

Integrated Design Manual for Fabricated Shapes

Presented to:

Ship Design and Material Technology Panel
National Shipbuilding Research Program

**The Shape You *Need*
For
The Ship You *Want***



**The Ship You *Get*
with
The Shape They *Got***

Larry Thompson and Paul Blomquist
Applied Thermal Sciences, Inc.

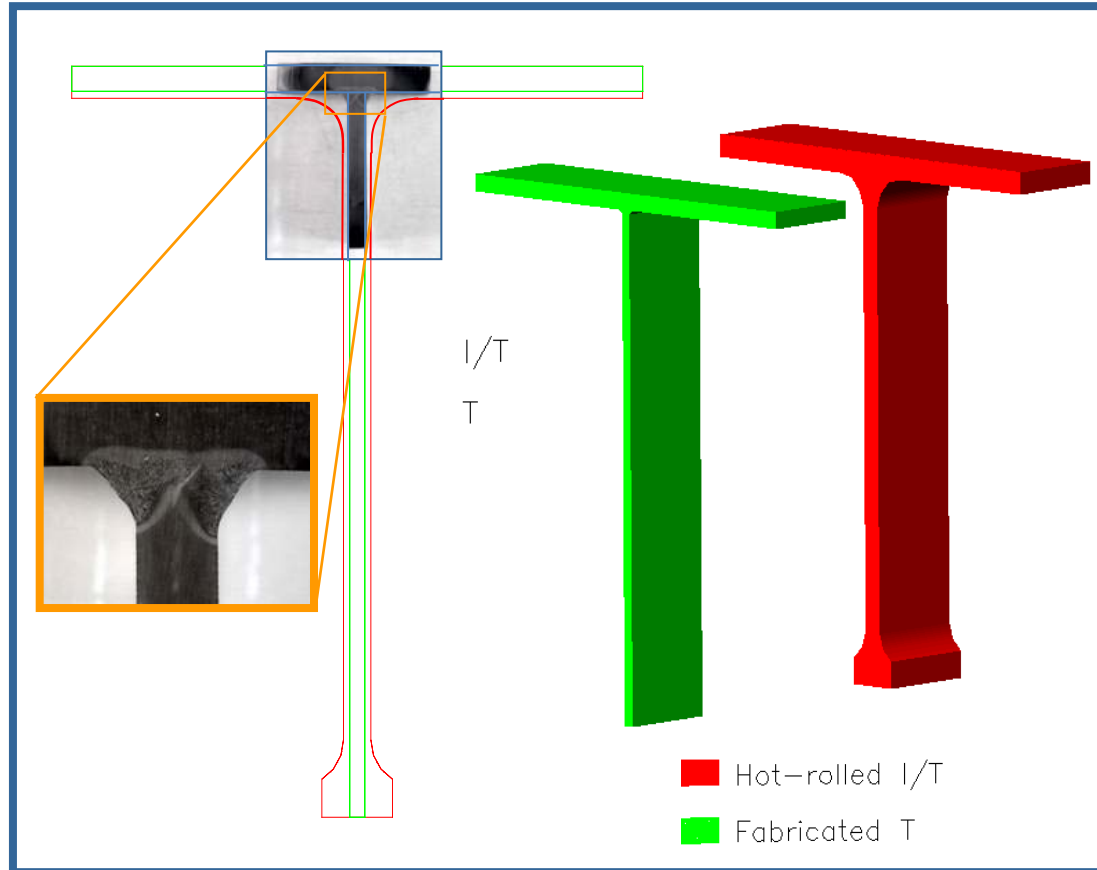
March 17, 2011

Outline

- Programmatic Overview
- Historical Perspective
- Technical Approach
 - “Substitutional Design”
 - Replacement of existing T-beams in existing design
 - “Optimal Design”
 - “Clean sheet of paper” - no prior design
- Design Tool Development Overview
- Future Work



Why Do This?



**9.0# DH-36 I/T Replaced by 6.3# DH-36 Fabricated Tee (33% wt. savings)
Entirely within DD-51 Ship Specification Design Rules; Still Over-Strength**

Source: NSRP N7-91-4



Historical Perspective

- **Legacy Stiffeners**
 - I/T's, W/T's, Angles, Bulb Flats, Flats
- **First NSRP-Funded Analysis**
 - N7-91-4 Tee-Beam Manufacturing Analysis (I/T's)
- **Extended Analysis**
 - DDG-51 Shapes - included W/T's as well as I/T'S
- **Implementation on CVN-78**
 - Shift to HSLA-65; Saves >480 Tons; Saves Assembly Costs
- **ATS Completes Sandwich Panel Design Tool**
 - Fast Iteration of Potential Designs
 - Less Than One Minute 30 Combinations of 16 design attributes
- **Implementation on DDG-1000**
 - Shift to HSLA-80
- **Inquiry Regarding LCS**
 - Issues with Mill Schedules, Interested in Potential





Programmatic Update

- Project Team: ATS - NGSB-GC - Marinette Marine
- Contracts / Subcontracts in Place: February 2011
- Conference Call with Marinette Marine 2/22/11
- Design Tool Development Initiated
 - Inputs / Outputs / Constraints / User Interface
- Planning for Down-Select of Technical Approach
- Anticipated Beta-Review
- Completion of First Approach
- Determination of Next Step
- Workshop
- Completion on or before 1/31/2012



Technical Approach

Two schools of thought

Substitutional Design

(Existing H-R Beam Replacement**)

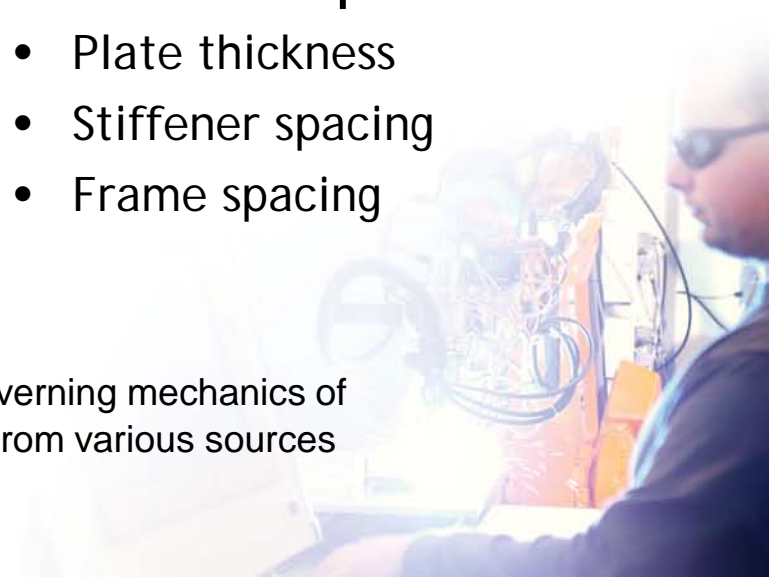
- **Additional Input**
 - Plate thickness
 - Stiffener spacing
 - Frame spacing
 - Existing T-BEAM
 - Existing Plate thickness
 - T-BEAM constraints
 - Depth of Section
 - Flange width
 - Strength considerations
 - Bending rigidity /deflection

Optimal Design

("Clean Sheet of Paper")**

- **Assumptions**
 - Fabricated shapes will be used
- **Additional Input**
 - Limit for the overall depth of section
- **Additional Output**
 - Plate thickness
 - Stiffener spacing
 - Frame spacing

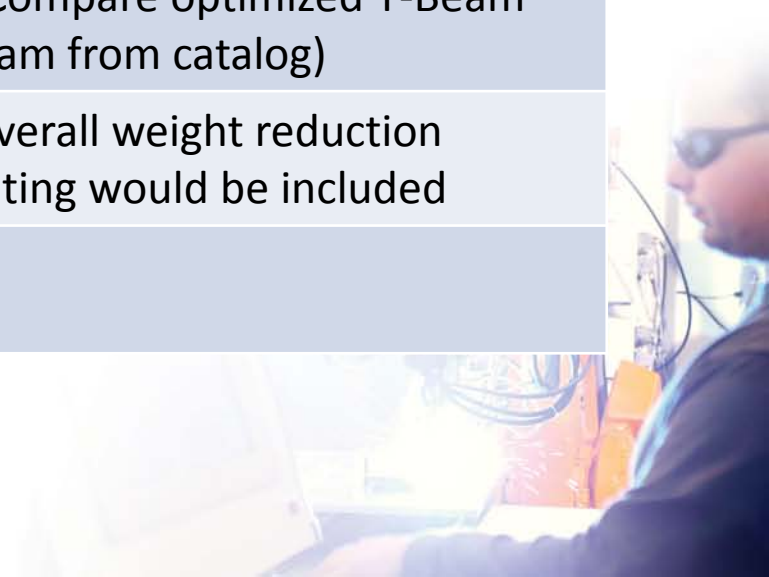
** Both approaches will be based on governing mechanics of materials and elastic stability equations from various sources





Benefits of Each Technical Approach

Substitutional Design	Optimal Design
Rapidly Assess the weight impacts of fabricated shapes to existing design.	More general tool for new construction
Minimal changes to existing drawings	First order solution for bids and proposals
Minimal impact on subsequent fabrication and outfitting	Evaluate penalties for using hot rolled shapes. (Compare optimized T-Beam with T-Beam from catalog)
	Greater overall weight reduction > plating would be included



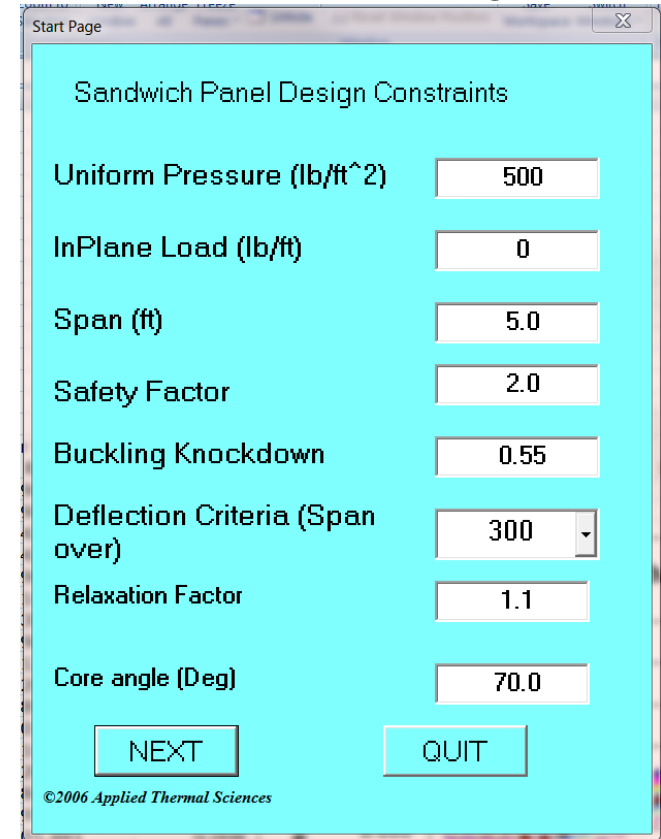
- **Design and develop:**
 - BEAM-stiffened plate optimization tool
 - MS Excel / Visual Basic
 - Run as a macro within MS Excel.
- **User Manual:**
 - Guide for the using the tool
 - Section on fundamental theory



Input Parameters

- **Load Case**
 - Simply supported with uniform pressure distribution
- **Span or Frame Spacing**
 - Input parameters (Substitutional)
 - Output values (Optimal design)
- **Safety Factor**
- **Deflection Criteria**

Example of an Input Dialog Box*



Sandwich Panel Design Constraints	
Uniform Pressure (lb/ft ²)	500
InPlane Load (lb/ft)	0
Span (ft)	5.0
Safety Factor	2.0
Buckling Knockdown	0.55
Deflection Criteria (Span over)	300
Relaxation Factor	1.1
Core angle (Deg)	70.0

NEXT QUIT

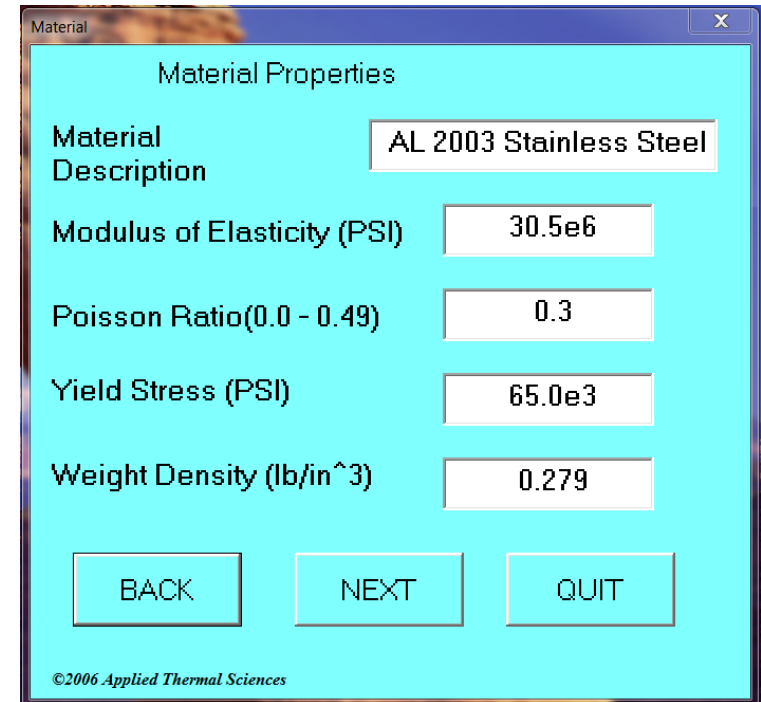
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* Taken from ATS' sandwich panel design optimization tool

Input Parameters (continued)

- Material Selection Dialog box, thicknesses will start at 1/8" and go to 3/4" in 1/16" increments
- List of standard ship construction materials to pick from
 - HSLA 80
 - DH 36
 - EH 36
 - Others (??)
 - User Defined Material

Example of a user defined material Input Dialog Box*

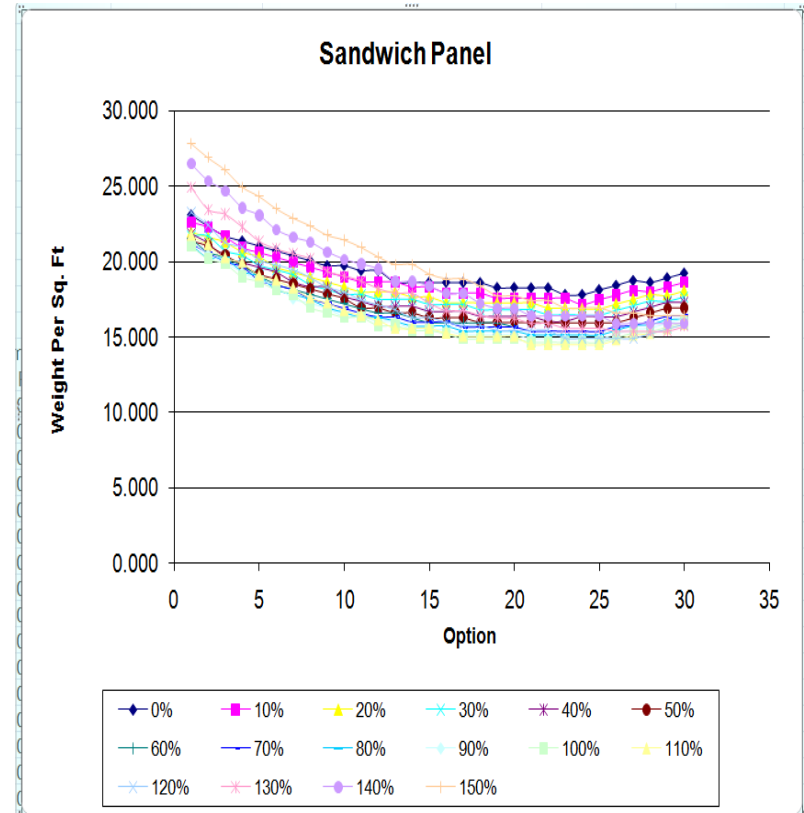


Material Properties	
Material Description	AL 2003 Stainless Steel
Modulus of Elasticity (PSI)	30.5e6
Poisson Ratio(0.0 - 0.49)	0.3
Yield Stress (PSI)	65.0e3
Weight Density (lb/in ³)	0.279
<input type="button" value="BACK"/> <input type="button" value="NEXT"/> <input type="button" value="QUIT"/>	
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*

Taken from ATS' sandwich panel design optimization tool

- Table of output parameters
 - T-Beam
 - Elastic properties: I_{xx} , I_{yy} , S_x , S_y , r_x , and r_y
 - Area
 - Web details
 - Flange details
 - Stiffener Spacing
- Potential for application to composite properties



Example of a weight optimization curve*

*

Taken from ATS' sandwich panel design optimization tool



Future Work

- **Select Initial Technical Approach**
 - Substitutional or Optimal?
- **Complete Beta Version of Design Tool**
 - Review, Test and Validate Internally
 - Review, Test and Validate Externally
- **Depending on Resources:**
 - Develop Design Tool for Alternate Strategy
 - Hold a Workshop for Potential Users
 - “Publish” - Release to NSRP Community
 - Evaluate other materials

