Estimating the Cost of New Construction Using *PERCEPTION*
Computerized Cost Estimating

- Computer-based tools to quickly formulate a cost estimate
- Manage cost data from central database
- Maintain current catalog of actual costs
- Maintain catalog of prior estimates
Establish Libraries of Centrally Available Cost Data
Benefits

• Fewer cost surprises
• Faster bid response
• Lower cost risk
• Greater profit potential
• More competitive bids
Basic Tool Set:

- Application of learning curves
- Complexity & productivity factors
- Cost escalation
- Cost risk analysis
- Cost trade-off
- Global edits and update features
- Return cost data analysis
- User documentation of cost estimate
- Tracking of estimate sources and changes
Work Breakdown Structures

The cost estimates are developed according to a Work Breakdown Structure (WBS):

- Identify work items
- Identify work process costs
Identify Work Items

Work Items may be cataloged by

- Ship System WBS (SWBS)
- Shipyard Product WBS (PWBS)
- Ship Owner’s WBS
- Government Contract Line Item (CLIN)

Each structure can be customized by shipyard, by contract.
Identify Work Process

Work Process may be cataloged by

- Stage of Construction (Rip-Out, Shop Work, On-Unit, On-Block, On-Board, Test)
- Shipyard Department (COA)

Each structure can be customized by shipyard, by contract.
Cataloging Standard Costs

Catalog Standard Cost Estimating Relationships (CERs) onto Computer Database
What is a CER?

A Cost Estimate Relationship (CER) is a formula relating the cost of an item to the item’s physical or functional characteristics or relating the item’s cost to the cost of another item or group of items.

Examples:

a) for steel block assembly, 25 man-hours/ton;
b) for pipe material, $25/meter; and
c) for shipyard support service, 10% production hours.
Cataloging Standard Costs By Work Sequence

Pre-Outfitted Hull Block Construction

Equipment & Outfit System Modules
Hull CERs by Block Type

Steel Production

Mid-Ships Block Types

- Prep & Fab
- Assembly
- Erect
- On-Ship Weld
- Total

Stage of Construction

Labor Hours Per MTON

- 0.00
- 10.00
- 20.00
- 30.00
- 40.00
- 50.00
- 60.00
- 70.00
Develop Standards of Labor & Material Cost Packages

Complete Equipment Packages
Cargo Zone Packages
Accommodations Outfit Packages
Safety Equipment Packages
Electronics Packages
Shipyard Services Packages
.....and more.
Cataloging Standard Costs By Sequence

- Rip-Out
- Replace
- Repair
- Install
- Test

- Engineer
- Fabricate
- Assemble
- Install
- Test
Possible Levels of Product-Based CERs

- Cargo Hold: Mhrs/BBL
- Block Erection: Mhrs/Ton
- Outfit Fittings: Mhrs/EA
- Outfit Pipe: Mhrs/IN-FT
- Block Paint: Mhrs/SQFT
- Block Assembly: Mhrs/Ton
- Steel Fab: Mhrs/Ton
- Steel Prep: Mhrs/Ton

Product & Process Sequence

[Diagram with process sequence and corresponding man-hours rates]
Outfit CERs by Stage of Construction
Cataloging Standard Costs By Ship System (SWBS)

- Structural Work
- Machinery
- Piping
- HVAC
- Electrical
- Paint
- Outfit
- Shipyard Services
Cataloging Standard Costs By Ship Zone (PWBS)

- Bow Construction Zone
- Cargo Construction Zone
- Machinery Construction Zone
- Stern Construction Zone
- Deckhouse Construction Zone
- Ship-Wide Construction Zone
Variations of CERs:

Line Item CER:
Single V-butt weld size 3/16" - 5/16" (2 pass)  0.250  MH/FT

Re-Use Package CER:

<table>
<thead>
<tr>
<th>Welding Repairs:Cracks</th>
<th>Labor CER</th>
<th>Labor UoM</th>
<th>Material CER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drill Out</td>
<td>0.500</td>
<td>MH/FT</td>
<td>$</td>
</tr>
<tr>
<td>Welding Repairs:</td>
<td>0.250</td>
<td>MH/FT</td>
<td>$ 1.4680</td>
</tr>
<tr>
<td>Gen Labor:</td>
<td>0.250</td>
<td>MH/FT</td>
<td>$</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>1.000</strong></td>
<td><strong>MH/FT</strong></td>
<td><strong>$ 1.4680</strong></td>
</tr>
</tbody>
</table>
Variations of CERs:

CERs Based Upon Ship Design & Performance Characteristics:

<table>
<thead>
<tr>
<th></th>
<th>Labor Hours CER</th>
<th>Material Cost CER</th>
<th>UoM CER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cargo Transfer Pumps</td>
<td>0.0606</td>
<td>$22.93</td>
<td>GPM</td>
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<tr>
<td>Paint</td>
<td>15.59</td>
<td>$425.17</td>
<td>CuNo</td>
</tr>
<tr>
<td>Shafting</td>
<td>0.1695</td>
<td>$20.26</td>
<td>kW</td>
</tr>
<tr>
<td>Dry Docking</td>
<td></td>
<td>$0.27</td>
<td>Days-GRT</td>
</tr>
<tr>
<td>Hauling</td>
<td></td>
<td>$0.50</td>
<td>Days-LOA</td>
</tr>
</tbody>
</table>
Variations of CERs:

**CERs Based Upon Multiple Parameters:**

<table>
<thead>
<tr>
<th>Main Propulsion Installation Labor Hours</th>
<th>$2.27 \times [\text{Displacement} \times \text{Speed}^3]/[\sqrt{\text{LWL}}^3]$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ship Characteristics Parameters</strong></td>
<td></td>
</tr>
<tr>
<td>Displacement - LTONs</td>
<td></td>
</tr>
<tr>
<td>Speed - Knots</td>
<td></td>
</tr>
<tr>
<td>LWL - Feet</td>
<td></td>
</tr>
</tbody>
</table>
Cost Adjustments

\[ \text{Cost} = f_{\text{adjust}} \times \text{Standard Cost} \]
Automating Cost Adjustments

- Work Productivity
- Work Site
- Work Access
- Economic Cost Escalation
- Learning Experience
- Standard Material Savings
- Material Waste Adjustments
Impact of Work Productivity

- **Alternate Methods**: Expensive staging versus mobile lift
- **Automation**: Manual versus automated welding
- **Alternate Resources**: In-House versus Sub-Contract
- **Worker Skill Level**
Impact of Work Site

Added Cost Factor

- In Shop
- On Block
- On Board

Cost Factors:
- 0%
- 100%
- 200%
- 300%
- 400%
- 500%
- 600%
Impact of Work Access:

Added Cost Factor

On Weather Deck | Oil Tanks | Engine Room | Superstructure | Pump Room | Holds | Double Bottoms
--- | --- | --- | --- | --- | --- | ---
0% | 10% | 20% | 30% | 40% | 50% | 60%
Impact of Work Access:

Over-Head

Down-Hand

More Difficult = More Expensive
**Productivity vs Ship Type and Shipyard**

- **Ship Type:**
  - G-Submarine
  - F-8,000 Ton Combatant
  - E-100,000 Ton Combatant
  - D-2,500 Ton Auxiliary
  - C-17,000 Ton Auxiliary
  - B-40,000 Ton Auxiliary
  - A-45,000 Ton Supply/Oiler

- **Shipyard:**
  - 1
  - 2
  - 3
  - 4
  - 5
  - 6
  - 7
  - 8
  - 11
  - 12
  - 13
  - 14
  - 15
  - 22
  - 23
  - 24

*Based on Structural data*
Impact of Cost Escalation:

Cost Escalation Index

1.40
1.35
1.30
1.25
1.20
1.15
1.10
1.05
1.00

Year


Cost Escalation Index

Escalation Index
Impact of Learning:

Cost Reductions From Repeatability

Percent of First Item Cost

Number of Similar Items Worked

Effectiveness Over Time

Cost Reductions Over Time

Impact of Learning:

Cost Reductions From Repeatability

Percent of First Item Cost

Number of Similar Items Worked

Effectiveness Over Time

Cost Reductions Over Time

Impact of Learning:

Cost Reductions From Repeatability

Percent of First Item Cost

Number of Similar Items Worked

Effectiveness Over Time

Cost Reductions Over Time
Impact of Standard Materials:

- **Standard material items** typically less expensive than non-standard items.
- **Standard material deliveries** less expensive than high-priority rush orders.
Cost Risk Analysis

Cost Risk

Range of Costs

Minimum | Expected | Maximum

$0 | $200 | $1,400

$200 | $400 | $1,600

$400 | $600 | $1,800

$600 | $800 |

$800 | $1,000 |

$1,000 | $1,200 | $1,400

$1,200 | $1,400 | $1,600

$1,400 | $1,600 |
Cost Risk Analysis

Cost Probability

Probability

Cost Range

$0 $500 $1,000 $1,500 $2,000
0% 20% 40% 60% 80% 100% 120%
Hardware Options

Single User Laptop

Single User Desktop
Hardware Options

Multi-User Network
Many Report Formats

- Detail Cost Item Reports
- WBS Summary Reports
- Major Equipment Lists
- Detail Bills of Material
Cost Detail Information

• Labor Hours
• Labor Costs
• Material costs
• Total Direct Costs
• Taxes & Duties
• Indirect Costs
• Profit
• Total Cost
Other Capabilities:

• **Import/Export**: Spreadsheets & Databases
• **Data Analysis Module**: statistical analysis of cost information to develop CERs
• **Return Cost Module**: link to shipyard production management systems
• **Link to CAD systems**: automated cost estimating from design process
• **Link to CAD systems**: automated down-loading of bills of material
Over 35 Years Serving the Shipbuilding & Repair Industry

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