NSRP Project: Design for Producibility for Mid-Tiered Shipyards

PDMT Panel Meeting Brief
June 4, 2008 Seattle, WA

Technology Investment Agreement (TIA) 2007-380:

DFP Project Mgmt Summary

- **Shipyard Participants**
  - Bollinger Shipyards - Lockport, LLC (Prime)
    - POC: Dennis Fanguy (Project Manager)
  - Todd Pacific Shipyards
    - POC: Bob Gilbert
    - Also: Scott Bawden, Eric Atkins
  - Atlantic Marine – Jacksonville, LLC
    - POC: Chuck Nugent
- **Technical Council**
  - Victoria Dlugokecki, P.E.
  - Hepinstall Consulting Group, Inc.: Lisa Hepinstall
- **Project Scope**
  - Awarded: January 2007; Final Workshop: November 2008
  - NSRP ASE Investment: $742K; Industry Investment: $742K

Overall:

On Budget

On Scope

On Schedule

Category B Data – Government Purpose Rights

Why this project?
…from FMI Benchmark on DFP

- "…there is a low appreciation of the importance of ***capturing production knowledge*** and ***defining facility constraints and attributes*** in order to ***define design parameters*** that result in optimum production performance…"
- "…high turnover of staff in many of U.S. yards means there is often a ***loss of DFP knowledge*** during gaps in design activity…"

(NSRP, "A National Consensus Investment Strategy to Address the findings of the 2004 Global Shipbuilding Industry Base Benchmarking Study", 2005)

Final Project Deliverables

"How To" Manual

- **Compilation of the "process" external deliverables**
  - Defines the entire development process for a shipyard's DFP Manual
  - Provides "blank" ship production tables, and "sample" ship production tables and rules

Final DFP Manual and Associated Manual Template

Shipyard DFP Manuals

- **Compilation of all the individual shipyard data gathered during the process**
  - Includes Facility Capabilities
  - Includes Steel Production Tables and Design Rules
  - Includes Outfitting Production Tables and Design Rules

DFP Manual – Bollinger
DFP Manual – Todd
DFP Manual – Atlantic

Category B Data – Government Purpose Rights

Shipyard Application and DFP Awareness Training

- **General information for each individual participating shipyard**
  - Principal Product Lines
  - Engineering Strategy and Capabilities
  - Production Processes and Capabilities
  - Facility Layout and Capabilities
- **Expectations of DFP Implementation**
- **DFP Awareness Training provided to shipyard personnel**

DFP Awareness Training Presentation – Available to Industry

Shipyard Capabilities and Constraints

- **Facility Information – Shops/Workstations**
- **Facility Information – Equipment Specifics**
- **Processes Outsourced**

Capabilities and Constraints Information Captured for Each Participating Shipyard

Formalizing the Shipyard Capabilities and Constraints Report – Available to Industry

Shipyard Capabilities and Constraints

- **Data Gathered for Each Shop/Area**
  - Primary Function of Shop
  - Workstation Identification
  - Material Flow
  - Length/Width of Bldg
  - Clear Height
  - Clear Width
  - Square Footage
  - Height under hook
  - Door Opening
  - Crane Support
  - Method of Transportation
  - Major Equipment

- **Data Gathered for Equipment**
  - Equipment Name and Description
  - Footprint
  - Max / Min Size Part / Plate that can be processed
  - Part Type (Plate, Flat Bar, Angles, etc)
  - Process (Manual, CNC, etc.)

Data documented on 11x17 "easy reference" tables

(1) Fabrication & Assy Areas

(2) Paint/Outside Covered Areas

(3) Specialty Shops

Structural Steel Preferences and Design Rules

- List of potential preferences for each structural steel process characteristic
- Evaluate alternatives and select preferred alternatives based on a total cost perspective
- Document the structural steel preferences of the shipyard in an easy-to-use ship production tables
- Document structural steel design rules for various phases of design – functional design, product modeling, production information development

Formalizing Structural Steel Preferences and Design Rules Reports – Available to Industry

Steel Production Tables

Table	Title	Atlantic	Todd	Bollinger
1	Hull Form Software File Compatibility	X	X	X
2	Steel Plate Ship Constructor Color Codes		X	
3	Steel Plate NC Pyros Task Color Codes	X	X	
4	Steel Plate Size / Thickness Preferences – Imperial Units	X	X	X
5	Steel Plate Thickness Preferences – Metric Units	X		X
6	Steel Shrinkage Factors and Adjustments – Compensated for in Lofting	X		
7	Steel Shrinkage Allowances for One-Sided Welder and DC Sub Arc Welds	X		
8	Steel Plate Cutting and Beveling Capabilities	X	X	X
9	Steel Plate Flanging Capabilities	X	X	X
10	Steel Plate Forming Capabilities	X		
11	Steel Plate Forming Details	X	X	
12	Steel Profile Size Preferences – Angles	X	X	X
13	Steel Profile Size Preferences – Flat Bars	X	X	X
14	Steel Profile Size and Cutting Preferences			X
15	Stiffener End-Cut Standards	X	X	X
16	Standard Structural Details Preferences	X	X	X
17	Standard Bracket Preferences			X
18	Structural Steel Process Size and Weight Limitations			X
19	Bevel Details Preferences	X	X	

Example of Steel Production Table

Steel Profile Size and Cutting Preferences								
Profile size	**3/16”**	**1/4”**	**5/16”**	**3/8”**	**1/2"**	**5/8”**	**3/4"**	**1”**
3” x 2”	**P**	**P**	**P**	**P**	**X**	**X**	**X**	**X**
4” x 3”	**X**	**P**	**P**	**P**	**A**	**X**	**X**	**X**
5” x 3”	**X**	**P**	**P**	**A**	**A**	**X**	**X**	**X**
5” x 3-1/2”	**X**	**X**	**P**	**P**	**A**	**X**	**A**	**X**
6” x 4”	**X**	**X**	**X**	**P**	**P**	**A**	**A**	**X**
7” x 4”	**X**	**X**	**X**	**A**	**A**	**X**	**A**	**X**
8” x 4”	**X**	**X**	**X**	**X**	**P**	**X**	**A**	**A**

Notes:

P indicates BSI preferred profile sizes

A indicates available profile sizes – non-preferred

X indicates not readily available profiles

Preferred: ***Everything above the demarcation line can be cut with the iron worker.***

Not Preferred: ***Everything below the demarcation line needs to be hand-cut.***

Outfitting Preferences and Design Rules

- List of potential preferences for each outfitting discipline's individual process characteristics
  - ➢ Outfitting Disciplines: Piping, Electrical, Machinery, HVAC and Vent, Joiner and Insulation, Paint, Metal Outfit
- Evaluate alternatives and select preferred alternatives based on a total cost perspective
- Document the outfitting preferences of the shipyard in easy-to-use ship production tables
- Document outfitting design rules for various phases of design – functional design, product modeling, production information development

Formalizing Outfitting Preferences Report – Available to Industry

Formalizing Outfitting Design Rules Report – currently working; will be Available to Industry

Outfitting Production Tables

Table	Title	Atlantic	Todd	Bollinger
1	Pipe Clearance Guidelines	X	X	X
2	Pipe Clearances - Pipe to Pipe		X	
3	Pipe Clearances - Crossing Pipes		X	
4	Nominal Pipe Size - Imperial to Metric Conversion	X	X	X
5	Pipe Material Schedule - Steel Systems - 1	X	X	X
6	Pipe Material Schedule - Steel Systems - 2	X	X	
7	Pipe Material Schedule - Sea Water Systems	X	X	X
8	Pipe Material Schedule - Exhaust Systems	X	X	X
9	Pipe Material Schedule - Stainless Steel Systems	X	X	X
10	Preferred Stainless Steel Tubing Sizes w/ pressures	X	X	X
11	Pipe Material Schedule - Copper Tubing	X	X	X
12	Pipe Joint Preferences	X	X	X
13	Pipe Bending Information - Pipe	X	X	X
14	Pipe Bending Information - Tubing	X	X	X
15	Pipe Hanger Spacing	X	X	X
16	Misc. Piping Metal Outfitting Preferences	X	X	X

Outfitting Production Tables

Table	Title	Atlantic	Todd	Bollinger
17	Electrical Design and Construction References	X		
18	Electrical Outfitting Modeling and PI Requirements	X	X	X
19	Preferred Electrical Cable Characterictics (3/4 cond)	X	X	X
20	Preferred Electrical Cable Characteristics (2 cond)	X	X	X
21	Preffered Electrical Control Cables	X	X	X
22	Preferred Electrical Power Panel Boxes (208V/102V)	X	X	X
23	Preferred Electrical Power Panel Boxes (480V)	X	X	X
24	Preferred Electrical Motor Controllers (Starters)	X	X	X
25	Preferred Electrical Wireways		X	
26	Preferred Electrical Penetrations		X	
27	Preferred ROX Multiple Cable Transit Frames	X		
28	Lighting Fixture Preferences	X		
29	Multi-Conductor Cable Color Code	X		
30	Electrical Outfitting Stardards Preferences	X		X

Outfitting Production Tables

Table	Title	Atlantic	Todd	Bollinger
31	List of Standard Technical Purchase Specifications	X		X
32	Equipment 3D Modeling Requirements	X		
33	Machinery Installation Preferences	X	X	X
34	HVAC and Ventilation Modeling and PI Requirements	X	X	X
35	Preferred Low Pressure System Duct Sizes: Round	X	X	X
36	Preferred Low Pressure System Duct Sizes: Rect.	X	X	X
37	Joiner Systems - Standard Sizes and Materials	X	?	X
38	Furnishings - Standard Sizes and Materials	X	?	X
39	Gellery, Mess and Laundry Equipment - Standard Sizes and Mate	X	?	X
40	Sanitary Fixtures - Standard Sizes and Materials	X		
41	Deck Covering Preferences		X	
42	Standard Drawing Preferences			X
43	Metal Outfitting Modeling and Drawing Preferences	X		
44	Preferred Steel Outfitting Installation and Paint Strategies	X	X	X
45	Misc Outfitting Standards	X	X	

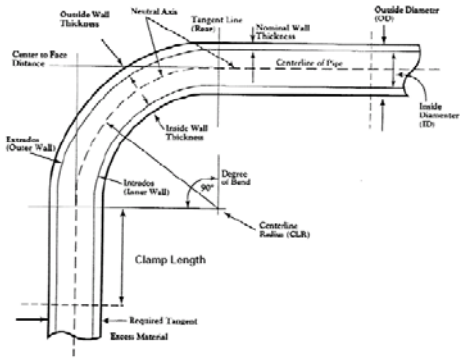
Example of Outfitting Production Tables

Pipe Bend Information –Steel Pipe

Nominal Diameter	Fixed Bend Radius (CLR)	Clamp Length *		Maximum Bend Angle	Distance Btw Bends (C to C)
		Ercolina Electric	RMD Hydraulic		
(inches)	(inches)	(inches)		(degrees)	(inches)
½"	1.8	3.8	5.8	90	6
¾"	2.2	4.5	5.5	90	8
1"	2.6	5.2	5.2	90	9
1 ¼"	3.5	5.6	4.6	90	11
1 ½"	3.9	6.3	7.3	90	14
2"	5.9	6.9	n/a	90	16
> 2"	Use Fittings (Also see note 1)				

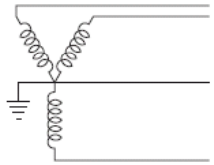
Note: Maximum pipe thickness is schedule 40.

* Clamp Length is the amount of pipe that needs to be inserted/held by the pipe bending machine – see sketch. The designer must allocate for at least this amount in the pipe spool design to enable the bending process.



Preferred Electrical Power Panel Boxes (208V/120V)

Square D NQ type Panels
208/120V, 3PH, 4W Service
Main Lug Only, Copper Bus
Factory Assembled
Plug-on Circuit Breakers



Amp Rating	No. of Circuits	Appox. Dimensions w/ Type 1 Enclosure			Appox. Dimensions w/ Type 12 Enclosure		
		W	H	D	W	H	D
100	18	20"	26"	5 ¾"	21"	26"	6 ¼"
100	30	20"	32"	5 ¾"	21"	32"	6 ¼"
225	30	20"	32"	5 ¾"	21"	32"	6 ¼"
225	42	20"	38"	5 ¾"	21"	38"	6 ¼"
400	30	20"	50"	5 ¾"	21"	50"	6 ¼"
400	42	20"	50"	5 ¾"	21"	50"	6 ¼"

Notes:

1) Dimensions given for basic space reservations. For detailed panel lay-out, see Square D catalogue 1640CT0701 (2007).
2) Use smallest panel (least amount of circuits) acceptable for intended application.
3) NEMA 1 Enclosure: Interior Spaces; Flush Mounted w/ door
   NEMA 12 Enclosure: Machinery Spaces; Surface Mounted box w/ front.
4) Flush Mounted panels for use only with Joiner Bulkheads.
   Surface Mounted panels for use in Machinery spaces, non-Joiner Bulkheads, etc.

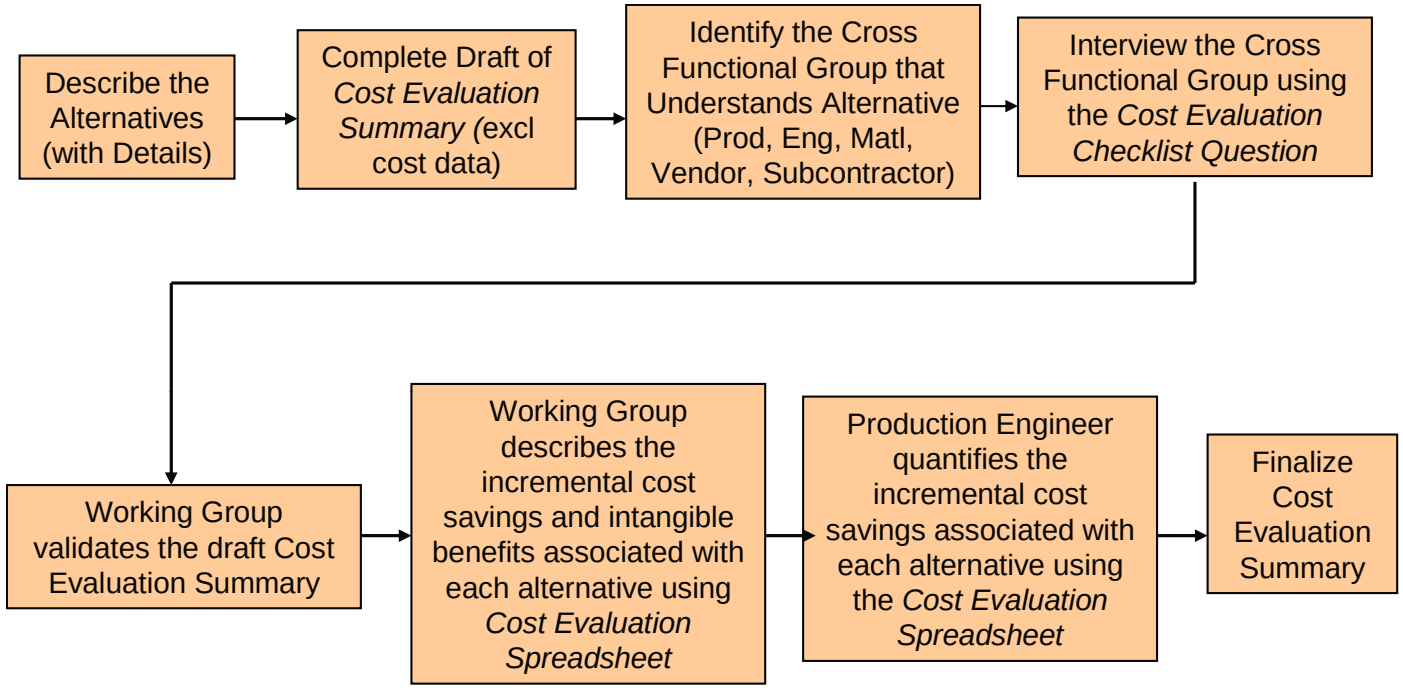
Steel and Outfitting Design Rules

Construction Discipline	Bollinger	Todd
Steel	57	70
Pipe	37	35
Electrica	31	22
Machinery	23	19
HVAC and Vent	27	27
Joiner and Insul	27	25
Paint	6	12
Metal Outfit	14	16
TOTAL	222	226

Examples of Steel and Outfitting Design Rules

- Maximize standardization of profile and frame scantlings and spacings.
- Minimize changes in plate thicknesses.
- Minimize number of plate strakes.
- Maximum module length is 39’-10” to allow for cutting of a 40’ plate. For curved portions of the hull, adjust as appropriate.
- Pipe bends are restricted to 90 and 45 degrees as far as practicable.
- Align parallel pipe runs on their outside diameter instead of their centerline to simplify supports
- Electrical penetrations are modeled, and included in the CNC plate information.
- Use local fan coil units (with no ducting) for ventilation of the pilothouse.
- Consider equipment installation and future maintenance requirements when determining equipment locations. The shipyard prefers to have a minimum of 1’ of clearance around all equipment if space is available.

Cost Evaluation Process



Cost Evaluation Process Enablers

- DFP Performance Evaluation Sheet
- Cost Evaluation Checklist Questions
- Cost Evaluation Spreadsheet

DFP Performance Evaluation Sheet (Cost Evaluation Summary)

DFP Preference Evaluation Sheet #1	
Method A Bollinger's preference is to order steel material by shipset and have it delivered by ship module in the sequence that it will be cut.	**Method B** An alternative method is to order steel material by shipset or by ship contract.
Impact Analysis ➢ Method A would incur an additional Material Unit Cost for added service. ➢ Method A requires stable detailed build strategy and intelligent nesting (nest by assembly vs nest by module) to determine the delivery sequence. ➢ Method A provides forcing function to ensure that build strategy is stable and executed according to plan. ➢ Method A - Risk of not having material available when needed. ➢ Method A - Less warehousing/storage area required. ➢ Method A - Potential for positive impact to cash flow. ➢ Method A -Less material handling due to delivering at point of use instead of warehouse or buffer area; Reduced search time; ➢ Method B - Negative Environmental impact associated with uncovered primed plate outside, resulting in zinc primer seepage into the water table. ➢ Method B – Negative material cost of material degradation. ➢ Method B - Opportunity cost associated with non-value added space utilization. ➢ Method A - Potential Material Savings from less lost material or damaged material. ➢ Method A - Multiple deliveries spread out over the build cycle might incur more labor associated with inspection, security, etc. ➢ Method A has more potential of incurring expediting fee. ➢ Method A increased purchasing function.	**Applicable DFP Guiding Principles** ➢ Minimize Lifting and Handling of Parts ➢ Minimize Number of Parts ➢ Optimize for Inspection and Test **Cost Summary** **Cost Savings per Rigdon Boat:** **Method A: $51,797** **Method B: $13,330** **$38,467** **Over 10 boat program $384,670** **Intangible Cost** Risk of vendor litigation would be reduced as vendor defects could be identified and resolved in the early deliveries. Less warehousing/storage area required so facility could be better utilized to support value-added activity Would reduce environmental impact associated with uncovered primed plate outside, resulting in zinc primer seepage into the water table.
Owner: Rhett Griffin	

- Method A Description
- Method B Description
- Impact Analysis
- Applicable DFP Principles
- Cost Summary
- Intangible Benefits
- Process Owner

Cost Evaluation Checklist Questions and Cost Evaluation Spreadsheet

- **Questions Developed for 8 Impact Areas**
  - Employee
  - Product/Service Quality
  - Productivity
  - Ship Delivery Lead Time
  - Material Cost
  - Facility & Equipment
  - Company Financial
  - Intangible

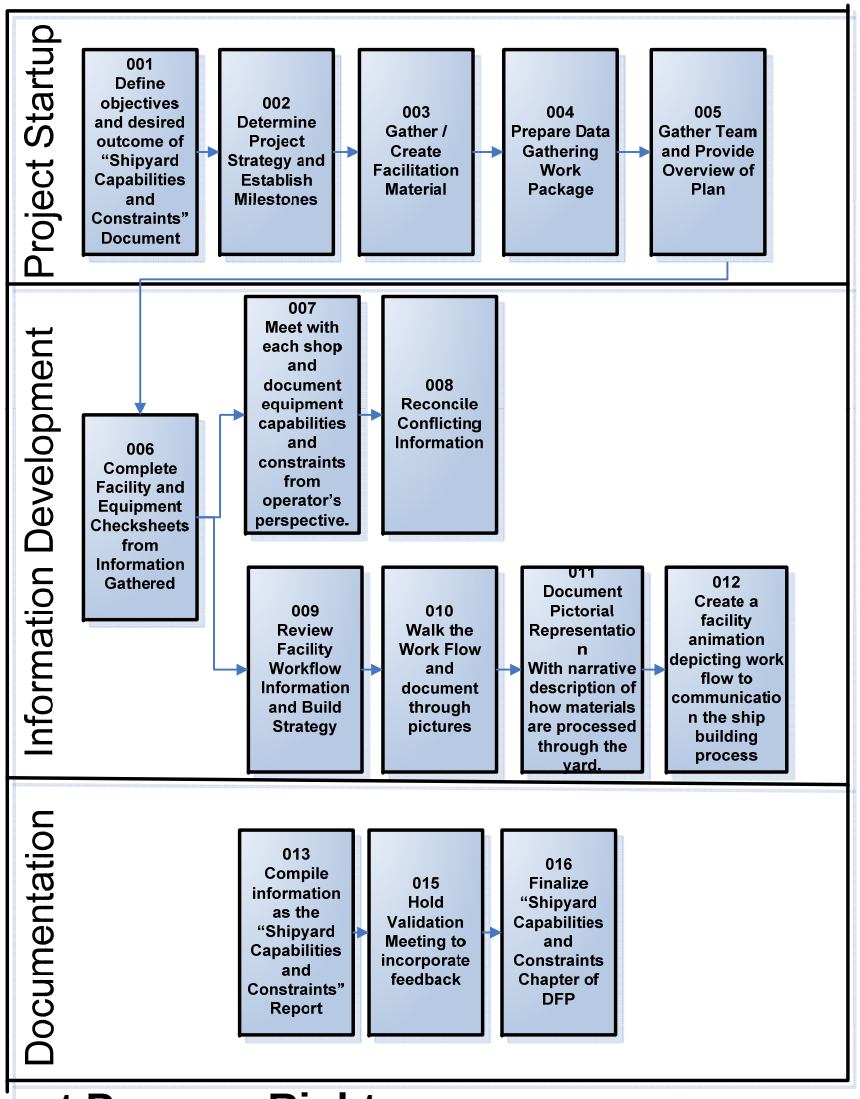
Cost Evaluation 1A		**Method Description:**								
			Incremental Cost Savings Explanation	**# Days**	**Eng Mhrs Saved**	**Prod Mhrs Saved**	**Mgmt Mhrs Saved**	**Labor $ Savings**	**Matl $ Savings**	**Added Revenue $**
1	**Employee Impact**	**Ergonomic Impact**	N/A					$ -	$ -	$ -
2		**Safety Risk**	Cost savings X% of Workers Comp from reduced safety risk associated with X less mhrs handling material (included in labor cost matl handling cost below)					$ -	$ -	$ -
3	**Quality Impact**	**Rework**	Cost savings of X Mhrs associated with rework would be achieved by surfacing engineering defects early in the process in time to correct for later shipments. Equates to the processing of 1 plate per boat @ X mhrs per plate.					$ -	$ -	$ -
5	**Productivity Impact**	**Ability to economically use construction aids**	N/A					$ -	$ -	$ -
		Labor Requirement	N/A							
6		**Value added time of supervisor**	Cost savings of X mhrs associated with time supervisor spends looking for materials					$	$	$

Category B Data – Government Purpose Rights

Approved for public release; Distribution is unlimited.

"Formalizing the …" Reports

- **Includes an overall definition of all of the process steps associated with each major DFP activity:**
  - Shipyard Constraints
  - Steel Preferences
  - Steel Production Tables and Design Rules
  - Outfitting Preferences
  - Outfitting Production Tables and Design Rules



"Formalizing the …" Reports

- **For each major process step, reports include:**
  - Purpose, Desired Outcome, Individual Process Steps, Inputs, and Deliverables
  - Inputs include process step guidelines, templates, instructions, questions, checklists, etc.

153 Templates to date

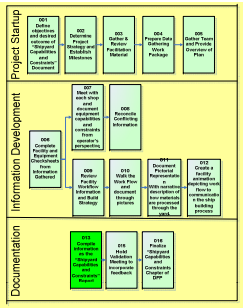
PROCESS STEP 013
Compile Information as the Shipyard Capabilities and Constraints Chapter of the DFP Manual

Purpose:

To consolidate the facility and equipment capabilities and constraints of the shipyard through "easy-to-use" summary tables and associated detailed information tables.

Desired Outcome:

A draft of the Shipyard Capabilities and Constraints Chapter of the DFP Manual is documented.



Process Step Visual

Process Owner: Project Team Leader

Process Steps:

Project Team Review PS-013 Guide-lines → Project Team reviews all inputs. → Project Team Reps incorporate data in the Summary Table Data Sheets → Project Team Reps format Shipyard Capabilities and Constraints → Project Team Reps draft narrative description - capabilities and → Project Team Reps incorporate Facility Flow Diagrams → Project Team Reps create draft of Shipyard Capabilities and Constraints

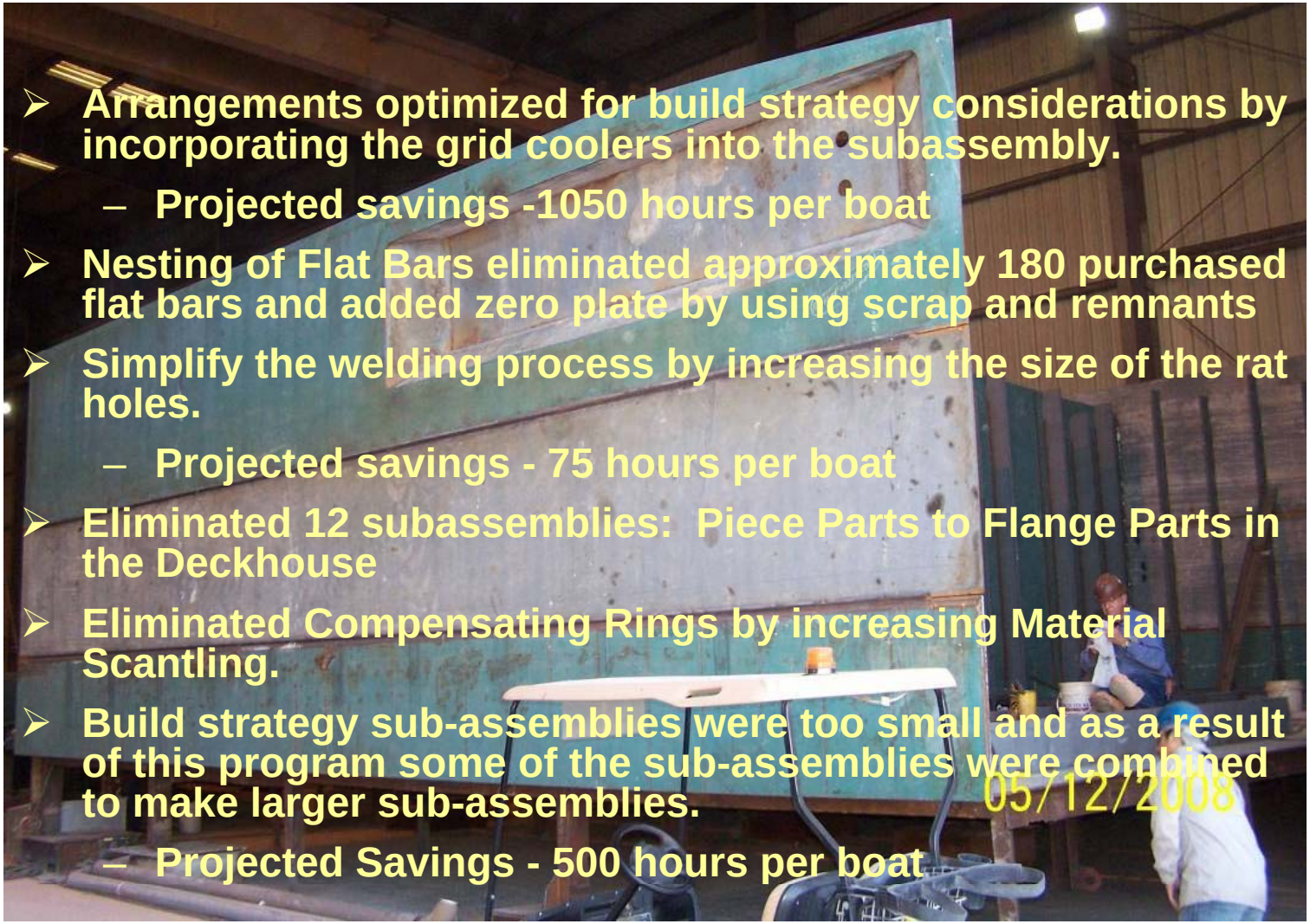
Inputs:

Process Step 013 Guidelines (A13)
Summary Table Data Sheets (11" x 17") (A55)
Facility Flow Diagram (A49)
Shop Flow Diagrams (A50)
Facility Flow Animation (A54)
Pictorial Representation of Work Flow for Shops (A53)
Pictorial Representation of Work Flow through Facility.
Completed Shipyard Data Collection Work Package.
Project Strategy Document (A16)

Deliverables:

Draft "Shipyard Capabilities and Constraints" Chapter of the DFP Manual. (A56)

Shipyard Implementation and Early Successes



- Arrangements optimized for build strategy considerations by incorporating the grid coolers into the subassembly.
  - Projected savings -1050 hours per boat
- Nesting of Flat Bars eliminated approximately 180 purchased flat bars and added zero plate by using scrap and remnants
- Simplify the welding process by increasing the size of the rat holes.
  - Projected savings - 75 hours per boat
- Eliminated 12 subassemblies: Piece Parts to Flange Parts in the Deckhouse
- Eliminated Compensating Rings by increasing Material Scantling.
- Build strategy sub-assemblies were too small and as a result of this program some of the sub-assemblies were combined to make larger sub-assemblies.
  - Projected Savings - 500 hours per boat


Questions?