Ship Systems Automation

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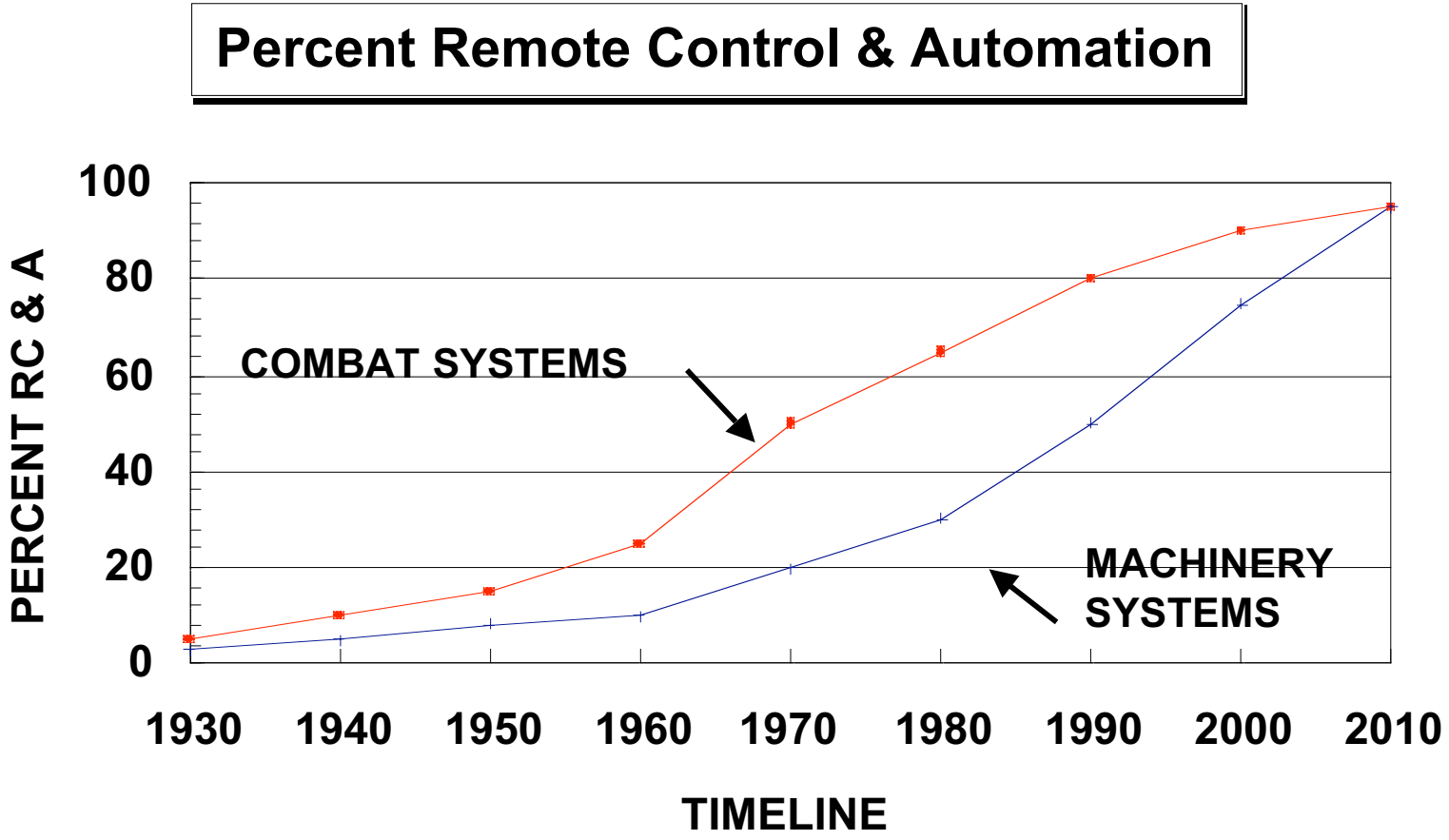
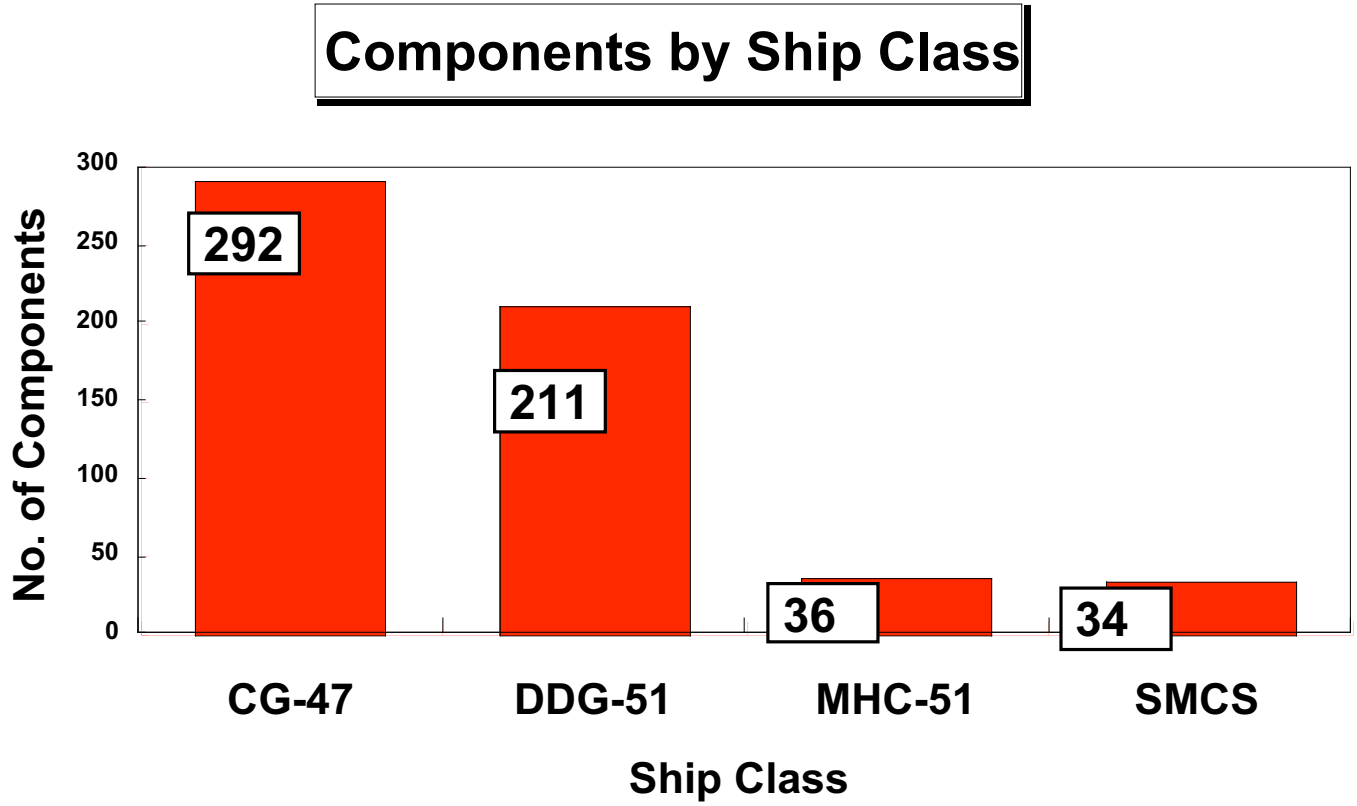
Note: This is a re-print of the original slide presentation given by the author, Joseph Famme, at the ASNE Intelligent Ship Symposium, Philadelphia, 1994. Mr. Famme is now president of ITE Inc., www.ITEinc.US, jfamme@ITEinc.US.

Automation


Percent Remote Control & Automation
PERCENT RC & A
100
80
60
40
20
0
COMBAT SYSTEMS
MACHINERY SYSTEMS
1930
1940
1950
1960
1970
1980
1990
2000
2010
TIMELINE

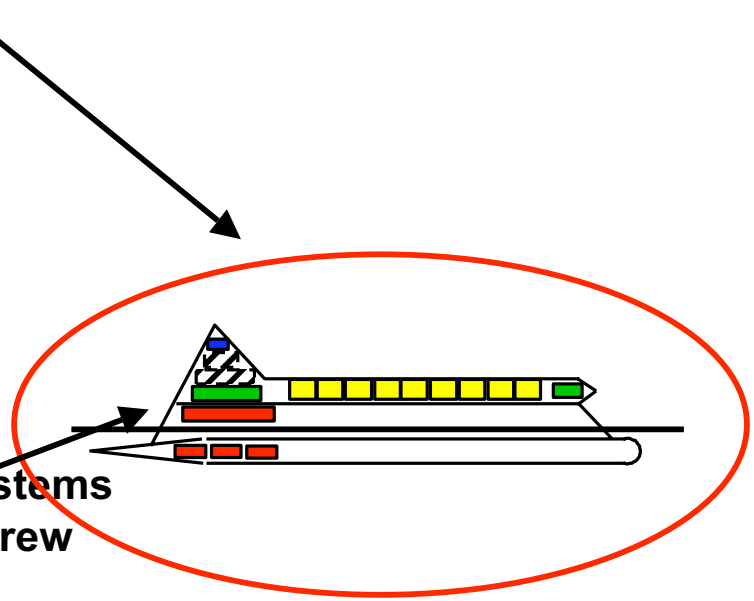
Technology Leverage

- Improve performance and survivability,
- Reduce costs: acquisition, training and maintenance



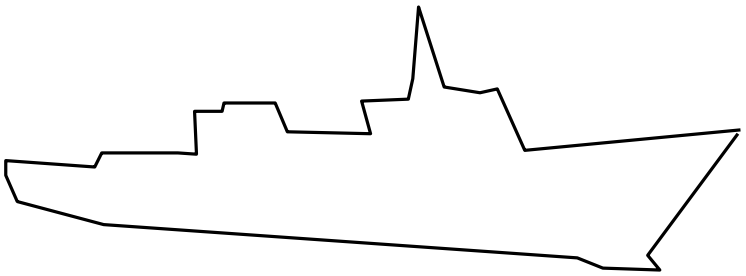
Operating Environment

- **External operating environment:**
  - **weather**
  - **sea state**
  - **ocean acoustics**
  - **water depth and bottom type**
  - **navigation hazards**
  - **shipping**
  - **enemy threats**
- **Internal operating environment:**
  - **readiness of vital & non-vital systems**
  - **readiness and alertness of the crew**
  - **automation doctrine in force**
  - **logistics readiness**

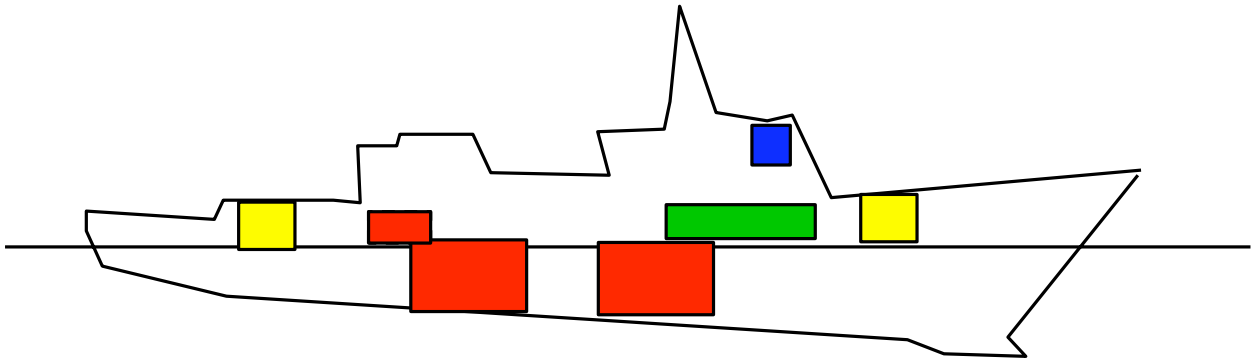


Warfighting Requirements

- **Ship Operational Characteristics Study 1988**
- **Twelve Imperative Characteristics. Five Apply to HME & DC:**
  - **Integrated machinery systems**
  - **Survivability & the ability to fight hurt**
  - **Embedded readiness assessment, mission planning & training**
  - **Condition-based maintenance**
  - **Collocation of ship control and CIC**

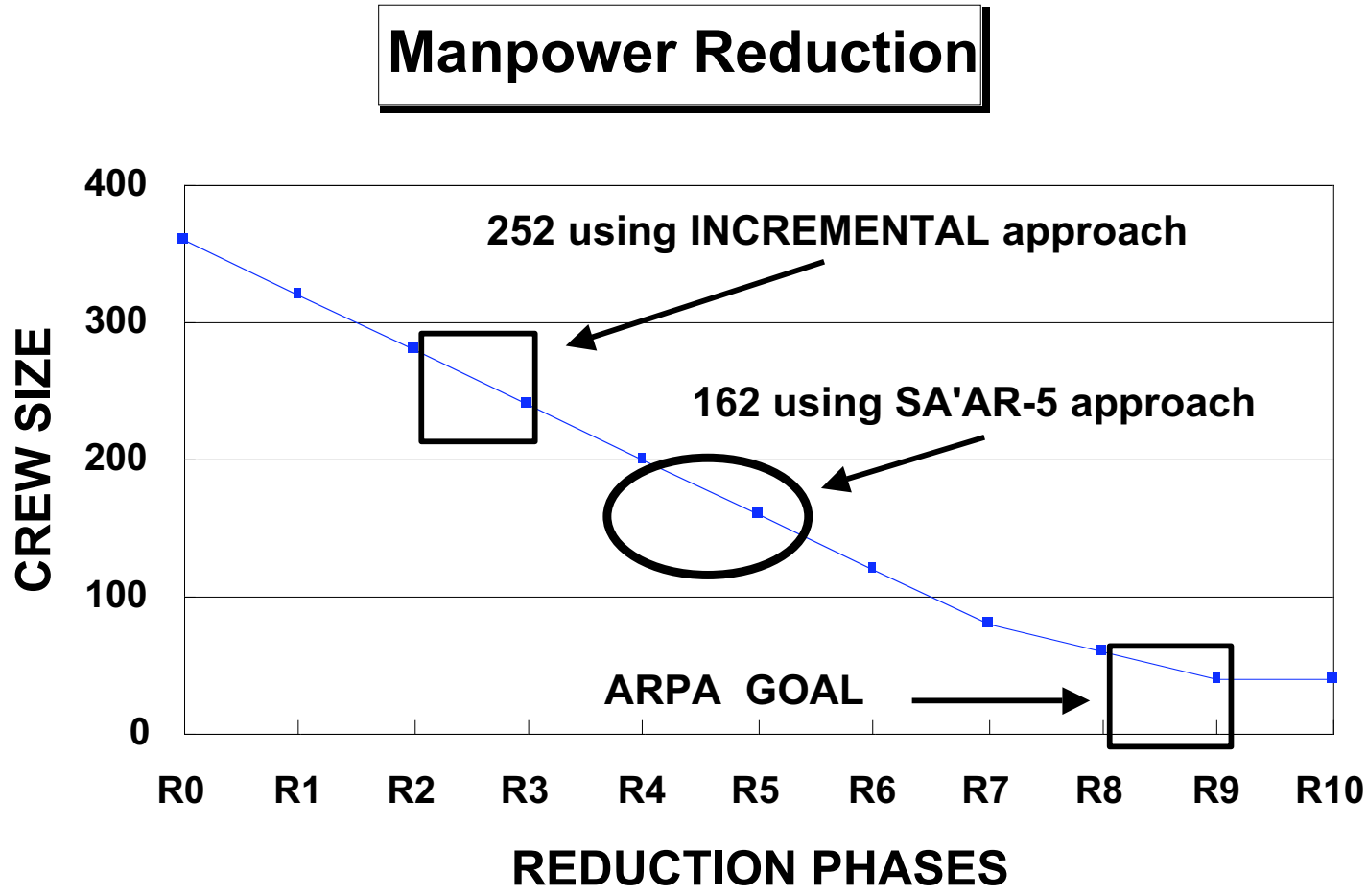


Notional Conventional



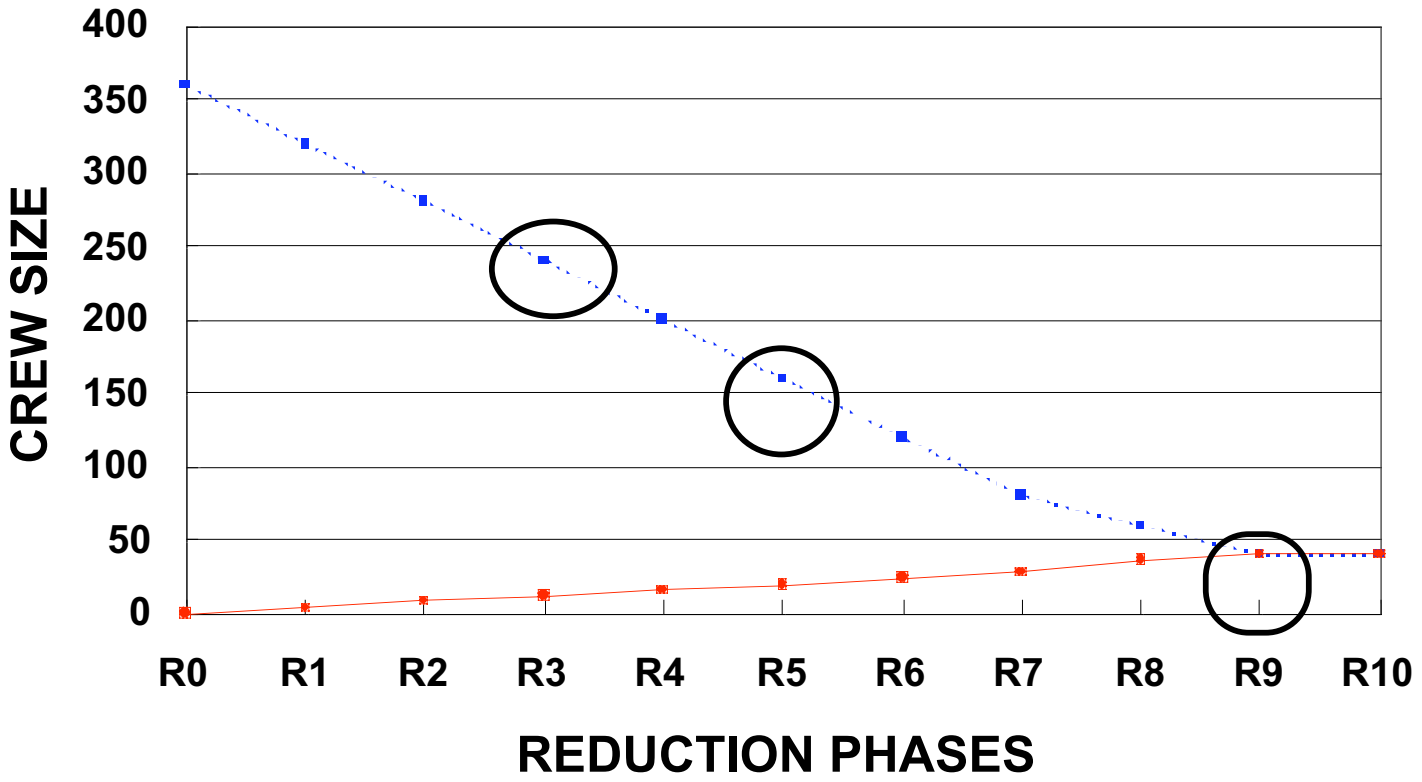
CREW 360, MISSILES 120

Incremental Approach

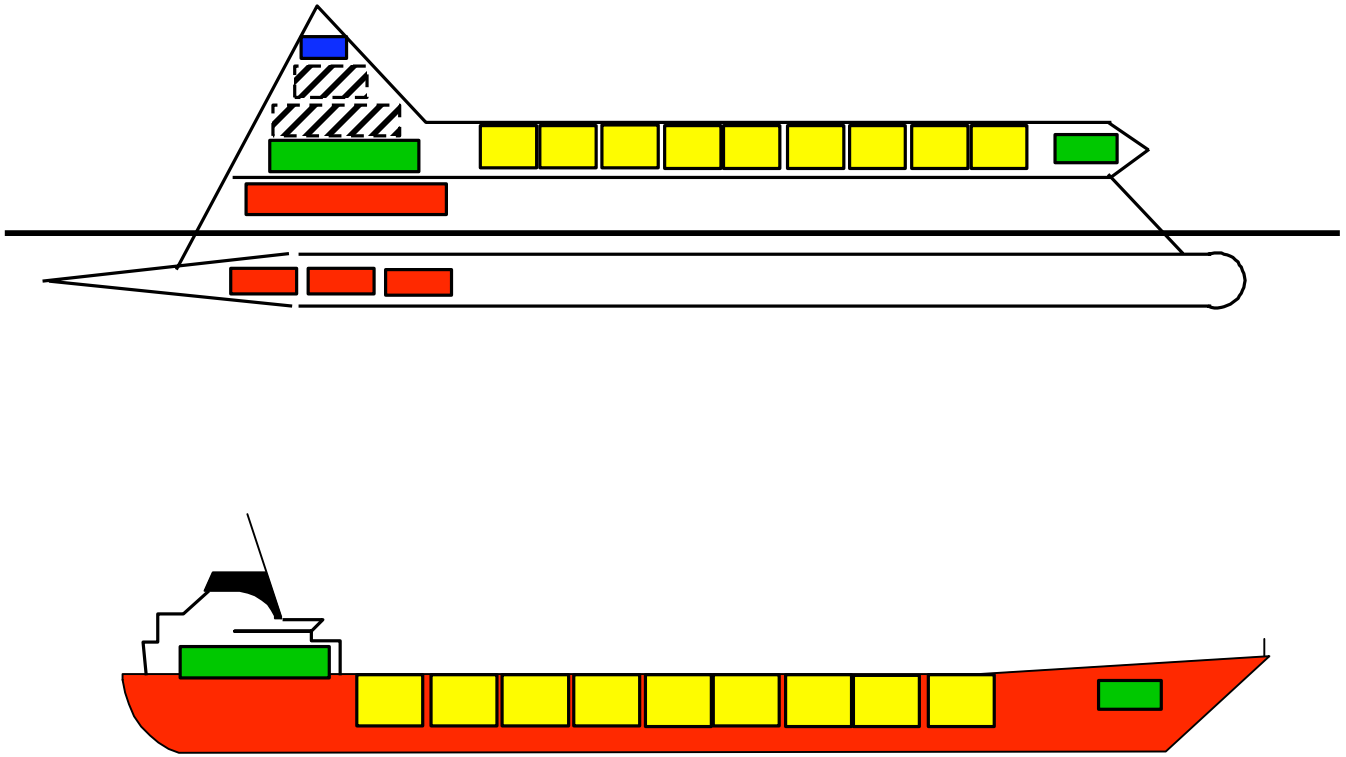


Reengineering

Manpower Reduction

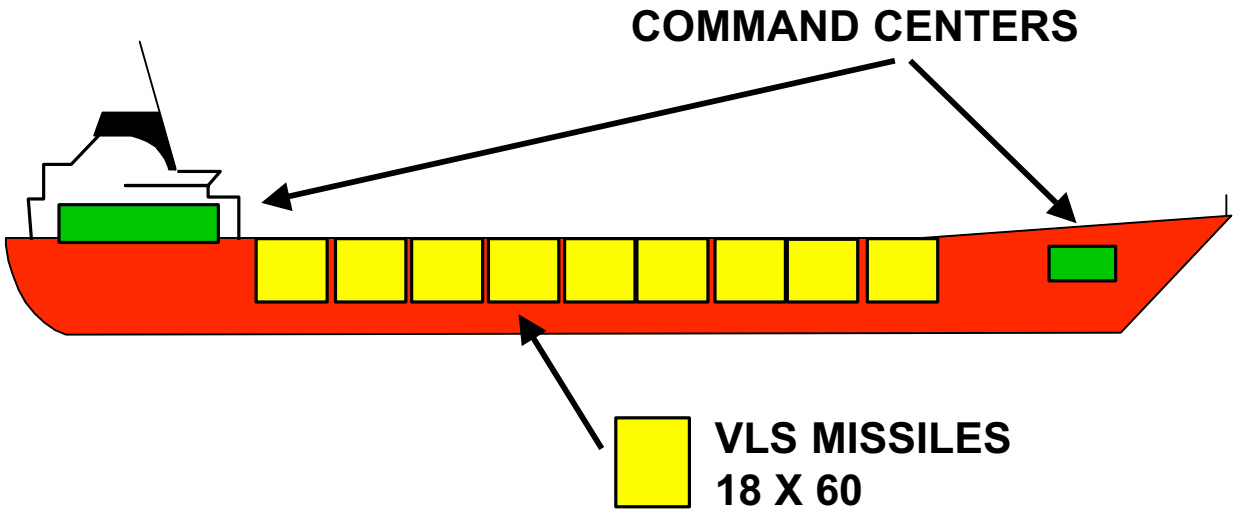


Two Versions Low - Mix ?



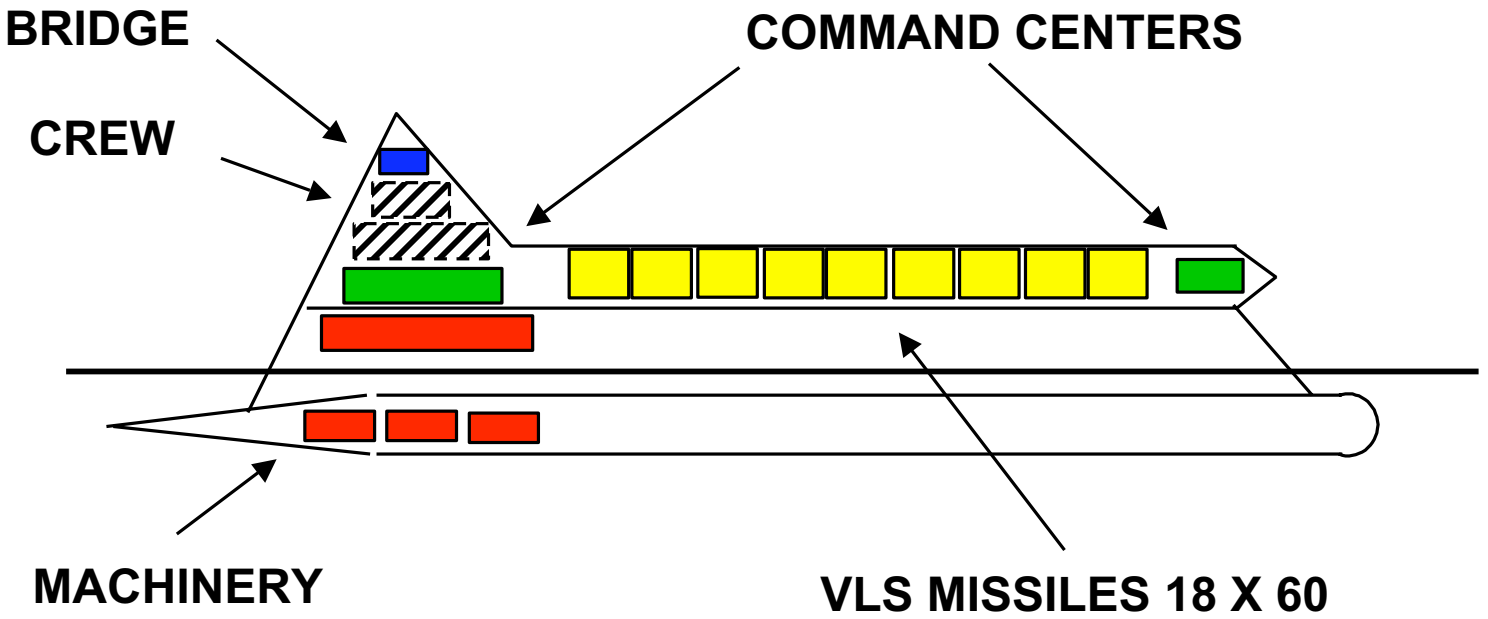
Conventional Low - Mix?

- Most merchant ships operate with a crew of less than twenty
- Can a commercial hull be modified to meet the SOCS requirements and reduce manpower as part of a high - low mix?
- High mix provides sensors & C3I
- Low mix, linked to a high mix, provides firepower

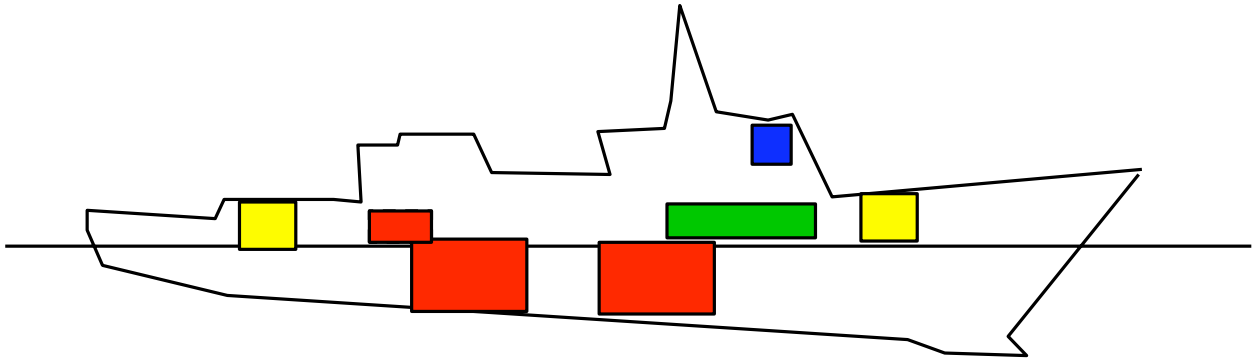


Low - mix Stealth?

CREW 40 - MISSILES 1080

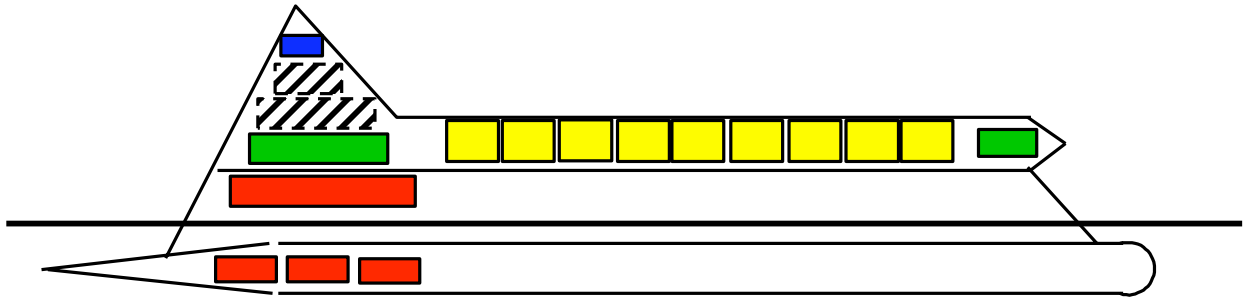


Tactical Team ?

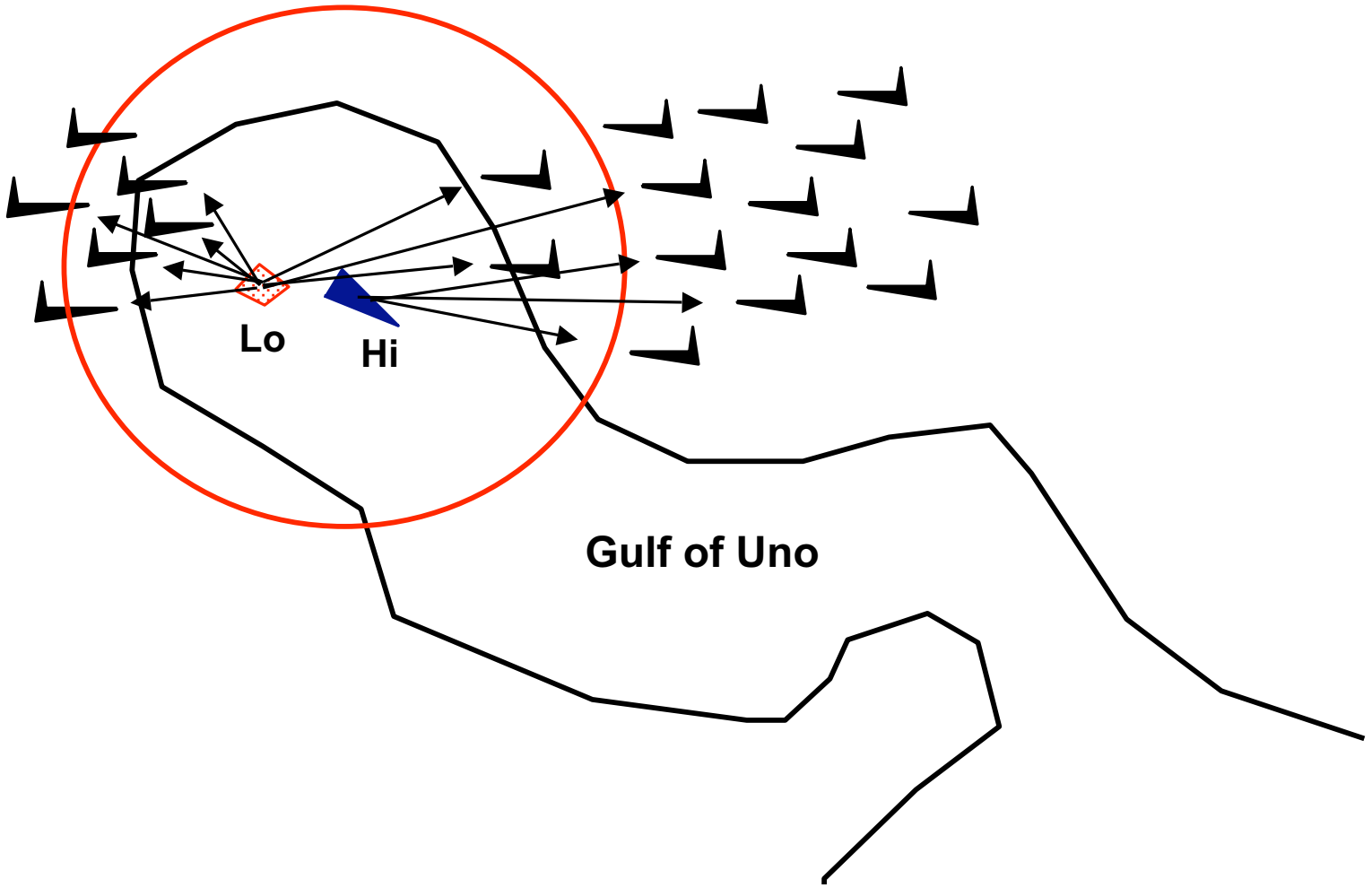


Crew 360 - Missiles 120

Crew 40 - Missiles 1080

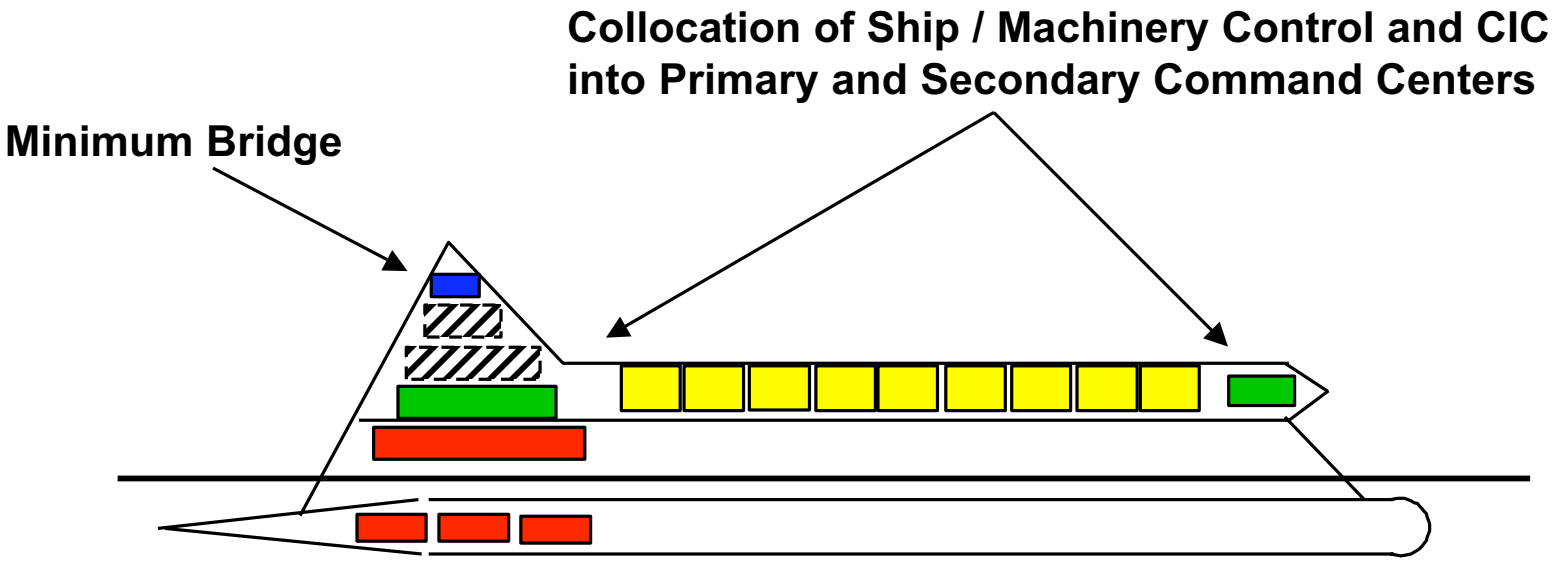


Tactical Application



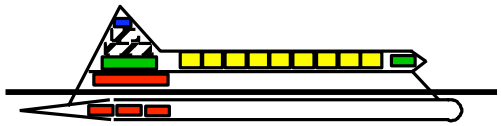
Navigation

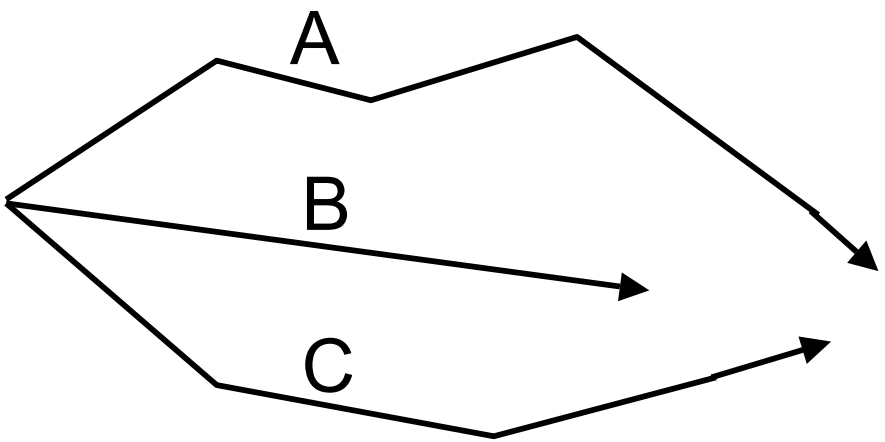
- Current bridge designs are inefficient and expose dozens of watchstanders to hazardous conditions
- Automation to meet SOCS requirements could use:
  - Navigation with autopilot, ECPINS, GPS, Radar Overlay, IR, ESM, threat warning, C3I about external environment
- USN SES-200 has ECPINS, GPS & radar overlay



Mission Planning

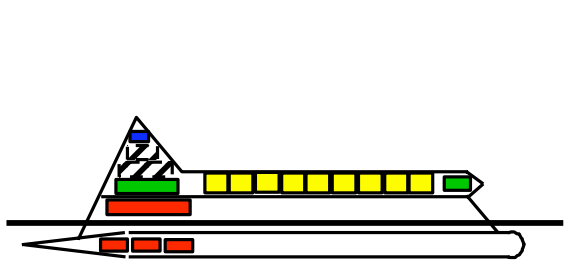
- **Current systems do not provide embedded readiness, mission planning and training**
- **This SOCS requirement requires the most effort to achieve due to the requirements to use 'ARTIFICIAL INTELLIGENCE" in the decision aiding process. Applications include:**
  - **Route selection considering the ship mission requirements, external environment and the ship's internal readiness**
  - **What if analysis of options**

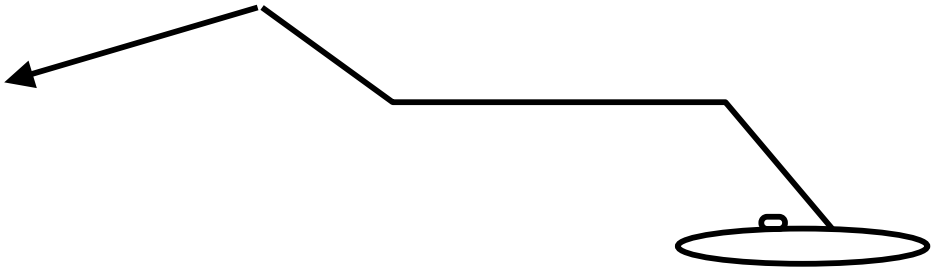




Threat Decision Aids

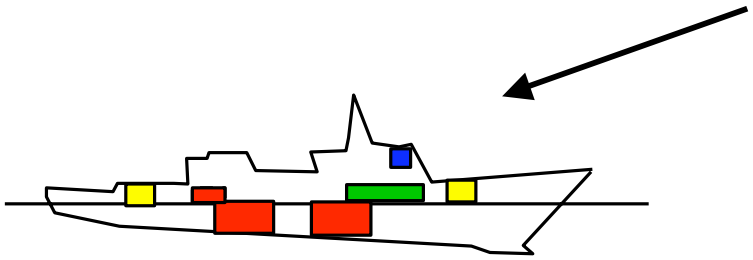
- Current ship HME & DC platform internal systems do not adapt automatically to the external environment (threat, sea state ...)
- The HME & DC systems should adapt automatically to improve:
  - operating efficiency
  - increase ship survivability
- Example: Pop up threat, cruise missile, 75 seconds time on top:
  - starting from Condition III
  - auto-start all vital systems and split for survivability
  - auto-full power to maneuver to pre-selected attack angle
  - turn ship for max-firepower, minimum damage / loss of life

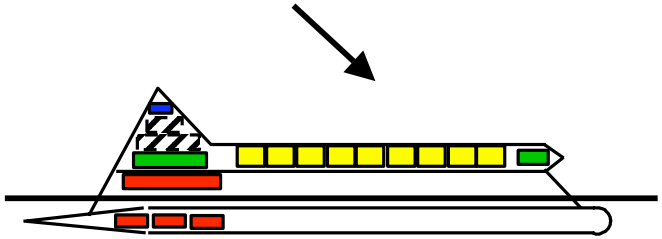




Machinery Control

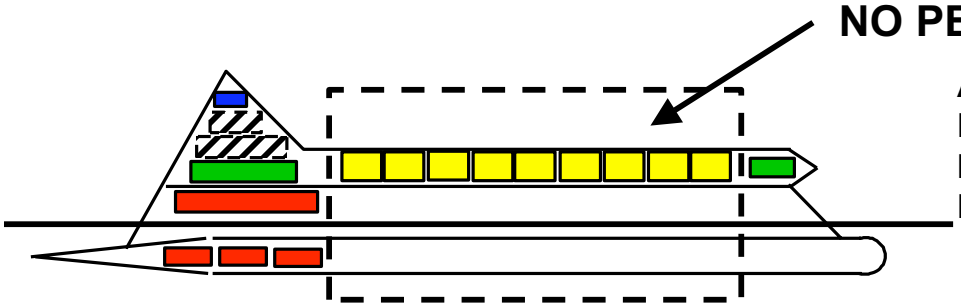
- SOCS requirements are being addressed in SMCS
- Will Navy ships apply these technologies?
  - full integration of ship control, HME & DC, and combat systems in dual command centers
  - full function consoles located in all vital decision stations
  - adaptive HME & DC reconfiguration
  - built-in training and mission planning
  - built-in test to the single LRU & built-in spares
  - low LRU count / maintenance requirements
  - reduced manning
  - increased combat volume: 23 % to more than 50%





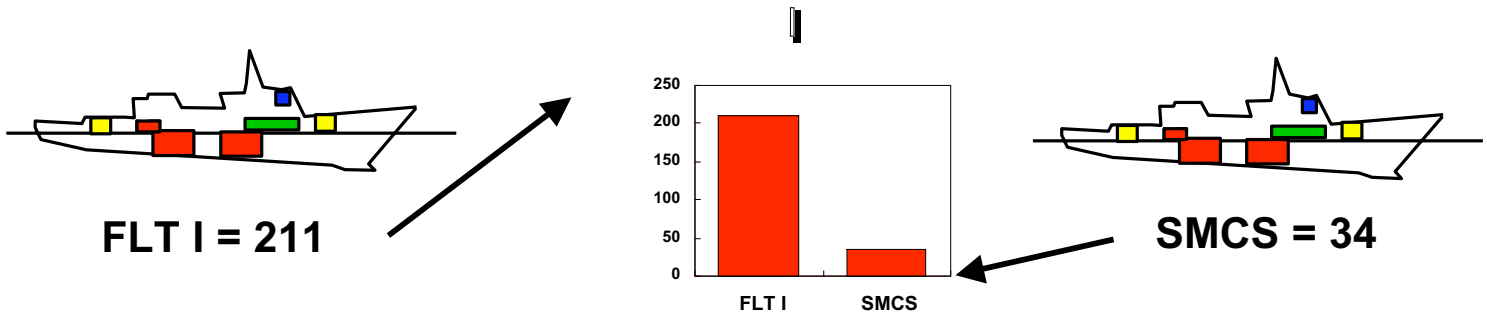
Damage Control

- The number one public concern today is loss of life in combat operations. Did Desert Storm set an non-repeatable precedent?
- The key to minimum loss of life in combat is sending the fewest possible people into harm's way
- New designs support aggressive damage control
  - automation to reduce personnel requirements
  - adaptive HME & DC systems
  - inert gasses and non-explosive space fillers



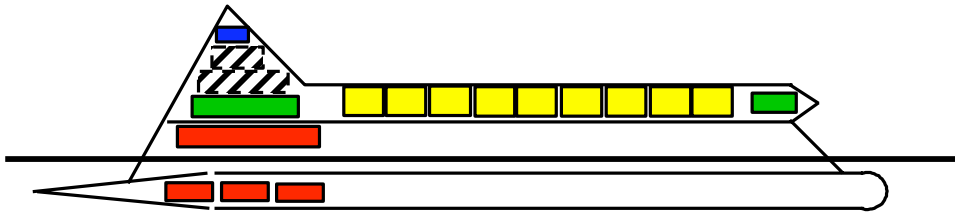
Condition Based Maintenance

- **Maintenance is the highest driver for crew size in addition to damage control. Methods to reduce maintenance manning are:**
  - **change the design of systems and components. (SMCS reduces the component type count for machinery control systems by 84%)**
    - ***Affordability Through Commonality***
  - **provide built-in test (BIT) and maintain systems based on condition rather than time**
    - **use BIT to automatically update ship readiness assessment and to support intelligent adaptive reaction to threats**
  - **convert watchstanders to non-watchstanders**



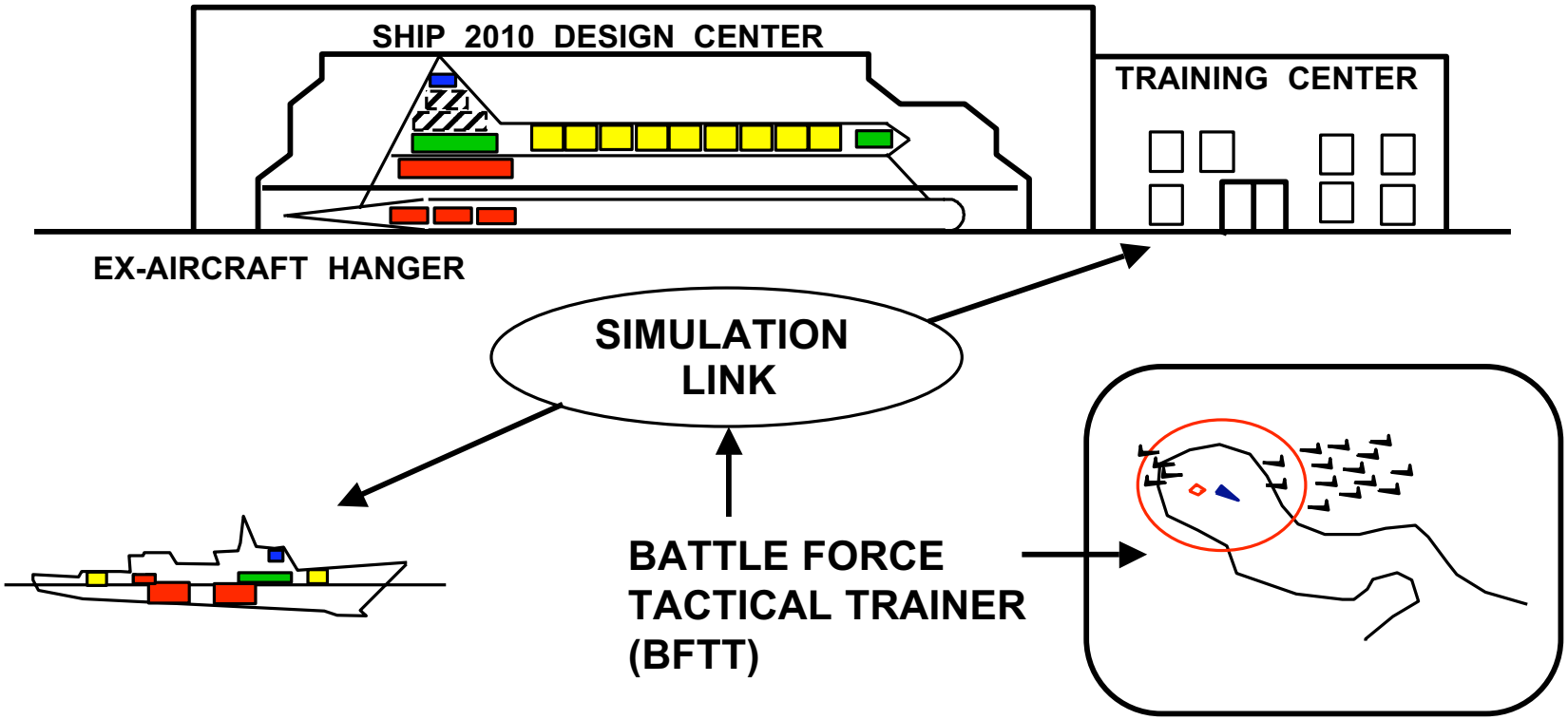
Enabling Technologies

- Computer power exists to support enabling technologies
- Application technologies in artificial intelligence and sensors requires significant work
- Simulation can be used to validate design and test warfighting assumptions
- Reengineering techniques are available to audit design rationale



Confidence Building

- Crew "trained" in the employment of automated systems and "new warfare doctrine".
- A "new culture" developed, as in the space program.
- Maximum firepower, mission accomplished, minimum human risk.

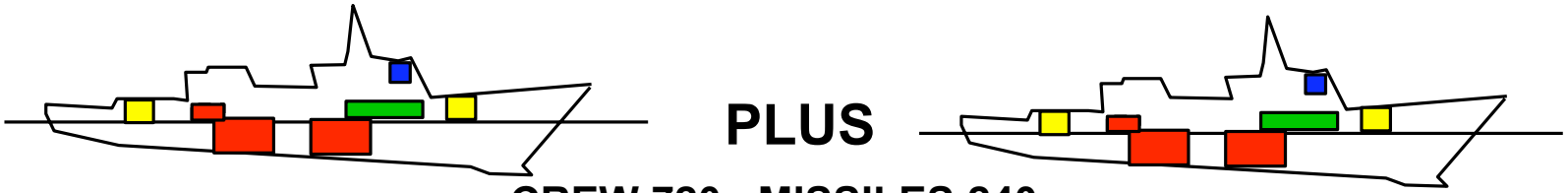


Change the Paradigm

- Manpower Reduction

to

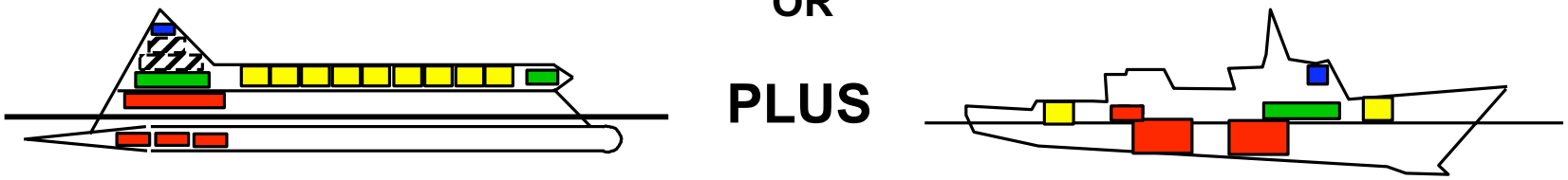
- Human Risk Mitigation



PLUS

CREW 720, MISSILES 240

OR



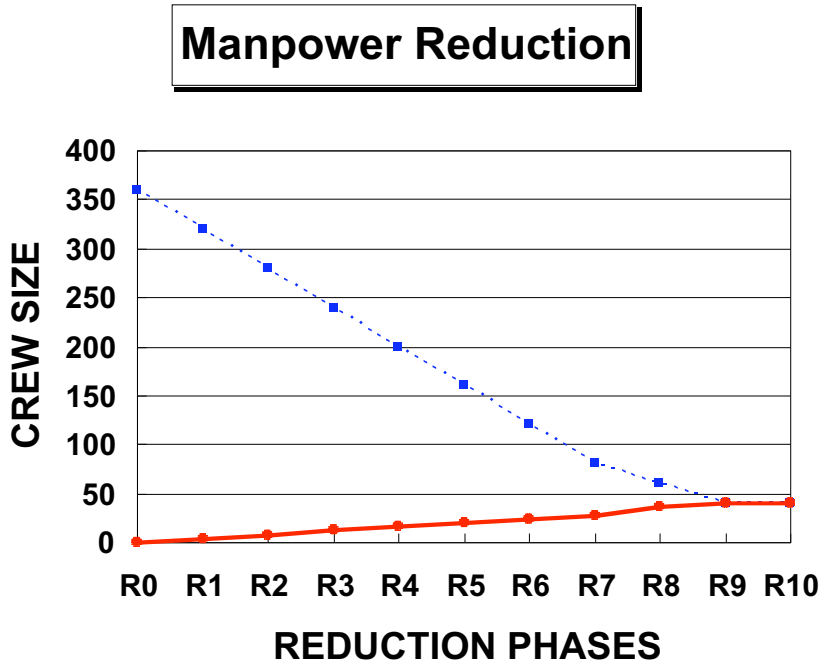
PLUS

CREW 400, MISSILES 1200

Change the Design Process !!

Don't Tinker with the Design

Reengineer!!



Cultural Change

ROLES AND MISSIONS

PRESENCE, SHOW THE FLAG

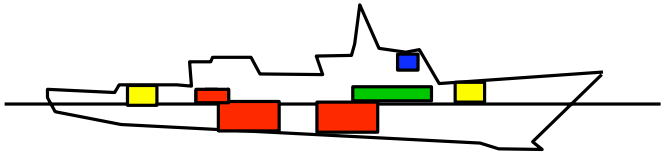
INTERNATIONAL AGREEMENTS

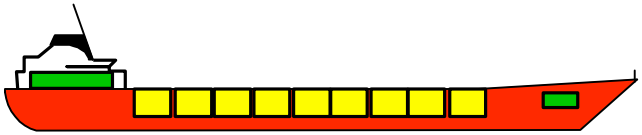
CUSTOM AND TRADITION

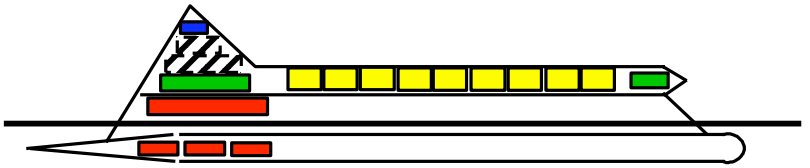
NAVY REGULATIONS

SAFETY

PRIDE







Conclusions

- Automation is here to stay
- Computer power exists to support the enabling technologies
- Application technologies in artificial intelligence and sensors requires significant work
- Conventional designs are prohibitively expensive
- Simulation can be used to validate design, test warfighting assumptions, and support cultural change
- Don't tinker with design, reengineer
- The paradigm has changed to human risk mitigation
- Cultural barriers will remain a challenge

It is an exciting time to be in the marine engineering profession!!