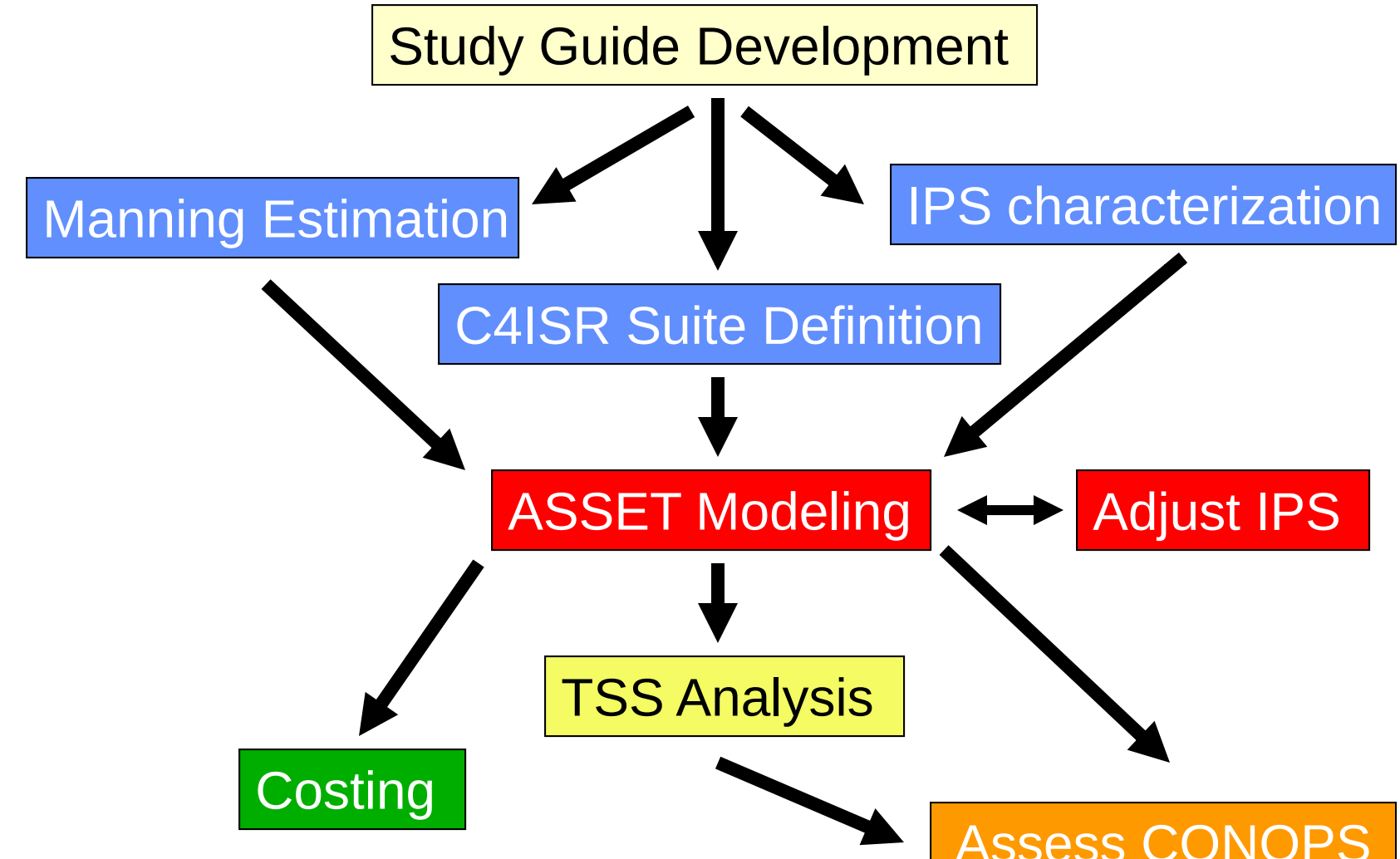
"Parallel - Serial Process"



Planning
Requirements
Design
Costing
Performance
CONOPS

"Classic" Design Spiral is too slow!

New Ship Concept Study



TSS = Total Ship Survivability IPS = Integrated Power System

Challenges in Comparing Ship Concepts

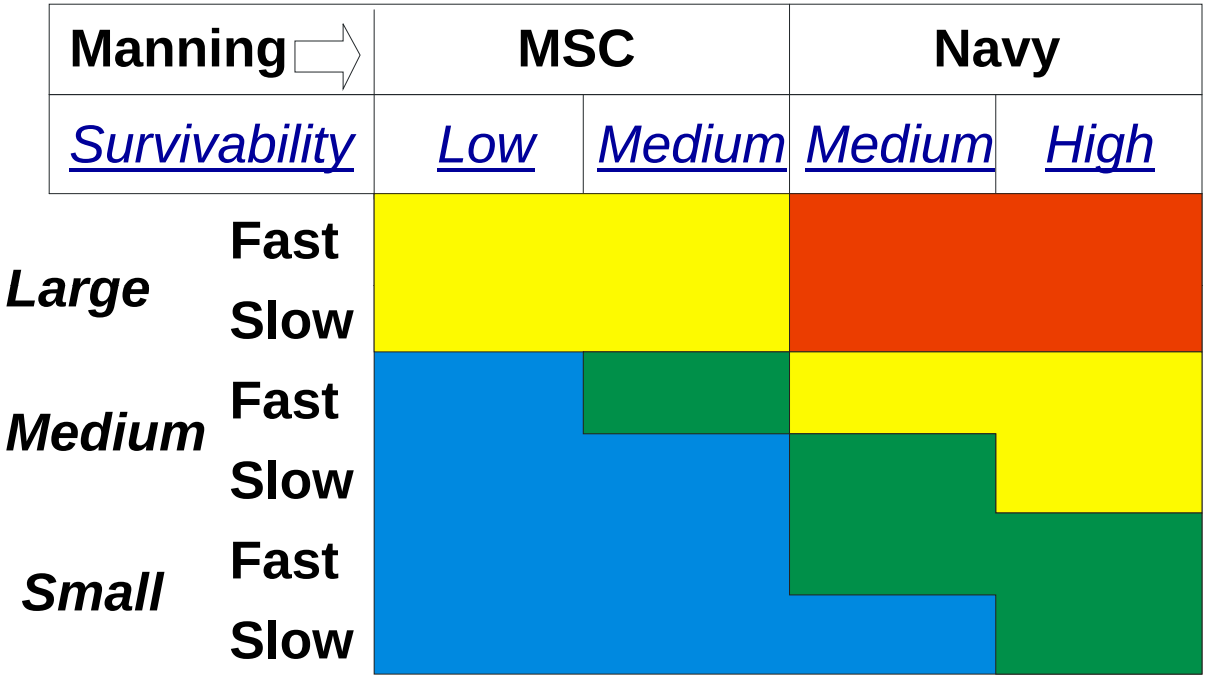
- **Changing Sets of Assumptions**
- **Naval Architects and the Learning Curve**
- **The "Artistic" component of Naval Architecture**
  - **Lack of Reproducible Results**
- **Synergistic effects of different feature sets**
- **Operator error**
- **Synthesis Tool bugs ...**
  (undocumented features)

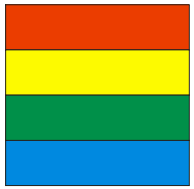
Need to Identify and Control Errors

Controlling Errors in Concept Comparisons

- **Develop Study Guides**
  - **Document Assumptions and Processes**
- **Limit impact of the Learning Curve**
  - **Conduct Studies in Blocks**
  - **Use the same design team**
- **Use “Design of Experiments” to define concept requirements and analyze results**
- **Automate comparison of synthesis tool (ASSET) results to identify anomalies**
- **Use regression analysis to identify potential discontinuities**

Presenting Results: Contour Maps



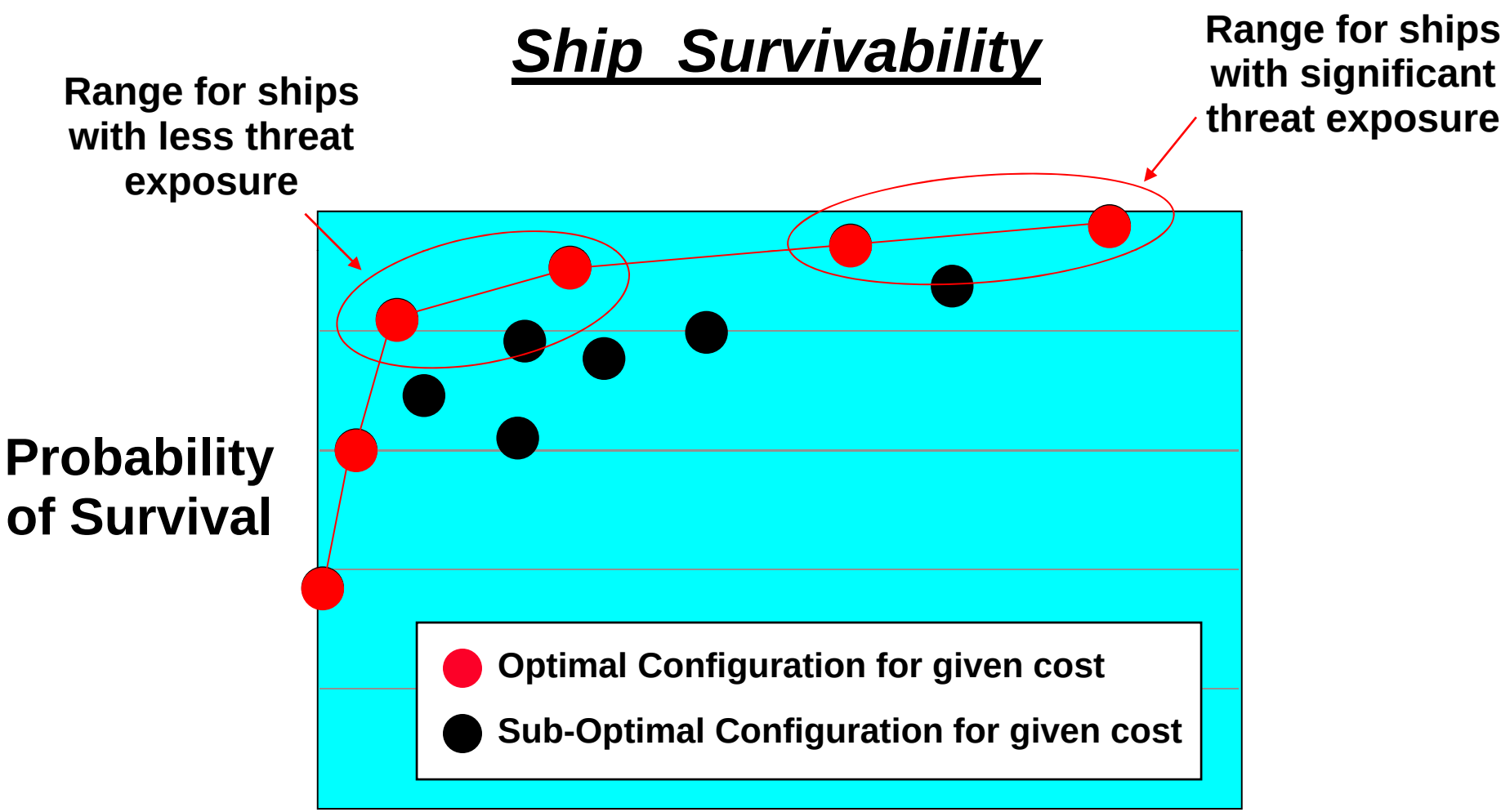


Greater than 18,000 m tons
15,000 to 18,000 m tons
12,000 to 15,000 m tons
Less than 12,000 m tons

Light Ship Displacement

Trends often more Important than Actual Values

Presenting Results: Cost Capability Curves



Modified Repeat / Conversion Studies

- **More Difficult than new design**
  - **Hard to obtain accurate technical data**
- **To keep study costs down ...**
  - **Eliminate less promising candidates using compelling arguments instead of modeling**
  - **Limit modeling to the minimum required to show cost effectiveness**
- **Modified Repeats are generally not cost effective if[1]:**
  - **The mission of the baseline ship is significantly different, or**
  - **More than two hulls are required**

JCC(X) studies showed that Modified Repeats and Conversions, while sometimes competitive, are not clearly more cost effective than new designs.

Note 1: Covich and Hammes, 1983

Conversion Example
Destroyer/Submarine Tender

Advantages

- Large Low Mileage Ships
- Technically Feasible
- 73% of light ship is “free”
  - Hull
  - Machinery
  - Electric plant

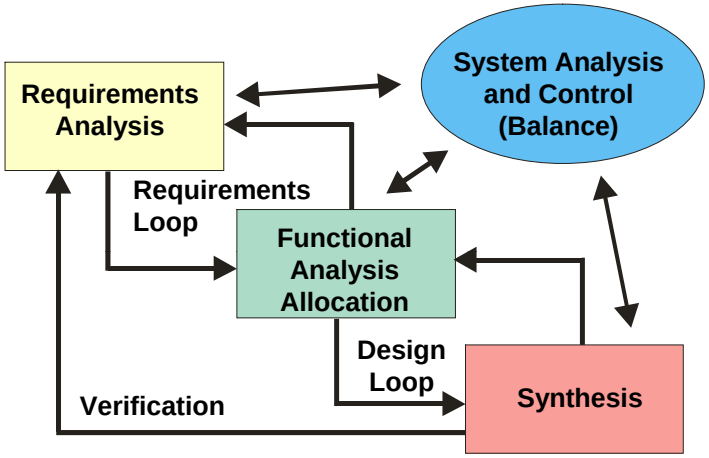
Disadvantages

- Precision scrapping of 27%
- New work is inefficient
  - Waterfront vice Shop
- Resulting ship unattractive
  - Poor Seakeeping
  - Single Screw Steam Plant
  - Low sustained speed (19 kts)
  - Forced Fit solution
  - 15 year old hull
  - Cost rivaling a new ship

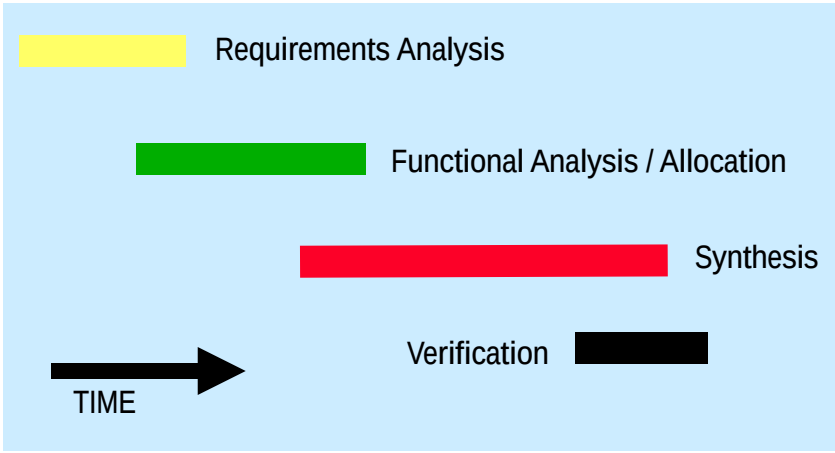
Study Based on Industrial Efficiency
Not on detailed ship modeling

Systems Engineering

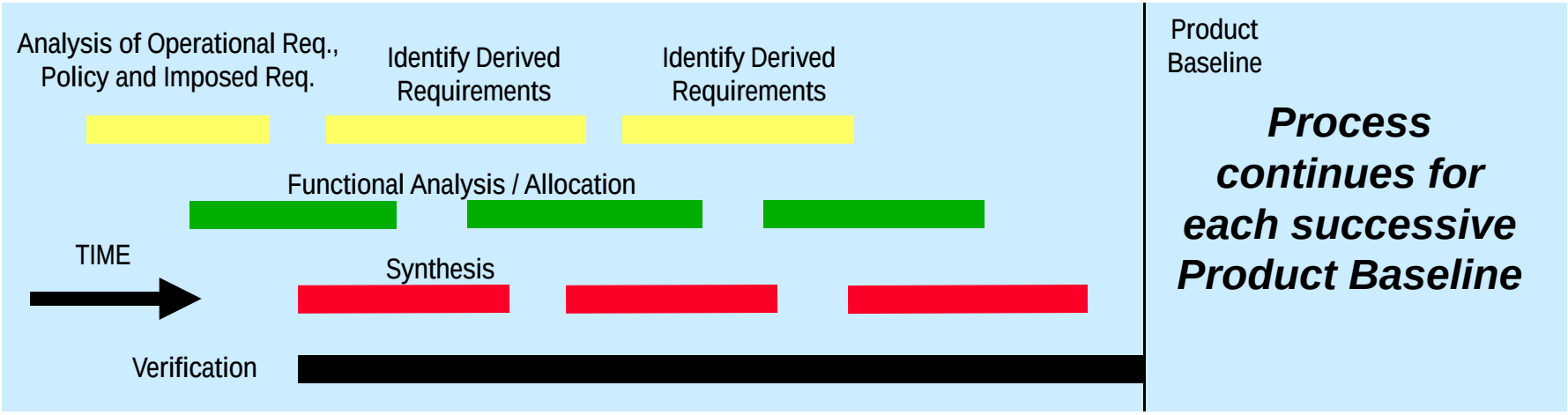
Classic Systems Engineering Process



Typical Interpretation



Actual Practice



Systems Engineering Observations

- Three types of Requirements
  - Direct - “owned” by the customer
    - ORD
    - Policy, Practices, and customs
  - Derived - “owned” by the designer
  - Imposed - come from external organizations
- Requirements Traceability Tools should:
  - Identify the type of requirement
  - Identify the source of the requirement
    - Direct - which document (ORD, Instruction, etc)
    - Derived - which configuration items
    - Imposed - which document (Law, standard, etc)

Need to know who has Change Authority for each Requirement

Future Research Opportunities

- **Experimental Design Tools**
  - **Need tools to identify which design tools should be used and how they link**
- **Genetic Algorithms**
  - **Eliminate "Learning Curve" to develop optimal configuration for each concept**
- **Error Analysis Tools and Procedures**
  - **Currently no way of knowing whether modeling errors are significant**
  - **Build error analysis into existing tools**
- **Requirements Risk Analysis**
  - **Identify Requirements that are likely to change and use risk management tools to address the problem**
    - **Margin Policy**
    - **Open Systems Architectures**