Planning New Construction
&
Major Ship Conversions
Using
PERCEPTION®
Fundamental Project Tasks

- Develop the Basic Product Structure
  - Hull Blocks,
  - Ship Zones, and
  - Equipment/Outfit Modules

- Identify Product Teams & Responsibilities

- Develop Manufacturing & Build Strategy

- Develop Management Strategy

- Execute the Plan
Develop the Production Management Plan

- Budgets (Labor & Material) & Schedules
- Work Orders & Time Charging
- Material Control & Work Order Pallets
- Technical Packages for Production
- Tests & Quality Assurance
Develop the Contract Management Plan

- Project Management Team
- Change Order Management
- Progress Milestones & Payment Management
Establish the Basic Building Plan

Product Teams

- Engineering Planning Purchasing Production
- Hull Block Construction
- Parts Manufacturing
- Zone Outfit
- Tests & Trials
An integrated planning and resource management system coordinates schedules and tracks costs for

- Engineering,
- Purchasing & Deliveries,
- Inventory Control,
- Work Orders & Material Pallets,
- Trade Manpower,
- Subcontractors, and
- Shipyards Facilities.
Cost Estimating

Planning, Budgeting & Scheduling

Labor & Manpower Cost Management

Earned Value Management Reporting

Purchasing & Material Cost Management

Cost Analysis
PERCEPTION Integrates the Shipyard Business Processes
Planning and managing ship construction requires careful coordination of a wide variety of different resources & responsibilities.
- Engineering & technical development
- Purchasing & material control
- Subcontractors & vendors
- Production shops, trades & support services
- Hull erection sites and assembly areas
- Waterfront facilities & equipment
- Financial & project management services
- Classification societies & government authorities
- Ship owner representatives
Assembly operations are the most significant cost drivers. They are influenced by a very large degree by when the assembly is performed.
Assembly on Outfit Unit

(most productive stage of construction)

Assembly on Hull Block

(more productive than on board ship)

Assembly on Board ship

(least productive stage of construction)
Primary Labor Costs: Assembly & Installation

<table>
<thead>
<tr>
<th>Stages of Production</th>
<th>Percent Cost</th>
</tr>
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<tbody>
<tr>
<td>Parts Mfg</td>
<td>0%</td>
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<tr>
<td>On-Unit Ass'y</td>
<td>100%</td>
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<tr>
<td>On-Block Ass'y</td>
<td>200%</td>
</tr>
<tr>
<td>On-Board Ass'y</td>
<td>400%</td>
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</tbody>
</table>
Options for outfitting hull blocks:

1. "Stick" build outfit materials on block
2. Assemble outfit module in shop, then install module on block.
"Stick" building outfit materials on block.

- Less productive work environment than in shop.
- Few opportunities for repeatable products cost savings.
Building outfit module in shop.

- More productive work environment
- Opportunities for repeatable products cost savings.
Installing outfit module on block (limited effort outside shop).

Net Cost Savings
Productivity of Assembly On-Block also is dependent upon block size.
Productivity vs Block Size

Production Cost

Block Size (Tons)
The primary focus of planning must be to organize all work activities to support the major assembly operations:

- Outfit Units
- Hull Blocks
- On-Board Ship Outfit Zones
Planning, Integrating & Managing Shipyard Resources

- Engineering
- Purchasing
- Planning
- Parts Manufacturing
- Shipyard facilities
- Sub-Contractors

Shipyard Products

- Equipment & Outfit System Modules
- Pre-Outfitted Hull Block Construction
- On-Board Outfit Zones
Develop the Performance Management Plan

• Product Work Breakdown Structure (PWBS)

• Process Work Centers & Work Stations (Cost Codes)

• Systems Work Breakdown Structure (SWBS)
Product Work Breakdown Structure

PWBS

Ship

- Services
  - Services Package
  - Zone Outfit Package

- Super Structure
  - Outfit Unit Package
  - Unit
    - Flat Panels
    - Curve Panels
    - 3-D Struct
    - Shell

- Engine Room
  - Engine Package
  - Block
    - Block

- Stern

- Midbody

- Bow
Product Work Breakdown Structure

PWBS

Ship
Ship Zone & Hull Block
Hull Unit & Outfit Module
Assembly
Sub Assembly
Manufactured Parts
Components

Product Cost Management
Process Cost Management
Shipyard Process Cost Codes

- Project Total
  - Shipyard Division
    - Department
      - Work Center
    - Work Centers
  - Work Orders
  - Time Charges
Systems Work Breakdown Structure

SWBS

Project Total

System Group

System Accounts

Systems-Based WORK ORDERS

TIME CHARGES
Relating Process Costs to Ship System Costs Via Allocated Distributed Work Orders

Automated Cost Allocation
Develop the Build Strategy

- Production Engineering Plan
- Manufacturing & Assembly of Structural Parts Plan
- Manufacturing & Assembly of Outfit Systems Plan
- Hull Block Construction Erection Sequence Plan
- Assembly & Erection of Equipment & Outfit Modules Plan
- On-Board Zone Outfit Plan
- Tests & Trials Plan
Plan Manufacturing & Assembly Processes

Pre-Outfitted Hull Block Construction

Equipment & Outfit System Modules
Develop Erection Sequence of Hull Blocks & Equipment Modules

Integrate with On-Board Zone Outfit, Tests & Trials
Criteria for Maximizing Efficiency

- Maximize work during most productive stages of construction (On-Unit & On-Block)
- Minimize work during less productive stages of construction (On-Board)
- Maximize work under cover
- Maximize access to work
- Minimize material handling
- Minimize non-productive activities
• Maximize productivity of available manufacturing processes

• Ensure all necessary resources are readily available at work times scheduled
  • drawings,
  • materials,
  • tools & facilities, and
  • manpower

• Exploit benefits of engineering, material and production standards
Maximize Productivity of Available Manufacturing Processes

Efficiency Lost From Process Interruption

Process Cost Per Unit Produced

Units Produced

Interrupted Process
Un-Interrupted Process
Develop Material Management Plan to Support Production

- Purchase Order Management
- Sub-Contract Management
- Warehouse & Inventory Management
- Production Work Order Kitting Management
Managing Material
From Engineering to Production

PERCEPTION

Life Cycle
Material Control

- Material Requisitions
- Purchasing
- Receiving
- Inspecting
- Warehousing
- Kitting
- Issues to Production
- Actual Usage
- Excess Stores
- Historical Records
- Planned Requirements
- Optional CAD Interface
- Vendor Invoices
- Customer Billings
- Interface with Accounting Systems

Interface with Accounting Systems
Packaging Work for Stages of Construction

RAW MATERIALS:
- Direct Purchase Material
- General Stock Material
- Owner Furnished Material
- Manufactured Parts

BILL OF MATERIAL REQUISITION ITEM
PURCHASE ORDER ITEM
Develop Production Work Orders

Process Sequence: Pre-Outfitted Hull Block Construction

Process Sequence: Outfit Fabricate & Install

Process Sequence: Repair & Install
A work order is a distinct and definable unit of work that can be started and completed without significant interruption under the direction of a single work center.
Size of Work Orders

The size of work orders will vary, depending on scope.

Generally, large work orders are more difficult to manage than smaller work orders.

Large work orders that are open and in-process for a long period of time always collect more costs than necessary. Actual progress is impossible to measure.

However, work orders too small also are difficult to manage. They require more overhead to plan and manage. They increase opportunities for time charge errors.
A good rule of thumb for new construction work orders:

Average 250 man-hours of labor

Average 2 weeks duration
Time Charging

*PERCEPTION* provides functions for entering and validating authorized work order time charges
The recording of time charges against authorized work orders is of major importance to the shipyard.

Correct and complete time charging against contracts is often the basis by which the shipyard bills its customers.

Without accurate and timely information, billings can be incomplete or late causing considerable problems with the ability of the shipyard to make a profit.
Completing Work Orders

Every work order should be authorized so that it can be completed without undue delay.

*PERCEPTION* provides a formal closing out procedure that indicates to the system that the work order is finished.
From completed work orders, *PERCEPTION* measures, tracks and forecasts cost variances automatically.
Work orders that are held up for QA inspections may have a QA & Pick Up work order created, with appropriate budget, that allows the bulk of the work to be closed out.
Suggestion: Work orders that require additional scope of work due to short-comings of preceding work orders should be reimbursed with budget transferred from those earlier work orders.
PERCEPTION offers 4 Primary Types of Work Orders for Different Operations Requirements

• Discrete Work Order
• Distributed Work Order
• Time-Phased Work Order
• Process Work Order
1. The discrete work order identifies work that can be catalogued easily within a given work breakdown structure.

The discrete work order identifies work that ultimately produces a definable interim or end product.
2. The distributed work order identifies work across multiple elements of the work breakdown structure.

The distributed work order is useful for collecting costs by unit module, ship zone or group manufacturing process and allocating the costs automatically to individual ship systems.

- Potable Water System
- Sanitary Waste System
- HVAC
- Foundations
3. The time-phased work order identifies a level of effort activity that has no clear end product. Examples include supervision and shipyard support services.

The time-phased work order manages time charge budgets on a monthly basis with no changes in the work order charge number.

Support Services Packages
4. The process work order measures actual production rates for specific manufacturing processes. Performance is measured not only in terms of labor hours and costs against budgets, but also in terms of planned versus actual production throughput units of measure (feet of weld, tons of steel, etc.).

The system generates forecasts of these throughput rates as learning becomes evident and efficiency improves.

Manufacturing Process
Work Packages
Managing the Project Execution

- Time Charging Procedures
- Material Issue Procedures
- Technical Package Issue Procedures
- Budgets & Integrated Schedules
- Performance Reporting
Tracking Performance Costs

Cost Performance For Contract 47K Tanker Project 1

- BAC
- ACP
- ROWS
- EAC
- BCWS

Perception
Tracking Progress

Planned vs. Actual Progress for Contract 47K Tanker Project 1

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- RED: ACTUAL PROGRESS
- GREEN: PLANNED PROGRESS
- BLUE: MANUAL PROGRESS
Tracking & Forecasting
Schedule Variance

Ahead-Behind Schedule For Contract 47K Tanker Project 1

% Progress

CURRENT WEEKS AHEAD
WEEKS TREND @ 100% PROGRESS
Tracking & Forecasting
Over-Budget/Savings Variance

Forecast Overrun For Contract 47/K Tanker Project 1

- Perception

- FORECAST OVERRUN
- TREND OVERRUN
Tracking Cost/1% Progress

Cost of 1% Progress For Contract 47K Tanker Project 1

- MANHOURS PER 1%
- PLANNED MANHOURS PER 1%
Tracking Performance Indexes

Performance Indices For Contract 47K Tanker Project 1

Perception

CPI  SPI  FCPI  CSPI  CCPI  TCPI
Tracking Material Costs

![Material Cost For Contract TSHIP CONTRACT Project 2002 Graph]

- Red: MATERIAL PAYMENTS
- Green: PURCHASES
- Blue: COMMITTED
- Yellow: RECEIPTS
- Pink: USED

Date:
- Jan '02
- Apr '02
- Jun '02
- Sep '02
- Dec '02

Cost:
- 0,00
- 5,000,000.00
- 10,000,000.00
- 15,000,000.00
- 20,000,000.00
- 25,000,000.00

Perception:

SPAR Associates, Inc.
## On-Line Cost & Schedule Status Reporting

### Summary Project Information

#### For Cont: TSHIP CONTRACT  Proj: 2002

<table>
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<tr>
<th>Labor Status</th>
<th>Material Status</th>
<th>Overall Status</th>
<th>Indexes</th>
<th>Variances</th>
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### Labor & Cost Details

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<tr>
<th>Man-Hours:</th>
<th>Budgeted Cost of Work Scheduled</th>
<th>Budgeted Cost of Work Performed</th>
<th>Actual Cost of Work Performed</th>
<th>Budgeted Cost</th>
<th>Estimated at Completion</th>
<th>Reserves</th>
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<td>16,732,769</td>
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<table>
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<th>Man-Hours:</th>
<th>Budget + Reserves</th>
<th>Less EAC</th>
<th>Less Rework</th>
<th>Labor Margin</th>
<th>Estimated Remaining Labor</th>
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### Start & Finish Dates

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<tr>
<th>Planned Start</th>
<th>Finish</th>
<th>Total Progress</th>
<th>% (Closed)</th>
<th>% In-Process</th>
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<tr>
<td>09/12/1991</td>
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<td>68.23</td>
<td>58.40</td>
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<td>Actual</td>
<td>Finish</td>
<td>Total Planned</td>
<td>% (Behind)</td>
<td>% Weeks</td>
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<td>Number of Work Packages</td>
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<td>Budgeted Hours</td>
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</table>

**NOTE:** Rework not included in Actual or EAC.
# PWBS Zone Progress Report

**Contract ID:** TSHIP CONTRACT-T-SHIP Series Contract

<table>
<thead>
<tr>
<th>Zone</th>
<th>Percent Progress</th>
<th>Current Labor Hours</th>
<th>Final Hours</th>
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<tbody>
<tr>
<td></td>
<td>Planned</td>
<td>Actual</td>
<td>Weeks Ahead</td>
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<tr>
<td>20 ENGINE ROOM</td>
<td>47.24</td>
<td>32.66</td>
<td>-14.38</td>
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<td>21 ER BELOW FLOOR PLTS</td>
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<td>100.00</td>
<td>0.00</td>
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<td>22 ER ABOVE FLOOR PLTS</td>
<td>82.19</td>
<td>48.10</td>
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<td>23 ER MACHINERY DECK</td>
<td>86.17</td>
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<td>24 ER MAIN DECK</td>
<td>68.42</td>
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<td>27 ER CASHING</td>
<td>55.67</td>
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<td>28 FUEL</td>
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<td>29 MAIN CONTROL ROOM</td>
<td>18.66</td>
<td>11.27</td>
<td>-7.39</td>
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Tracking Manpower Requirements

• As Planned in Baseline
• As Currently Planned
• As Actually Expended To Date
• As Forecast to Complete

Manpower can be evaluated by WBS, by shipyard work center, for one project or across multiple projects.

The analysis can combine current back-log with proposed new work.
Tracking Manpower Requirements (Planned Vs Actual Vs Forecast)
New Work Manpower Modeled On Top Of Active Work Manpower