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NAVAL SURFACE WARFARE CENTER
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SHIP STRUCTURAL COST PROGRAM

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ABSTRACT

A ship-cost computer tool has been developed to estimate U.S. Naval Surface Ship construction for both shop and field Engineered Uniform Method and Standards and current Naval shipbuilding practices.

This procedure has been incorporated into the Ship Structural Cost Program (SSCP) to provide a means of rapidly estimating structural cost for ship structures. In this form SSCP provides a three-phase cost analysis where the shop erection and field installation procedures are included in Phases 2 and 3 and the panel/grillage shop assembly procedures are included in Phase 1.

The overall aim of our cost program is to develop a cost/weight tradeoff tool that has the capability of performing weight/cost optimization tradeoff studies. This information will become useful for Navy research and design communities in assessing high cost areas in the new ship construction, identification of optimum plate-beam combinations with respect to cost and/or weight, and the identification of materials and design details which tend to reduce cost.
SHIP STRUCTURAL COST PROGRAM

AUTOMATED COST ESTIMATING TOOL

BASED ON NAVSEA

ENGINEERED UNIFORM METHODS & STANDARDS

FOR NAVAL SURFACE SHIP CONSTRUCTION

SHIP STRUCTURAL COST PROGRAM

SSCP

PHASE 1 - SUBASSEMBLY  PHASE-2 SHOP ERECTION  PHASE-3 FIELD INSTALLATION

SIGNIFICANT OPTIONS:
- GEOMETRY
- MONOHULL OR HIGH PERFORMANCE SHIP
- HULL AND/OR DECKHOUSE
- FLAT BAR STIFFENERS
- MATERIALS: NS, H15, HY88, ALUM
- DETAILS

CAPABILITIES:
- MATERIAL COST STUDIES
- CONFIGURATION STUDIES
- COST/WEIGHT OPTIMIZATION

FUTURE IMPROVEMENTS:
- NEW DETAILS
- ALUM FIRE PROTECTION COSTS
- BALLISTIC PLATING COSTS
- WELD BONDS COSTS

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SHIP STRUCTURAL COST PROGRAM

OBJECTIVES

LONG TERM
• DEVELOP COST/WEIGHT TRADE-OFF CAPABILITY FOR EFFICIENT USE OF MATERIAL & STRUCTURES

SHORT TERM
• DEVELOP A COST ESTIMATION PROGRAM FOR SURFACE SHIP STRUCTURES
• INCORPORATE THE CAPABILITY OF NAVY DESIGN PROGRAMS WITH THE COST PROGRAM TO PERFORM COST/WEIGHT OPTIMIZATION STUDIES

- IMPROVE RELATIVE COST/WEIGHT TRADE-OFF CAPABILITY FOR R & D COMMUNITIES
- PROVIDE NAVAL SHipyARDS WITH COMPUTERIZED METHOD FOR COST ESTIMATING REPAIR & CONVERSION
- EVALUATE HIGH COST AREAS OF SHIP CONSTRUCTION

COST/WEIGHT TRADE-OFF

<table>
<thead>
<tr>
<th>COST FACTORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOMETRY</td>
</tr>
<tr>
<td>LOADING</td>
</tr>
<tr>
<td>MATERIAL COST</td>
</tr>
<tr>
<td>PRODUCTION COST</td>
</tr>
</tbody>
</table>

[Graph showing the relationship between weight and cost with geometric factors]
## SSCP Applications

### Relative Cost Comparisons

<table>
<thead>
<tr>
<th>Material Cost Study</th>
<th>AL</th>
<th>MS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Configuration Study</td>
<td>MS-HTS</td>
<td>HY80</td>
</tr>
<tr>
<td>Deck Sections</td>
<td>6' F.S.</td>
<td>8' F.S.</td>
</tr>
<tr>
<td>Configuration Study</td>
<td>36 Panels</td>
<td>45 Panels</td>
</tr>
</tbody>
</table>

## Basic Concept

```
+-------------------------------+          +-------------------------------+
| Structural Unit               |          | Total Group 100 Cost for Unit |
| Material Cost S-LB            |          |                              |
| Construction Cost NHXXS/N-HD   |          |                              |
```

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ENGINEERED
UNIFORM METHODS & STANDARDS
TITLE: STRUCTURAL-LOFT LAYOUT & MACHINE

• LOFT
  DEVELOP & BUILD TEMPLATES & DRAWINGS 1/10 SCALE (PLATES & SHAPES)

• LAYOUT
  TRANSFERRING TEMPLATES & DRAWINGS (PLATES & SHAPES)
  TITLE: BURN FLAME CUT PRODUCTION

• PLATES
  TELEREX 90° CUT
  RADIOPHOTO BEVEL CUTTING
  SAW CUT ALUM
  SHEARING AL & ST

• STIFFENERS & DETAILS
  MANUAL HIAGD GUIDED
  90° CUT & BEVEL CUTTING
  SHEARING ALUM
**ENGINEERED UNIFORM METHODS & STANDARDS**

**TITLE: ROLLING OPERATIONS**

- PLATING: MAN HOURS AREA FUNCTION OF PLATE THICKNESS & WIDTH OF ROLL
- STIFFENERS: MAN HOURS AREA FUNCTION OF THE TYPE OF MACHINE OPERATION

**TITLE: STRUCTURAL SHOP ASSEMBLY**

- PLATE ASSEMBLY
- STIFFENER ASSEMBLY
- DETAIL ASSEMBLY
- VAC-U-BLAST
- PNEUMATIC SERVICES
- BURNING & WELDING SERVICES
- CRANE SERVICES

**TITLE: WELDING, STRUCTURAL PRODUCTION**

- MANUAL WELDING (MS, HTS, HY80)
  - SHIELDED METAL ARC
- AUTOMATIC WELDING
  - SUBMERGED METAL ARC (MS, HTS)
  - GAS METAL ARC (ALUM)

**INSPECTION**

- A: ND NDT
- B: BASIC NDT
- C: FULL NDT
PLATE & STIFFENER WELDING

STIFFENER INTERSECTIONS

TEE-TEE
TEE-BAR
BAR-BAR
PHASE 2 - SHOP ERECTION

PLATE STIFFENERS DETAIL ERECTION OF SUBASSEMBLY

PANEL JOINTS

- STIFFENER BUTTED AGAINST HATE

- END STIFFENER CUT - STIFFENER BUTTED

- END STIFFENER CUT - CUT OUT PLATE - STIFFENER BUTTED

- STIFFENER BUTTED - SAME SIZE
PHASE 3 - FIELD INSTALLATION

ENGINEERED UNIFORM METHODS & STANDARDS

TITLE: STRUCTURAL FIELD INSTALLATION

- SHELL
- DECK
- BULKHEADS
- STANCHIONS
- SIDE & WEB FRAMES
- DECKHOUSE
- SHELL UNIT
- BOW UNIT
- Stern UNIT
OUTPUT - PHASE 2-3

CONSTRUCTION COST PER JOINT LENGTH

ERECTION $  
  ASSEMBLY  
  WELDING  
  DETAIL  

INSTALLATION $  
  ASSEMBLY  
  WELDING  
  DETAIL  

PROGRAM EXECUTION SCHEME

DATA PREPARATION

MINI-COMPUTER

{ PRE-PROCESSOR DISPLAY SCREEN OR PLOTTER}

{ CHECK PANEL / GRILAGE DATA}

CORRECT

NO

YES

RUN SDFP-COC

{ TERMINAL OR BATCH}

OUTPUT
COST MODEL INPUT DATA

INITIAL DATA
- MATERIAL COST
- LABOR COST

PANEL DATA
- NODES
- GEOMETRY
- SCANTINGS
- DETAILS
- WELD INSP.
- CONST. SEQUENCE
- PLATE SIZE CATALOG

CONSTRUCTION COST MODEL

Shell Unit → Model
FUTURE WORK

- AUTOMATED COST/WEIGHT OPTIMIZATION PROGRAM

- DEVELOP COST ESTIMATING TOOL (REPAIR & CONVERSION) FOR NAVAL SHIPYARDS

DEVELOP COST ESTIMATING TOOL (REPAIR & MAINTENANCE) FOR NAVAL SHIPYARD
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