

***Develop and Implement 'World Class' U.S.  
Material Standards and Parametric Design  
Rules to Support Commercial and Naval  
Auxiliary Ship Construction***

**Project Final Status Report**

by

**National Steel & Shipbuilding Co.**

on

**June 16<sup>th</sup> 2004**

**Maritech ASE Project #99-21  
Technology Investment Agreement (TIA) 20000215**

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# Material Standards & Parametric Design Rules



## • Team Members

NASSCO (lead), Halter, Electric Boat, Bath Iron Works, Ingalls, Newport News Shipyard, M. Rosenblatt & Son, Designers and Planners, Proteus, Vibtech, Munro & Associates., First Marine International, SPAR, Integration Partners, ABS, Hopeman Bros., Simsmart, University of Washington, University of Michigan, Webb Institute.

# Major Accomplishments

Material Standards & Parametric Design Rules



- **Developed Functional Volume Design Approach and Training Software**
- **Enhanced Proteus IDNA Software**
- **Developed CID Architecture**
- **Developed Standards Library**
- **Developed Design Rules and Templates**
- **Applied Lean Design to Shipbuilding**
- **Training Materials Published**
- **Workshops conducted**

# Strategic Vision

Material Standards & Parametric Design Rules



**An integrated pre-production process based on comprehensive standardization across the principal functional areas of Engineering, Estimating, Materials, and Planning.**

**This process applies standardization to material, equipment, design, material selection, cost estimating, interim products, arrangements, zone designs and whole-ship designs**

# Expected Benefits

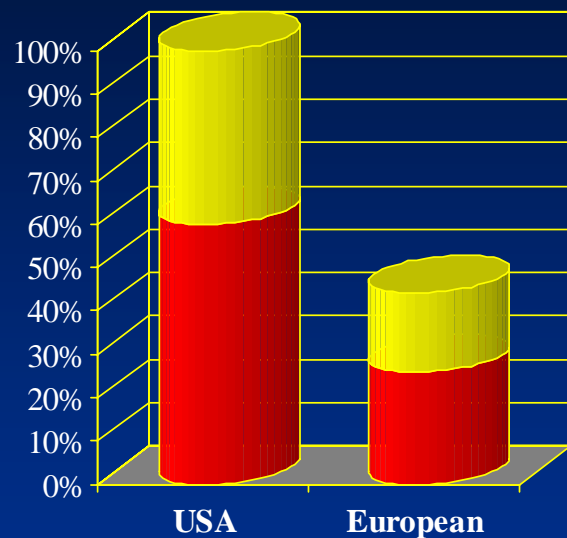
Material Standards & Parametric Design Rules



- **Five-fold increase in the throughput of preliminary designs and cost estimates that a shipyard can produce in response to market inquiries**
- **33% reduction in cost and cycle time for pre-production processes during the contract, transition, and detail design phases.**

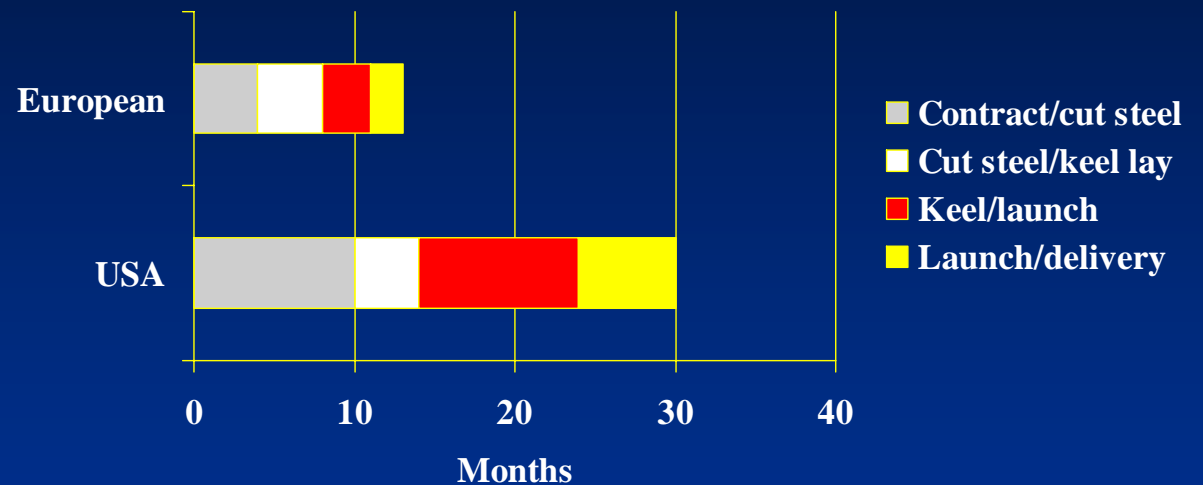
# Expected Benefits

Material Standards & Parametric Design Rules



- Added value
- Material and equipment

## Typical Suezmax Tanker Schedule USA & Europe



**Reduce Material Cost  
and Cycle Time**

# Typical Design and Engineering Cycle Time in the USA



# Proposed Process



## Material Standards & Parametric Design Rules

### Contract Definition

(Built from Project Specific Templates)

#### Guidance Documents

- Ship Specification
- General Arrangement
- Machinery Arrangement
- Midship Section/Scantlings
- Key System Diagrams
- Equipment List

#### System Development

- Structural Steel
- Piping Systems
- Electrical Sys.
- HVAC

#### Producability Issues:

- Defining and Locating Outfit Material
- Defining Structural Steel Product Breakdown

#### Estimating

Apply Material and Labor Rates linked to projects specific templates.

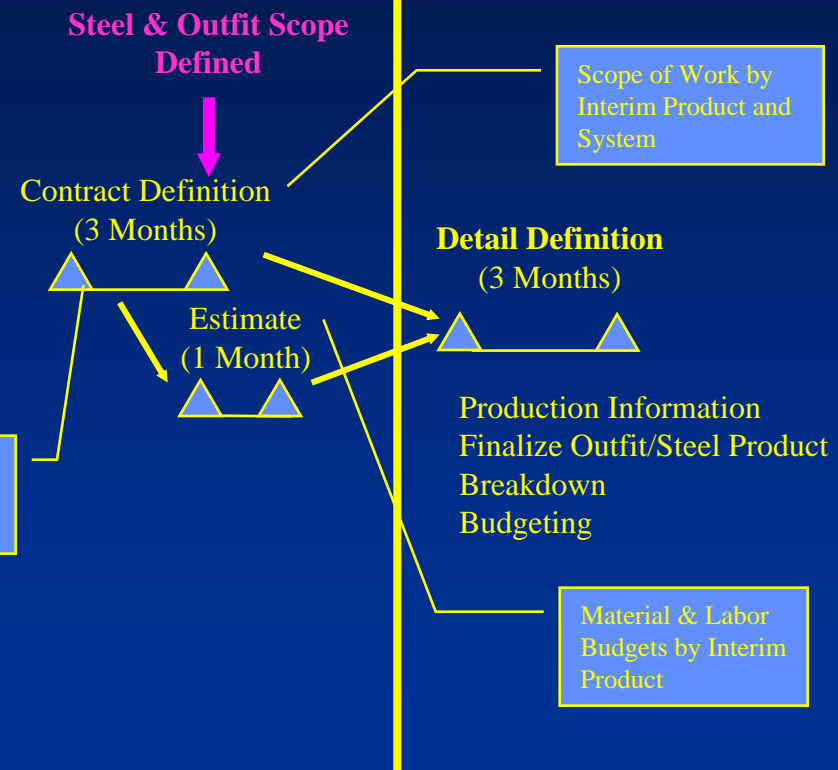
### Eng/Estimating Integration

3 - 4 Months

Contract Award

3 Months

Scope of Work is an input to the estimating process.





# Functional Volume Design

Material Standards & Parametric Design Rules



## Problems with the Existing Design Process

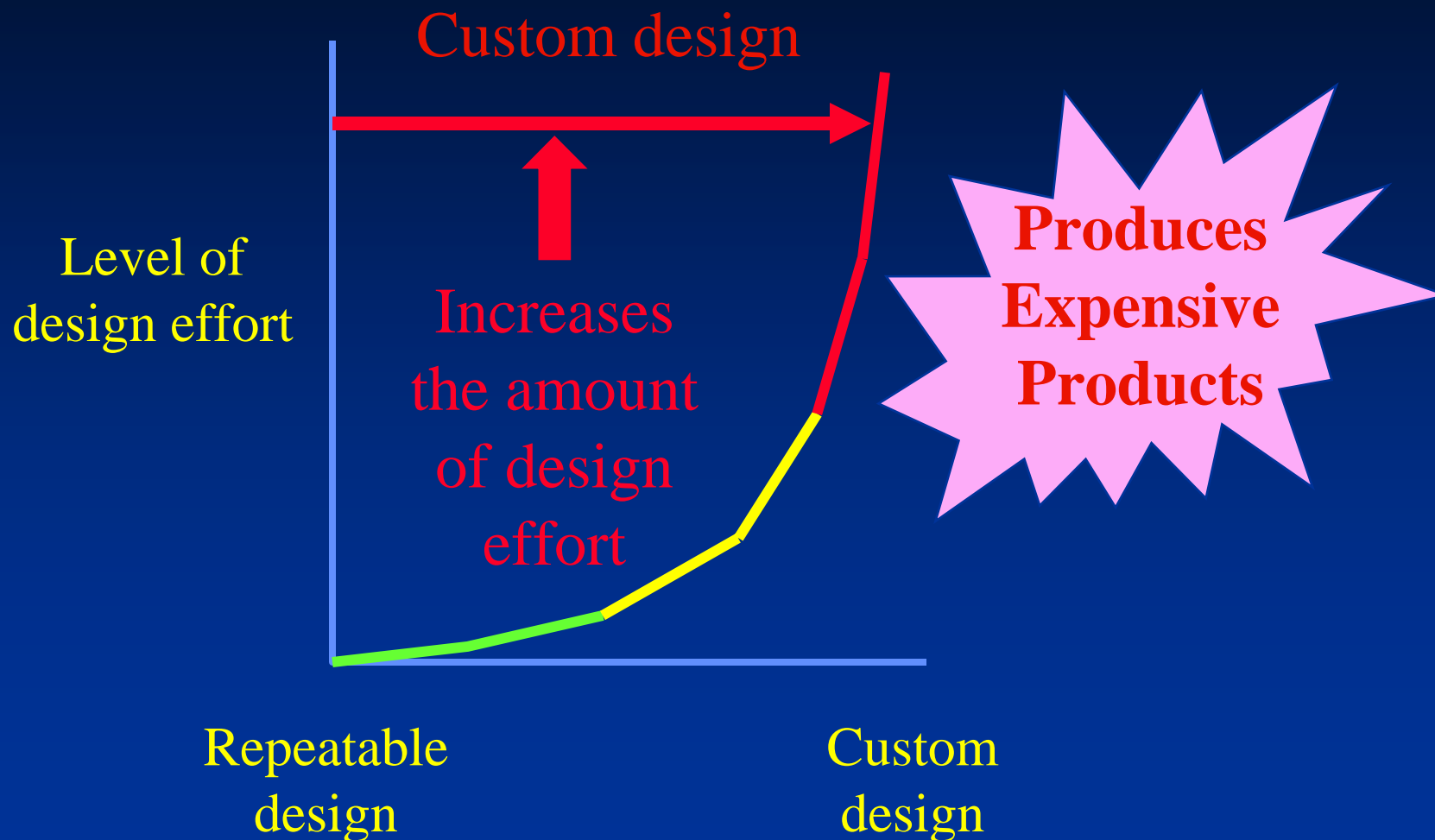
Creates “custom” design solutions that are:

- Inherently of “lower technical confidence” and “higher commercial risk”.
- At a price that is well above the expectations of the international market.
- At a cost that makes the shipyard uncompetitive.
- With excessive design cost and lead time.



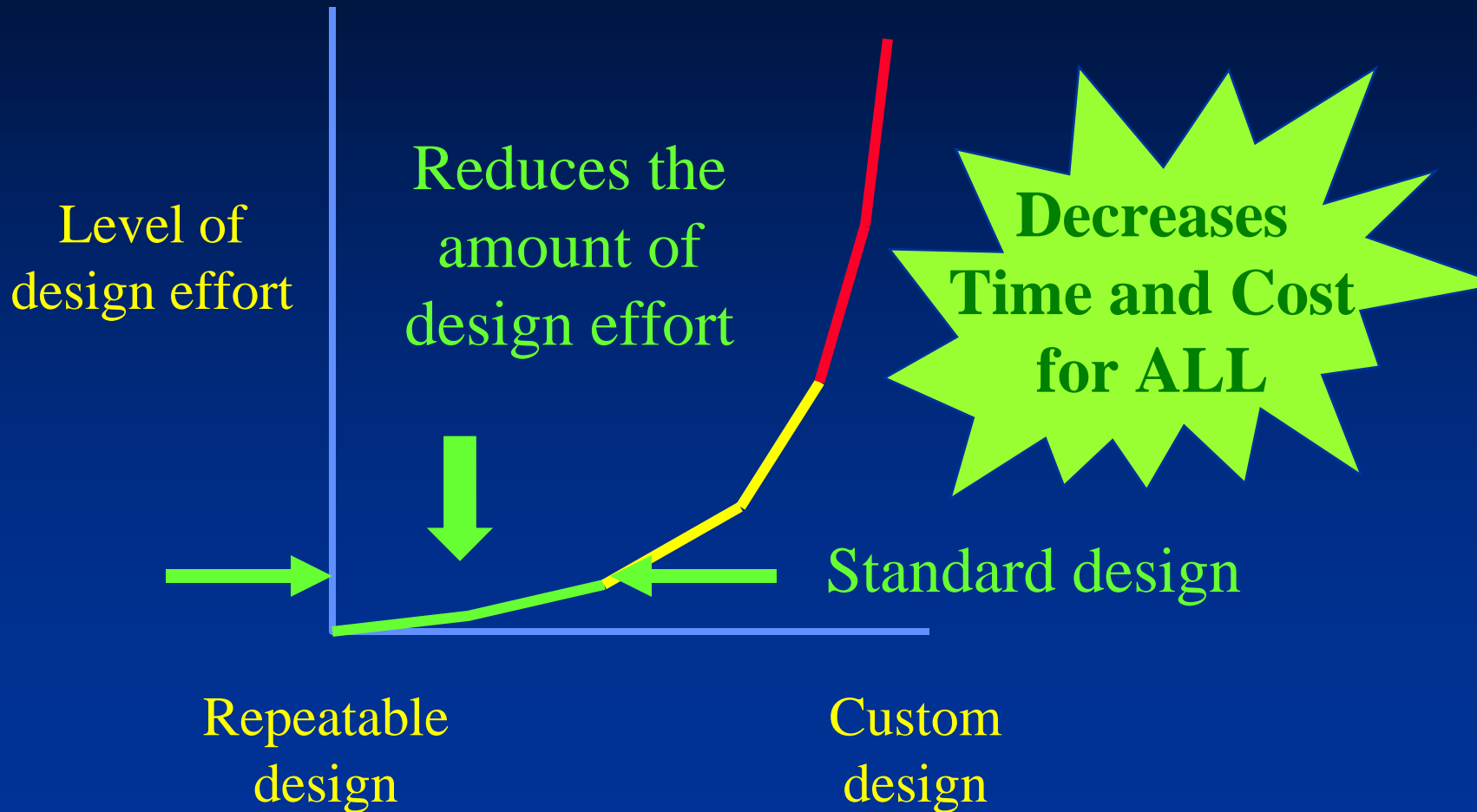
# Standard v Custom Design

Material Standards & Parametric Design Rules



# Standard v Custom Design

Material Standards & Parametric Design Rules



# Project Accomplishments

Material Standards & Parametric Design Rules



- **Task 1 - Methodology Templates & Guides**
  - Project Methodology template, revised
    - » Provided a detailed project plan
  - Lean Methodology Guide
    - » Conducted two industry workshops
    - » Provided hands-on experience in applying DFMA principles
  - Software Methodology Guide
    - » Provided guidance for software development (any project)
  - Education and Tech Transfer Guide
    - » Provided guidance and sets expectations

# Project Accomplishments

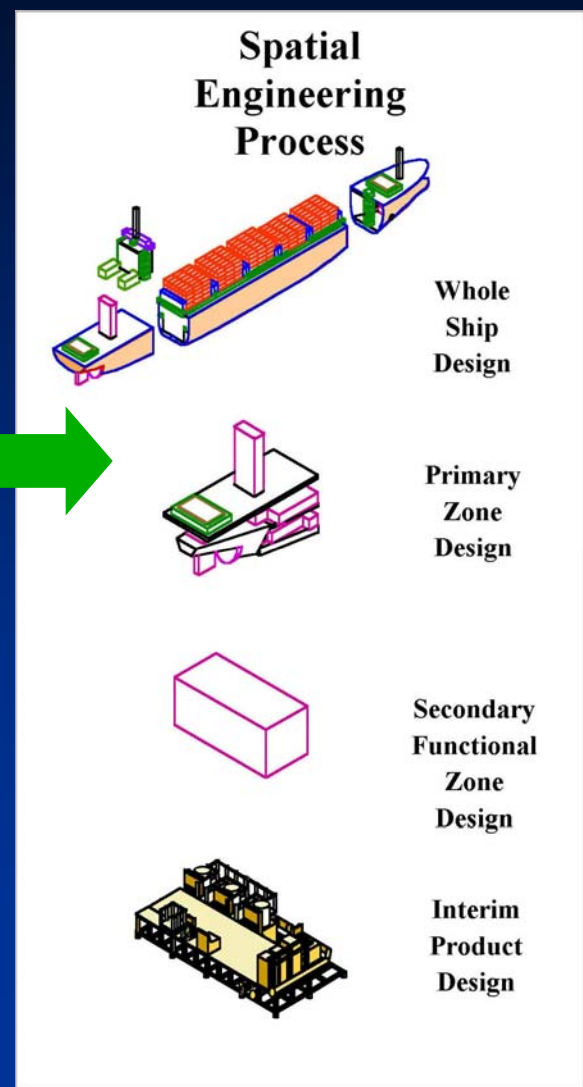
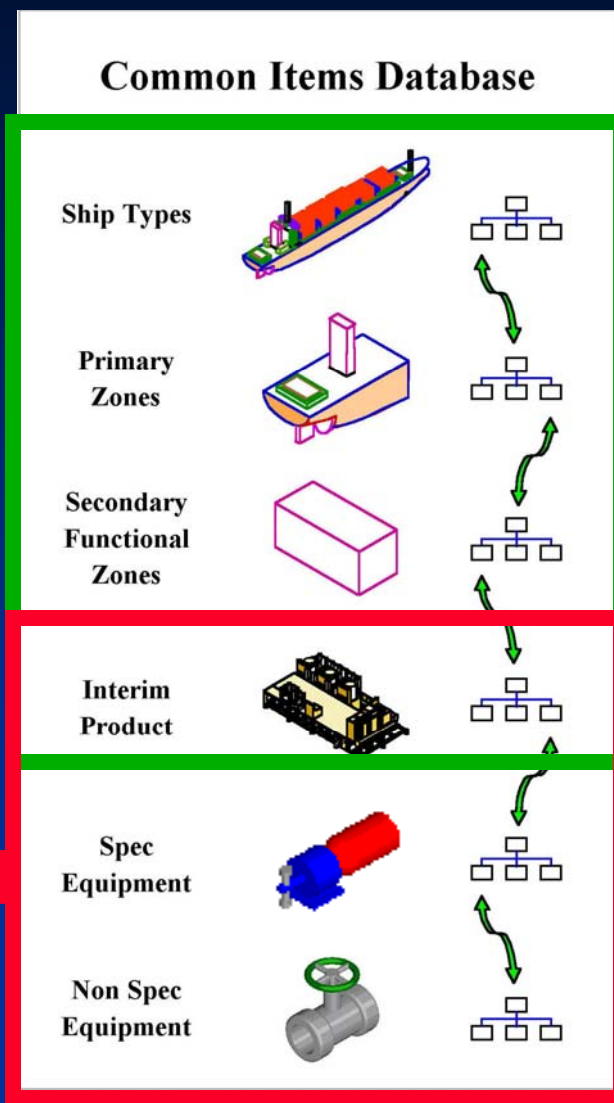
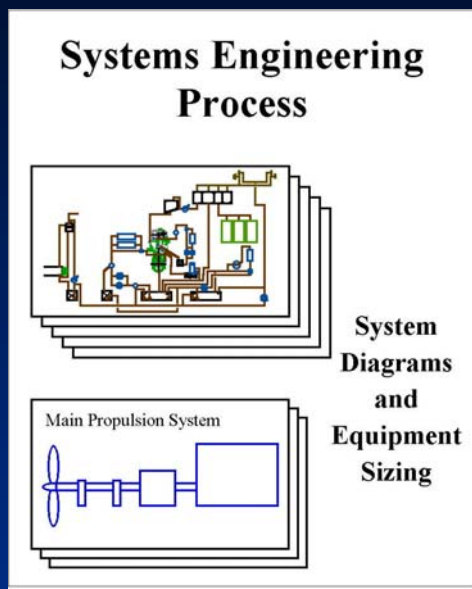
Material Standards & Parametric Design Rules



- **Task 2 - Common Item Database (CID)**
  - Develop and Populate CID with Spec & Non-Spec Material/Equipment
    - » Defined commercial shipyard data requirements
    - » Defined business process & procedures
    - » Defined organizational requirements
    - » Defined part equivalency process & procedures
    - » Defined CID architecture
    - » Populated CID with over 650 products from more than 730 suppliers (over 740 product types in 45 product categories)
    - » Product catalog development - Identified over 200 Data templates at the functional volume level with over 400 associated product templates

# CID and the Design Process

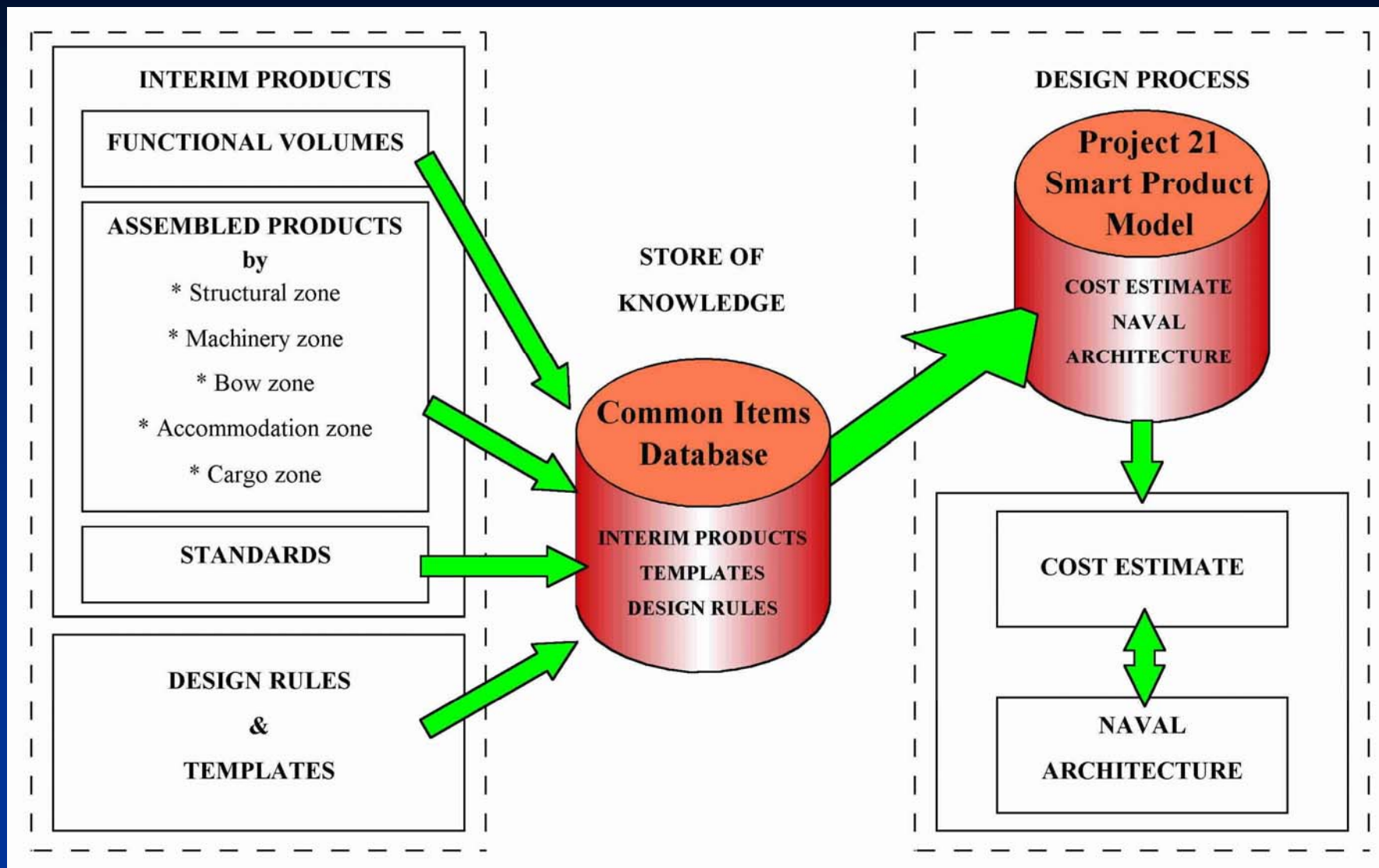
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# CID and the Design Process

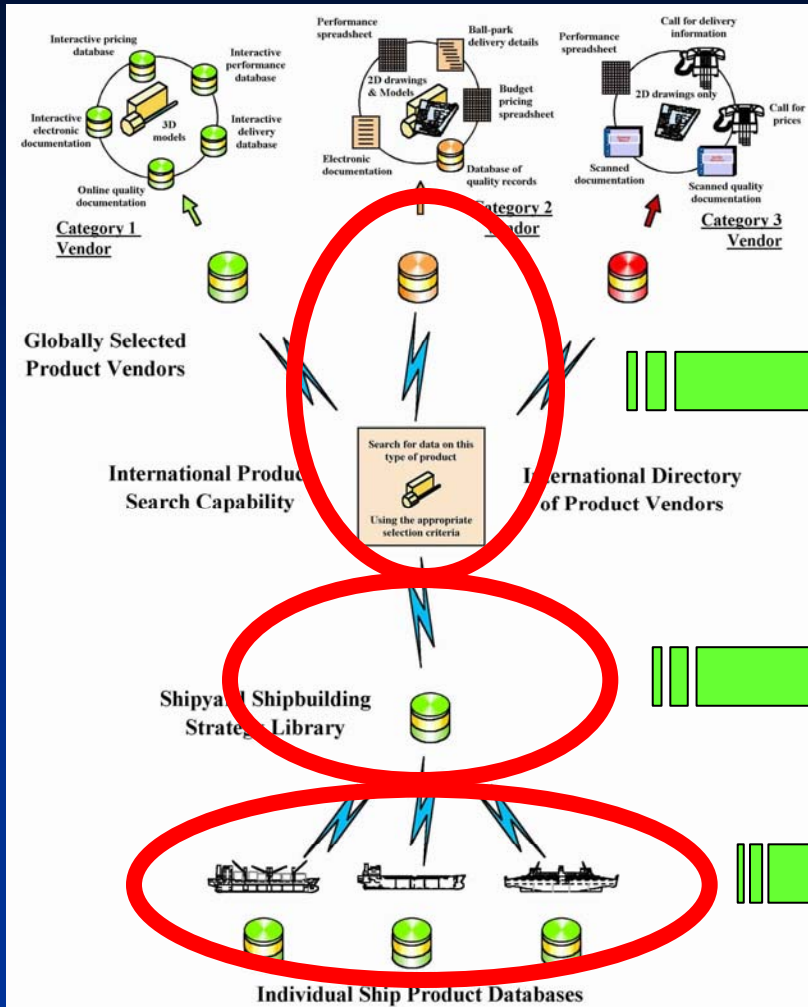
Material Standards & Parametric Design Rules





# CID Architecture

Material Standards & Parametric Design Rules



- Gatekeeper

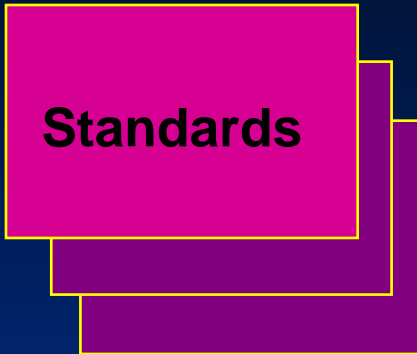
- Product Catalog

- Project Database



# Product Data Templates

Material Standards & Parametric Design Rules



Spec Equip

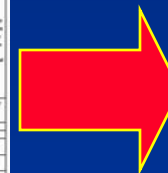
Non - Spec Equip



Information Type	Product Data Element	Product Type	Product Information (from Supplier)
Item	Part Name	Part Number	Example
Performance Data	Service	Material	Construction Air System
	Design System Pressure	Part No.	100-1000-000000
	Dimensions	Part No.	100-1000-000000
Material Data	Material Type	Material	100-1000-000000
	Material Dimensions	Material	100-1000-000000
Threshold Points	Request	Provide	
	Request	Provide	
Graphical Information	2D Symbol	Request	Provide
	3D Model	Request	Provide
Physical Properties	Principal Dimensions (Based on Development) Ex: L x H x W	Request	Provide
	Material Properties	Request	Provide
Approval and Certification	Classification Society	Request	Provide
	Labeling Instructions	Request	Provide
Supplier	Supplier Part Number	Request	Provide
	Supplier Name	Request	Provide
Schedule	Lead Time	Request	Provide
	Quantity	Request	Provide
Cost	Unit Price	Request	Provide
	Quantity Discount	Request	Provide

Data Sheets

- Performance Data
- Material Data
- Graphic 2D, 3D
- Physical Properties
- Approvals
- Labeling
- Supplier Data
- Schedule
- Cost



Common Item Database

# Project Accomplishments

Material Standards & Parametric Design Rules



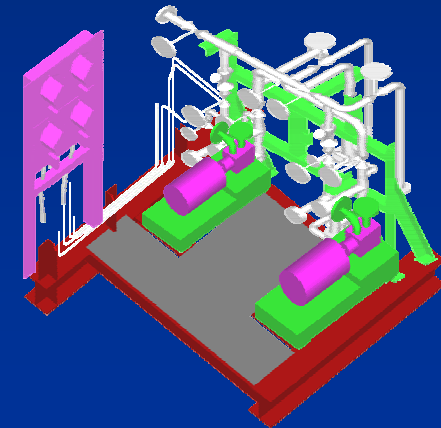
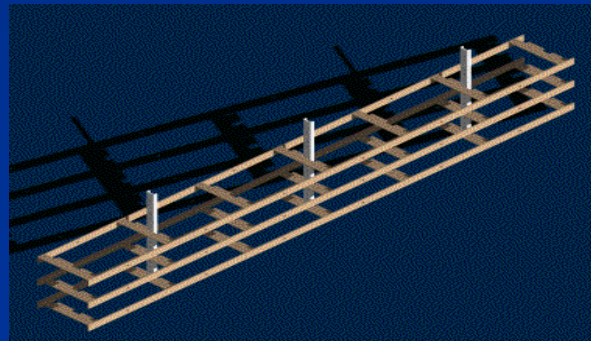
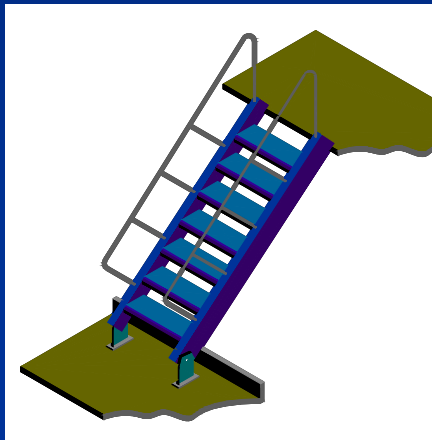
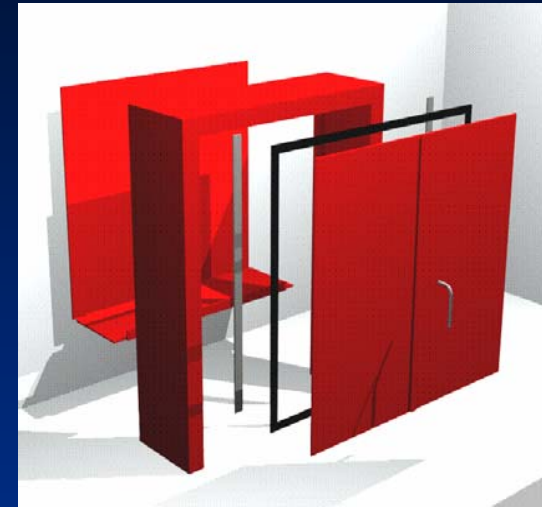
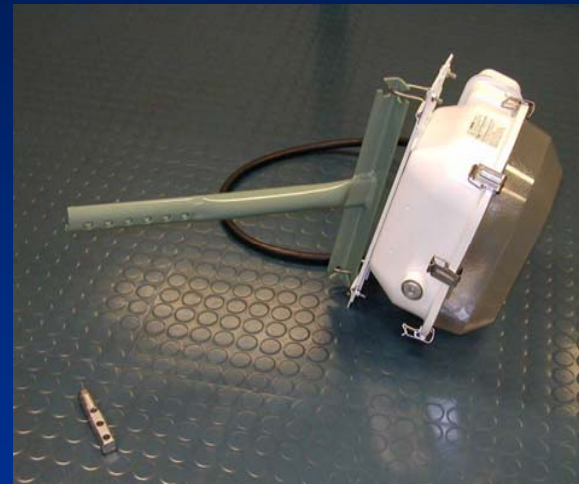
- **Task 3 - Develop a Set of Nationally Acceptable Material & Design Standards (outfit & structure)**
  - 960 steel and outfit standards delivered
  - Over 1200 standards submitted to project team for review
- **Delivered Standards**
  - 252 Structural Standards
  - 708 Outfitting Standards
    - » 95 Electrical Standards
    - » 134 Metal Outfit Standards
    - » 391 Piping Standards
    - » 88 HVAC Standards



# Types of Standards

Material Standards & Parametric Design Rules

- **Parts Standards**
- **Interim Product Standards**
  - Groups of parts or assemblies



# Material & Design Standards

## Material Standards & Parametric Design Rules



**DOG ASSEMBLY**  
NS 77-87-138  
3 PLACES

**HOOK & BUMPER ASSEMBLY (ALL DOORS)**  
DETAIL 8-A  
SEE DN 7

**HANDGRAB (H&G)**  
DETAIL 7-B

**H&G ASSEMBLY**  
NS 77-87-134

**BULKHEAD FRAME**  
DETAIL 4-A

**CL HINGE**

**DOOR PANEL**  
DETAIL 2-A

**HINGE ASSEMBLY**  
RH DOOR OR LH DOOR  
DETAIL 5-C

**CL HINGE**

**PIPE LEVER (H&F)**  
SEE 3-A FOR LOCATION

**FRAME CORNER**  
SEE DETAIL 4-A

**CL HINGE**

**DETAIL 1-B**  
H&G OUT OUT

**RIM STIFFENER**  
DETAIL 3-A

**CENTERING WEDGE**  
DETAIL 5-A

**DETAIL 1-A**  
WEATHERTIGHT DOOR (TYPE 1)  
LEFT HAND SHOWN  
LEFT HAND DOOR OPPOSITE

**CL DOOR**

**LEFT HAND DOOR**

**RIGHT HAND DOOR**

NOMINAL DOOR SIZE AND CLEAR OPENING	ASSEMBLY NUMBER		FRAM CL DOOR TO CH HINGE		TO RL HANDGRAB	DETAIL	EDGE ASSY		HINGE ASSY		WEIGHT (LBS)	REMARKS	
	A	B	RH	LH			C	D	RL	RL			RL
26	56	87-1843	87-1848	27	1/8	(NS/FS)	1-1/2	1-A	3	3	3	3	846
28	58	87-1843	87-1848	27	1/8	(NS/FS)	1-1/2	1-A	3	3	3	3	848

**NOTES:**

1. THIS TYPE OF WEATHERTIGHT DOOR TO BE USED IN AREA EXPOSED DIRECTLY TO WEATHER, NAMELY FRONT SUPERSTRUCTURE OR HOUSE BULKHEAD, ENGINE ROOM ENTRANCE AND ELSEWHERE WHERE PRESSURE DOES NOT EXCEED 4 PSI.
2. DIMENSIONS SHOWN ARE IN INCHES UP TO 32 AND IN FEET AND INCHES ABOVE 32.
3. DOOR WILL BE FREE OF WELD SPLOD, SPATTER, DEFECT, AND SHARP EDGES OR BUMPS.
4. PAINT CODE; MIPPE CORNARD (MC). FITTINGS PRESERVATION TO BE IN ACCORDANCE WITH SPECIFICATION SHOWN.
5. TESTING EACH DOOR SHALL BE SUBJECTED TO HOSE TEST AFTER COMPLETION OF INSTALLATION, TO THE SATISFACTION OF ABB BUYER/DOR.
6. A COLD WELDINGING ELEMENT WILL BE USED WHEN BONDING KEYPHONE GASKETS TO STEEL SURFACES.
7. FABRICATOR WILL INSTALL STAPLE & FREE RIDE DOOR BUMPER ASSY.

ALLOWABLE MANUFACTURERS: INT

DATE	REVISION	BY	CHKD

**DOOR, WEATHERTIGHT, SINGLE PANEL, 4 PSI MAX PRESSURE**

DATE	REVISION	BY	CHKD

1 OF 9



**W/T DOOR**



# Material & Design Standards

## Material Standards & Parametric Design Rules



### Life Rails

**INSTALLATION**

RAIL ASSEMBLY WITHOUT PAD					
NOMINAL SIZE FT-IN(MM)	ASSEMBLY W/ NO STAPLES	ASSEMBLY W/ STAPLES LEFT SIDE	ASSEMBLY W/ STAPLES RIGHT SIDE	ASSEMBLY W/ STAPLES BOTH SIDES	WEIGHT
3-00 (1525)	87-70801	87-70801L	87-70801R	87-70801UR	80
10-00 (3050)	87-70802	87-70802L	87-70802R	87-70802UR	84
13-00 (4275)	87-70803	87-70803L	87-70803R	87-70803UR	118
20-00 (6100)	87-70804	87-70804L	87-70804R	87-70804UR	15
RAIL ASSEMBLY WITH PAD					
NOMINAL SIZE FT-IN(MM)	ASSEMBLY WITH PAD	ASSEMBLY WITH PAD LEFT SIDE	ASSEMBLY WITH PAD RIGHT SIDE	ASSEMBLY WITH PAD BOTH SIDES	WEIGHT
3-00 (1525)	87-70801P	87-70801PL	87-70801PR	87-70801PUR	80
10-00 (3050)	87-70802P	87-70802PL	87-70802PR	87-70802PUR	84
13-00 (4275)	87-70803P	87-70803PL	87-70803PR	87-70803PUR	118
20-00 (6100)	87-70804P	87-70804PL	87-70804PR	87-70804PUR	15

**GENERAL NOTES:**

- ALL DIMENSIONS ARE IN INCHES.
- INSTALL STANCHIONS WITH A MAXIMUM SPACING OF 5 FEET.
- PROVIDE 3 INCHES CLEARANCE BETWEEN TOP HANDRAIL AND ANY OTHER STRUCTURE.
- USE STD DRG 77-87-020 FOR ACCESS OPENINGS THRU HANDRAILS.
- VERTICAL TOLERANCES WILL NOT EXCEED 1/8 IN ± FEET OF LENGTH.
- INSTALL INTERMEDIATE RAIL ON PROTECTION SIDE OF HANDRAIL.
- PROVIDE PADS WHEN REQUIRED BY SHIP SPECIFICATION ONLY.
- PAINT CODE: NIPPE DETRWD (10)

**ALLOWABLE MANUFACTURER: INT**

REV 01/04/99	DESCRIPTION
REV 01/04/99	HANDRAIL, TWO COURSE, AROUND MASTS, PLATFORMS, WALKWAYS
REV 01/04/99	
REV 01/04/99	
REV 01/04/99	

DATE: 01/04/99

BY: [Signature]

CHK: [Signature]

APP: [Signature]

REV: [Signature]

DATE: 01/04/99

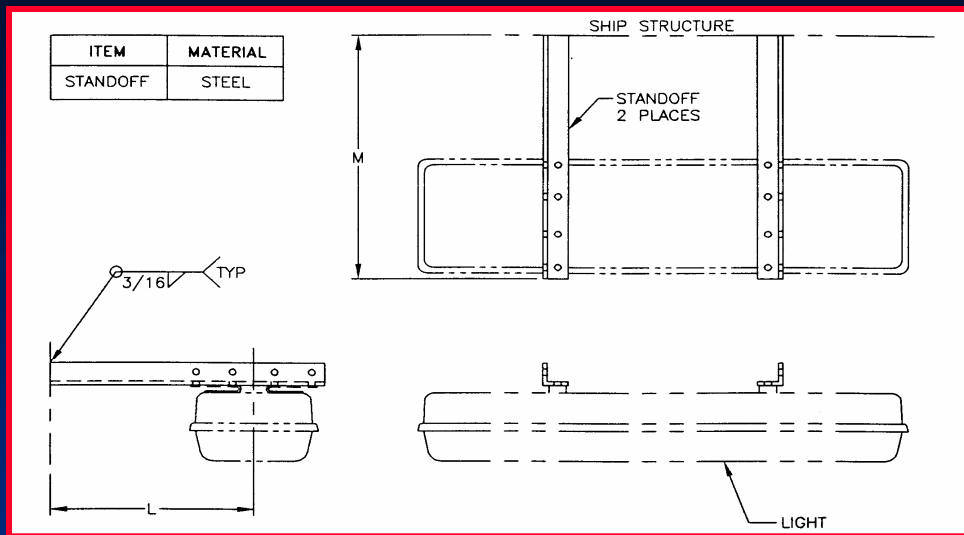
REV: 1 OF 2





# Material & Design Standards

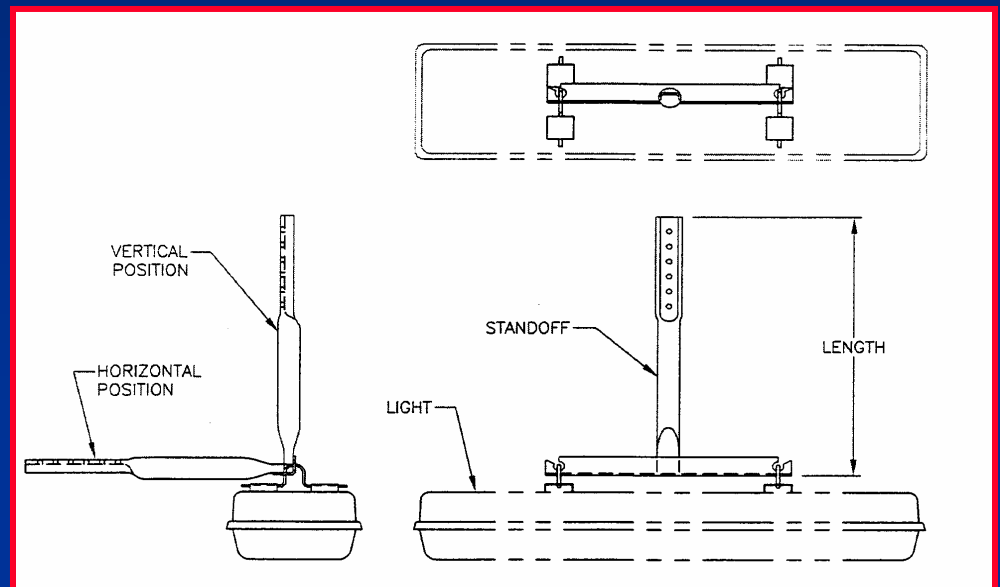
## Material Standards & Parametric Design Rules



Before

After

Light Standoff  
Reduction of Parts/Work  
Content & Increased  
Functionality

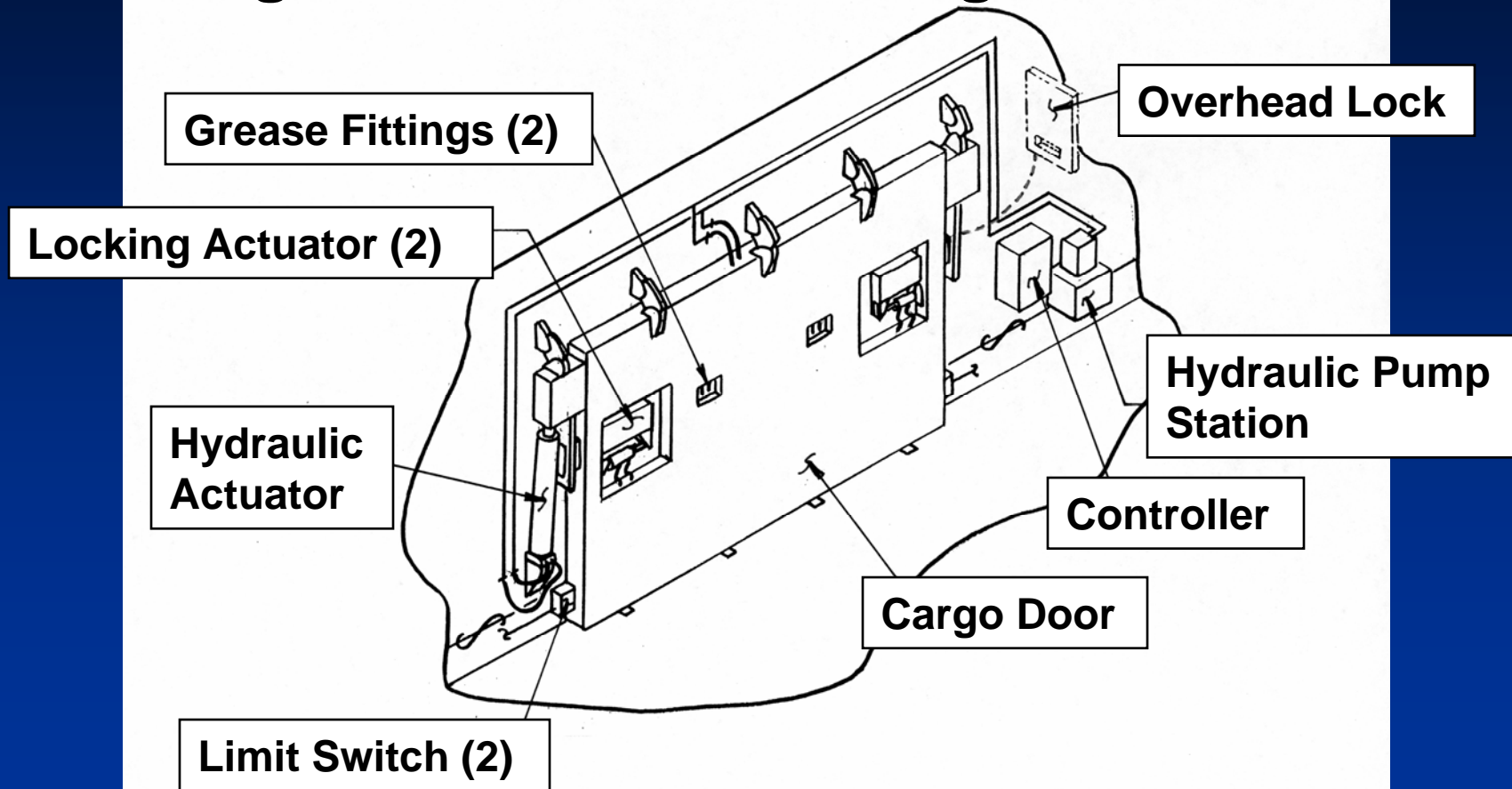


# Material & Design Standards

Material Standards & Parametric Design Rules



## Cargo Door Baseline Design

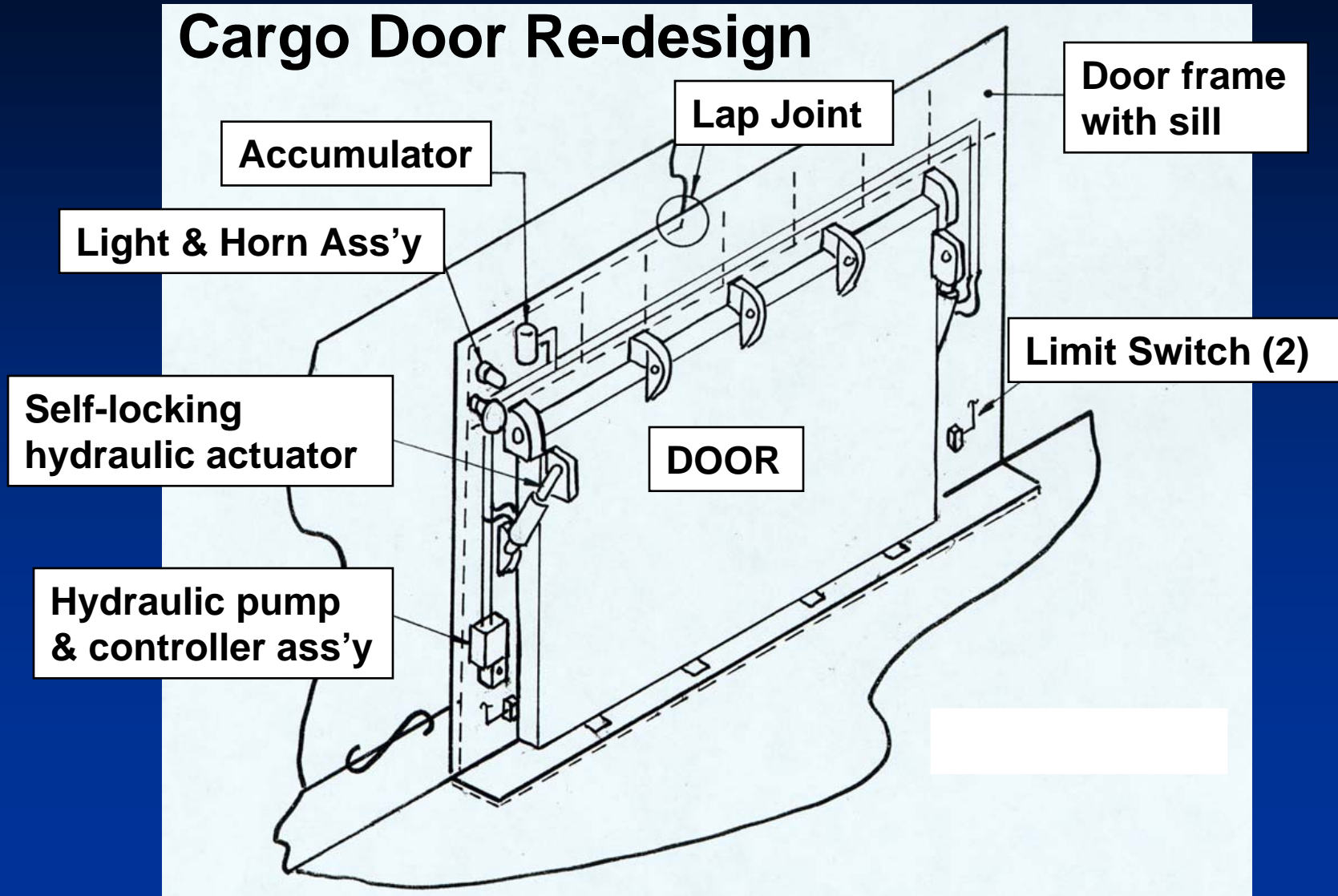


# Material & Design Standards

Material Standards & Parametric Design Rules



## Cargo Door Re-design





# Material & Design Standards

Material Standards & Parametric Design Rules



## Cargo Door Improvements

- Modular door & frame fully assembled and tested
- Lap joint to bulkhead
- Single lip seal
- Integrated control box
- Latching hydraulic cylinders
- Accumulator instead of hand pump

**Parts Reduction**

**> 40%**

**Operations Reduction**

**> 40%**

# Project Accomplishments

Material Standards & Parametric Design Rules



- **Task 4 - Develop Technical Approach for Early-Stage and Parametric Ship Design Tools**
  - Identified and evaluated existing tools
  - Developed Proteus/Spar Flagship software suite
    - » Released Smart Product Model (SPM) Advanced Parametric Ship Design, Cost Estimating, and Production Planning software
    - » Integrated the Herbert stability & hydrostatics toolset
    - » Industry workshops conducted to demonstrate the parametric “Smart Product Model” (SPM)
    - » Paper and demonstration presented at SPS Ypsilanti (2001)

# Initial Design Tools

Material Standards & Parametric Design Rules



- **GCRMTC / MR&S Design Synthesis Model**
  - Defines principle characteristics based on owner requirements
- **Proteus / Spar Flagship suite**
  - Smart Product Model (SPM) Advanced Parametric Ship Design, Cost Estimating, and Production Planning
- **SPM infrastructure**

## Software Product

- *FastShip*
- *GHS/SDS*
- *NavCad*
- *MAESTRO*
- *ESTI-MATE*
- *PERCEPTION*

## Functional Area

- Hullform Design
- Hydrostatics and Stability
- Resistance and Powering
- Structural Modeling / Design
- Cost Estimating
- Production Planning

# Smart Product Model (SPM)

Material Standards & Parametric Design Rules

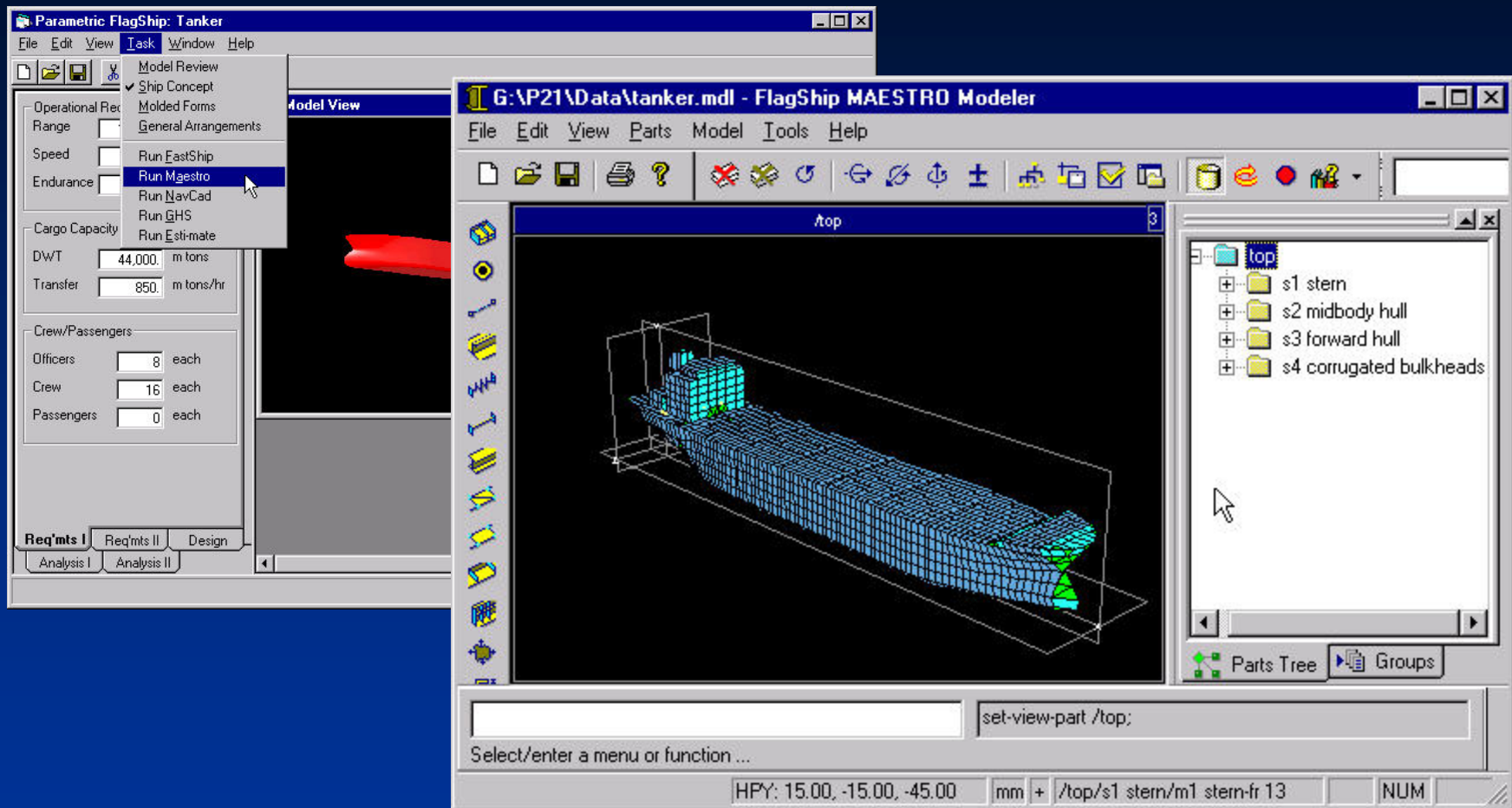
The screenshot shows the Parametric FlagShip: Tanker software interface. It consists of several windows:

- Parametric FlagShip: Tanker**: The main application window with a menu bar (File, Edit, View, Task, Window, Help) and a toolbar. A 'Task' menu is open, showing options like 'Model Review', 'Ship Concept', 'Molded Forms', 'General Arrangements', 'Run EastShip', 'Run Maestro', 'Run NavCad', 'Run GHS', and 'Run Estimate'. A red brushstroke is visible on the 'Model View' window.
- Parametric FlagShip: Tanker - [Model View]**: A window displaying a 3D model of a tanker ship hull, colored in red, blue, and green. A mouse cursor is pointing at the model.
- Operational Requirements**: A panel with input fields for Range (11,000 n mi), Speed (16 knots), and Endurance (29 days).
- Cargo Capacity and Req'ts**: A panel with input fields for DWT (44,000 m tons) and Transfer (850 m tons/hr).
- Crew/Passengers**: A panel with input fields for Officers (8 each), Crew (16 each), and Passengers (0 each).
- Req'ts I, Req'ts II, Design, Analysis I, Analysis II**: A set of buttons at the bottom of the requirements panel.
- demo**: A tree view on the right side of the interface showing a hierarchical structure of ship components: Structure, Propulsion Machinery (Fuel Oil, Lube Oil, Exhaust, Main Engine, Shafting, Propeller), Electrical, Electronics, Auxiliary, and Outfit.
- System, Volume, Geom, Cost**: A set of buttons at the bottom of the tree view.
- 12:16 PM**: A digital clock in the bottom right corner.

Parameters include top level owner's requirements, classification and limiting dimensions, naval architecture design parameters, ship characteristics, cost and labor analyses.

# Smart Product Model (SPM)

Material Standards & Parametric Design Rules



The SPM is linked to stand-alone tools for detailed design and analysis

# Cost ESTI-MATE Model

Material Standards & Parametric Design Rules



FlagShip Design Executive - Tanker Demo/T40

File Edit View Window Tools Help

Model View: Tanker Demo/T40 : 1

Parts Catalog: Category D-3-b

Part ID	Description	Weight	Spec
D-3-b-1000	FV-COMPRESSED AIR	0	P:\S
D-3-b-1001	FV-EOS	0	P:\S
D-3-b-1002	FV-MSD & Drainage	0	P:\S
D-3-b-1003	FV-Sludge Transfer	0	P:\S
D-3-b-1004	FV-Boiler & Panels	0	P:\S
D-3-b-1005	FV-Eng Workshop & Elect Workshop	0	P:\S
D-3-b-1006	FV-Spare Parts	0	P:\S
D-3-b-1007	FV-Reefer&AC	0	P:\S
D-3-b-1008	FV-FD Purification	0	P:\S
D-3-b-1009	FV-FD Transfer	0	P:\S
D-3-b-1010	FV-FD Purification	0	P:\S

Category Filter: D-3-b  Entire Catalog

Project T40

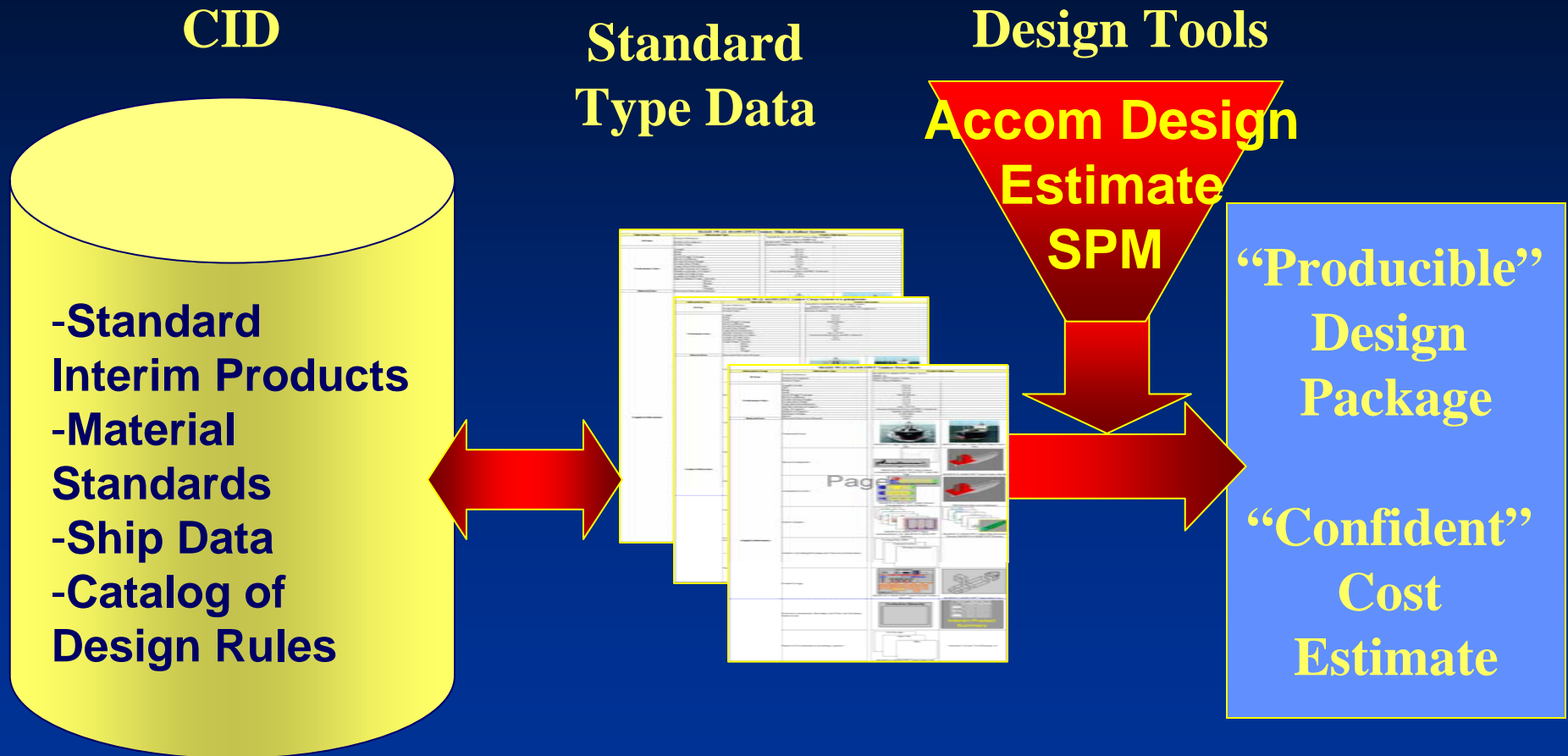
- SWBS
  - SWBS Group 1
  - SWBS Group 2
    - SWBS Account 210
    - SWBS Account 220
    - SWBS Account 230
    - SWBS Account 240
    - SWBS Account 250
    - SWBS Account 260
  - SWBS Group 3
  - SWBS Group 4
  - SWBS Group 5
  - SWBS Group 6
  - SWBS Group 7
  - SWBS Group 8
  - SWBS Group 9
- PWBS
  - PWBS Zone B
  - PWBS Zone C
  - PWBS Zone D
  - PWBS Zone M
  - PWBS Zone S
  - PWBS Zone DE
  - PWBS Zone SS
  - PWBS Zone SW
- Design Packages
  - Interim Product TD-CargoHandling Tank
  - Interim Product TD-CrewCosts Annual s
  - Interim Product TD-Deckhouse Outfit co
  - Interim Product TD-Design Engineering
  - Interim Product TD-Generator 1000 KW
  - Interim Product TD-MachineryZone Eng
  - Interim Product TD-Navigation Navigati
  - Interim Product TD-Paint Paint

Ready 03/13/2001 9:38 AM



# Design Process Development

Material Standards & Parametric Design Rules



# Project Accomplishments

Material Standards & Parametric Design Rules



- **Task 5 - Develop Metrics and Rules for 'Whole-Ship' Design**
  - Developed metrics that characterize design and cost estimating processes for three generic ship types that are representative of the product mix for a medium-size US shipyard
    - » Container ship
    - » Product/Crude Tanker
    - » RO/RO Trailer Ship
  - Rules catalog development, over 500 rules captured

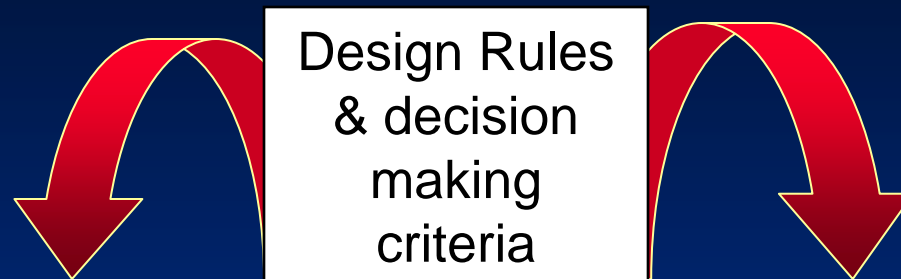




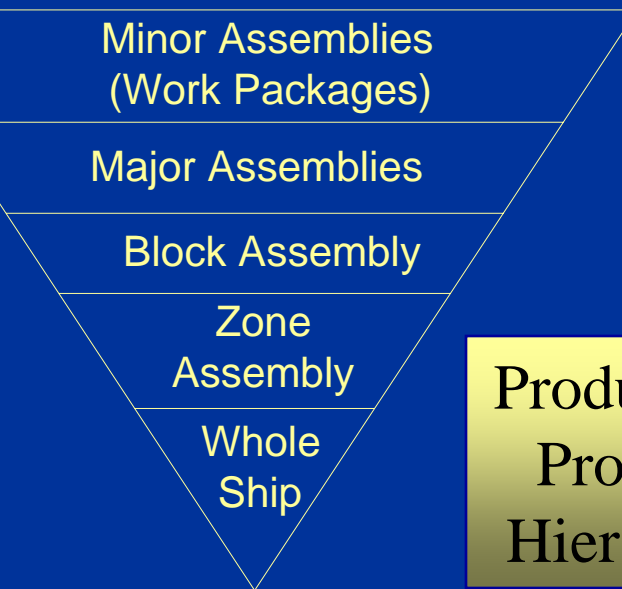
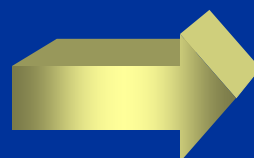
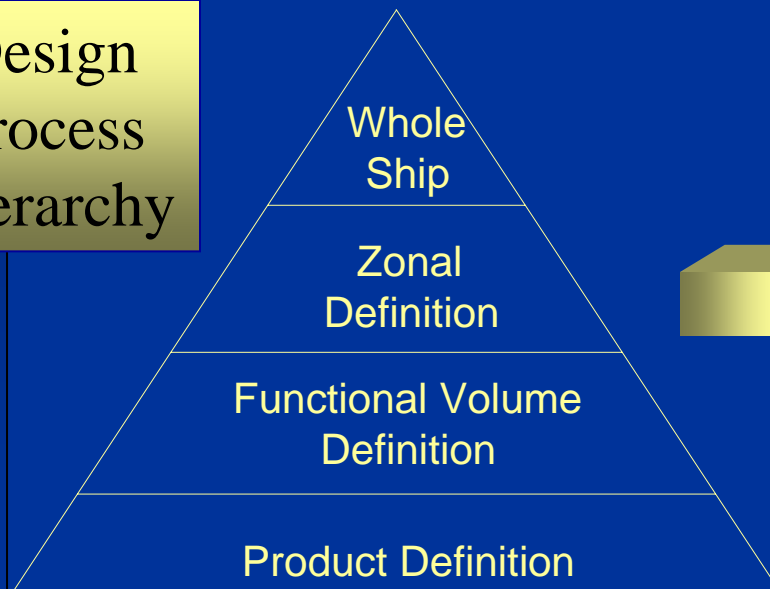
# Design Rule Hierarchy

Material Standards & Parametric Design Rules

## Design Rules Functional Volume Design



Design  
Process  
Hierarchy



Production  
Process  
Hierarchy

# Project Accomplishments

Material Standards & Parametric Design Rules



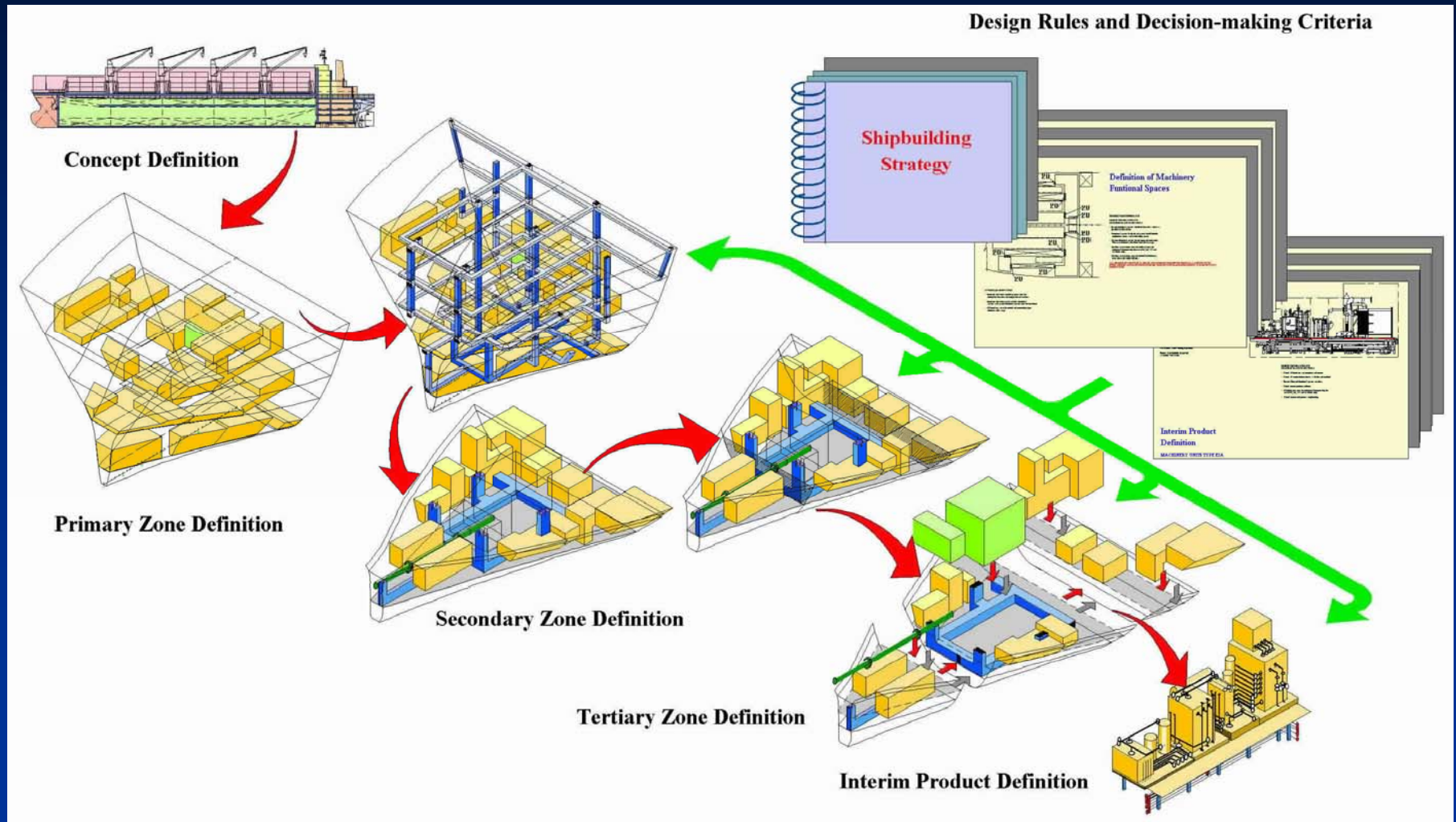
- **Task 6 - Develop Zone Design Rules & Material Templates**

- Generic Interim Products Defined
- Developed Design & Material Templates and Rules for each Ship Zone (Structure, Cargo, Machinery, Accommodations.)
- Defined Functional Volume Design method and processes
  - » Integrated design and cost estimating process
  - » Conducted training on methodology at Industry workshops
  - » Two technical papers presented at SNAME Ship Production Symposium

# Functional Volume Design

Material Standards & Parametric Design Rules

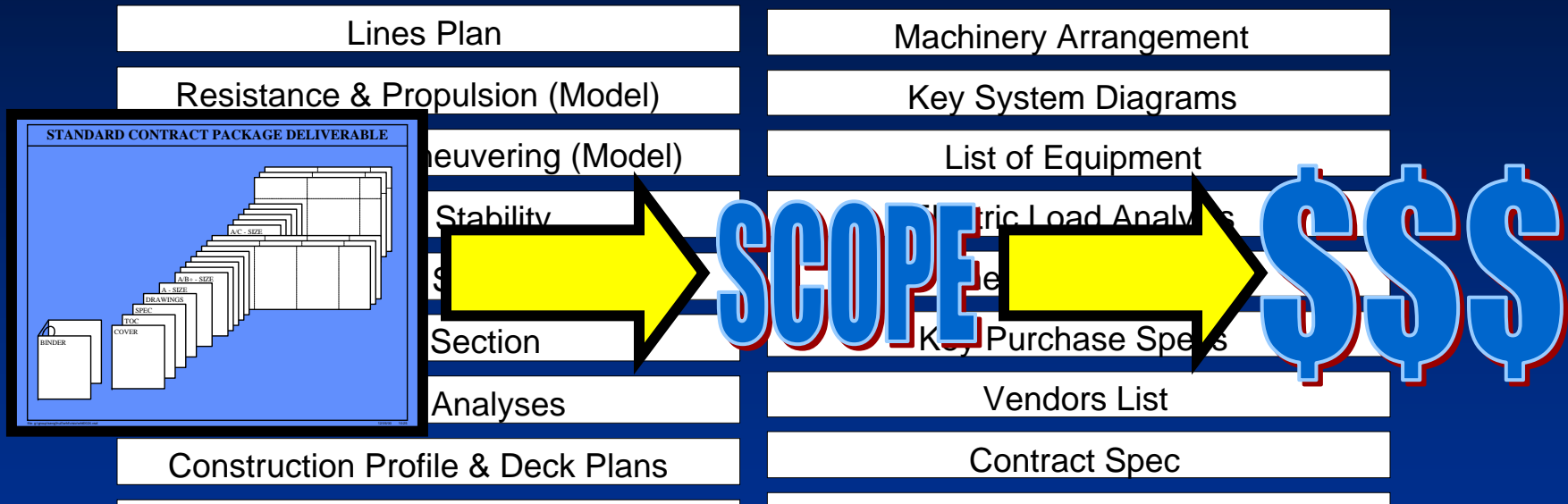
## Design Process Application



# Existing Design and Estimating Process



Material Standards & Parametric Design Rules



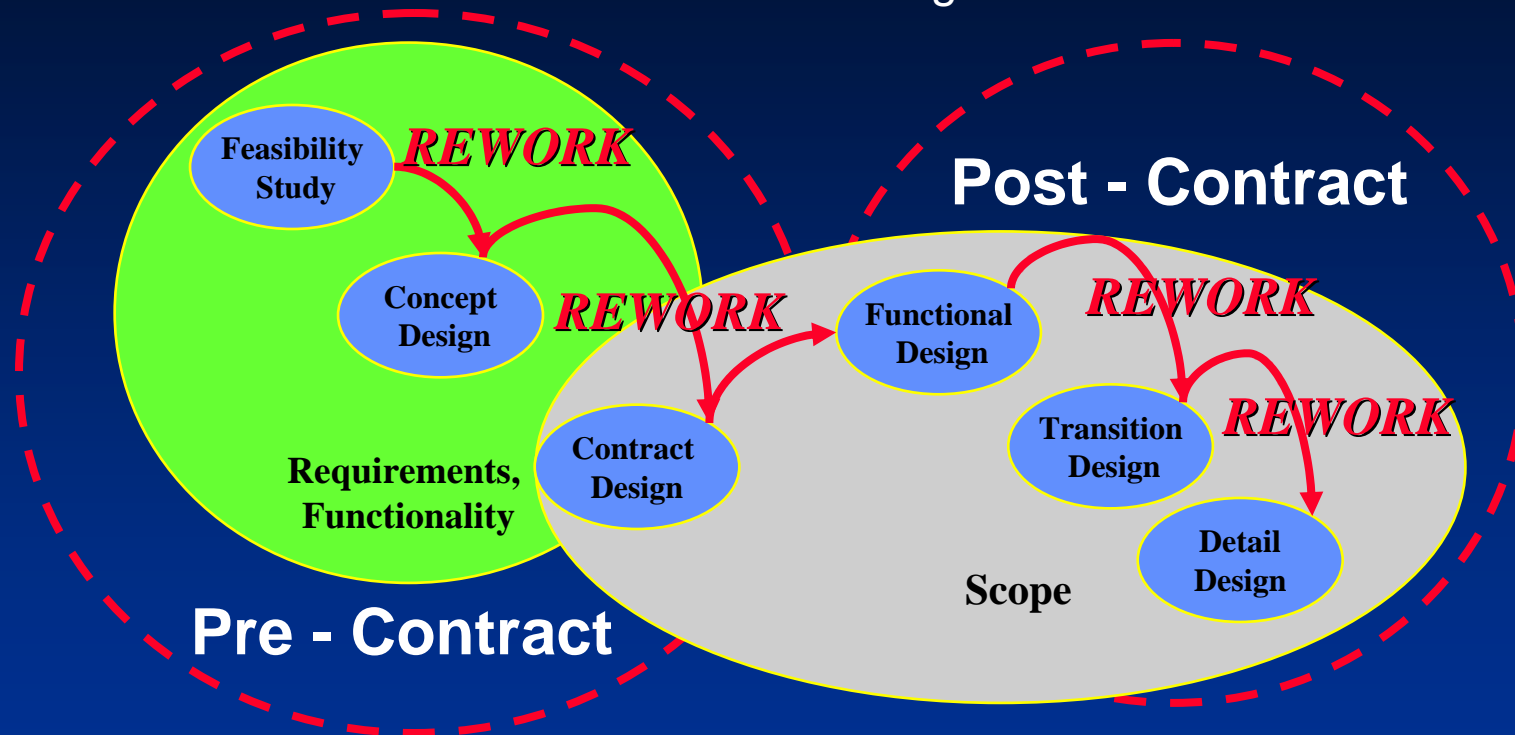
*Words and Pictures are converted to SCOPE and Dollars*

Capacity Plan & Stowage Arrgt.	Bid Level Estimate
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# Existing Design and Estimating Process



Material Standards & Parametric Design Rules



- Scope defined late
  - Therefore Estimating defines notional scope
- Many aspects of “design definition” are really “rework”
  - Rework is associated with information quality
  - Improving information quality reduces rework and shortens design cycle

# Functional Volume Design

Material Standards & Parametric Design Rules



**Integrates pre-contract activity to communicate SCOPE by using templates**

- ***Design* - visibility and responsibility for SCOPE**
- ***Estimating* - responsibility for rates and CER's**

**Together they drive out cost and eliminate re-work**

- **Risk is minimized - technical, cost, & schedule**
- **Schedule is reduced**

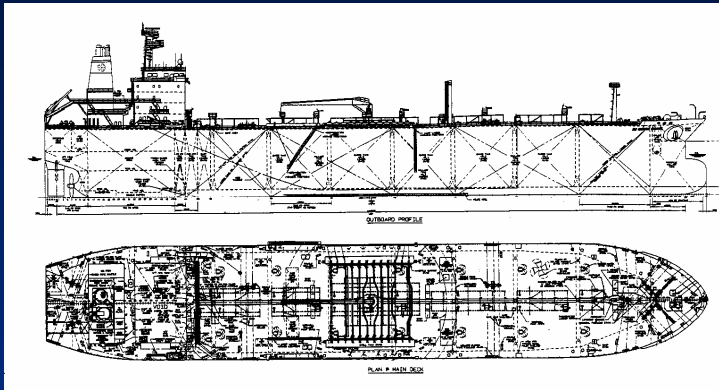


# Ship Type Selection

Material Standards & Parametric Design Rules



## • Task 7 - Validation Effort



Baseline Design selected as NNS Double Eagle Class Tanker

- Contract design package submitted
- Produced a video and a electronic photo file of the vessel

**A COMPLETE SHIP DESIGN WAS NOT VALIDATED**

# Project Accomplishments

Material Standards & Parametric Design Rules



- **Task 8 - Technology Transfer & Education**

- **Module 1 Background/Need for Project**

- **Module 1.1 Current State of Art/Lean Principles**

- **Module 1.2.1 Ship Design Toolset**

- **Module 1.2.2 Information Systems**

- **Module 2 Material & Equipment Standards**

- **Module 2.1.1 Use of Standards**

- **Module 2.1.2 Data Base Mgt – CID Part Equivalency**

- **Module 2.1.3 Data Base Mgt – CID Audit Process**

- **Module 2.1.4 Data Base Mgt – Data Element Dictionary**

- **Module 2.1.5 ABS/USCG Approvals**

- **Module 2.2.1 Specification Equipment Standards**

- **Module 2.2.2 CID Spec. Equipment Standards**

- **Module 2.2.3 CID Non-Spec. Equipment Standards**



# Project Accomplishments

Material Standards & Parametric Design Rules



- **Task 8 - Technology Transfer & Education**
  - **Module 3 Parametric Design Rules & System Tools**
    - Module 3.0 Improved Pre-Production Processes
    - Module 3.1 Introduction to Design Process
    - Module 3.2 Parametric Ship Design Tool
    - Module 3.6 Design & Material Templates
    - Module 3.7 Interim Products
    - Module 3.11 Accommodations & Deckhouse
  - **AccomDesign Software**
    - Module A1 Software Operating Instructions
    - Module A2 Software Use Example

# Project Accomplishments

Material Standards & Parametric Design Rules



## ● Task 9 - Prepare Project Reports & Deliverables

- 37 workshops and presentations conducted at Ship Production Symposia, NSRP Panel meetings, Project participant status reports and SNAME meetings at the national level.
- 8 Journal papers written
- Posted over 50 project deliverables on project web sites
  - » [nsrp.org](http://nsrp.org)
  - » [usashipbuilding.com](http://usashipbuilding.com)
- University classes and independent study work has been presented at U of Michigan & U of Washington
- One Master's Thesis at the University of Washington
- Developed ACCOM Design training software
- Completed 12 Education and Training Modules

# Potential Further Developments



- **Verify Functional Volume Design Approach Through Full Implementation**
  - A Methodology template has already been delivered
- **Continue Rules and Templates Development**
  - Further Develop Macro Standards for Integrated Products Across the Whole Ship
- **Demonstrate Applicability to Naval Ship Design**
- **Leverage On-going Developments with E Commerce and Common Parts Catalog Use**
- **Application of Expert Systems to Design Process**