

CHALLENGES IN HEAVY MANUFACTURING

PART I: PREDICTING WELD DISTORTION

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CONSEQUENCES OF WELD DISTORTION

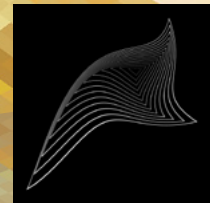
Weld-induced distortion is caused by the non-uniform expansion and contraction of the weld metal and adjacent base metal during the heating and cooling cycle. This leads to the creation of residual weld stresses which can result in:

- Additional fitting and tacking time and cost to fit distorted assemblies
- Increased weld time and cost for associated gaps between parts
- Compromised structural integrity
- Manufacturing and fabrication inaccuracies (dimensional control)
- Negatively impacted aesthetic appearance of structure or product

*MITIGATION AND CORRECTION
OF DISTORTION CAN BE BOTH
EXPENSIVE AND TIME-CONSUMING.*

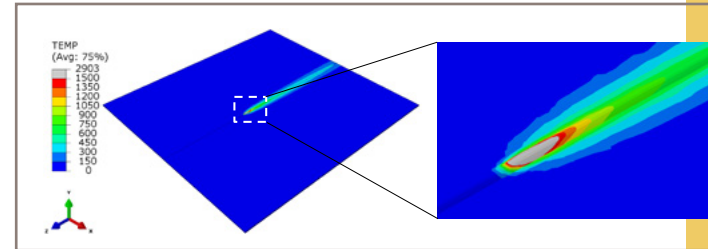
TYPES OF DISTORTION

- Longitudinal shrinkage
- Transverse shrinkage
- Angular distortion
- Bowing
- Buckling
- Twisting
- Bending



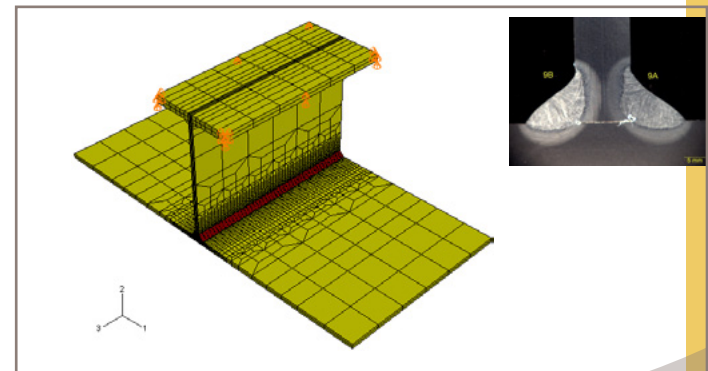
CONTROLLING WELD DISTORTION

Weld distortion prediction and modeling is used to understand the expected distortion and evaluate distortion control methods. It allows manufacturers to avoid significant repair costs down the road. There are different ways to predict distortion including utilizing simple shrinkage models and employing computational analysis.



MAJOR METHODS OF PREDICTING WELD DISTORTION

- Thermal elastic-plastic finite element analysis
- Inherent strain method
- Plasticity-based distortion analysis



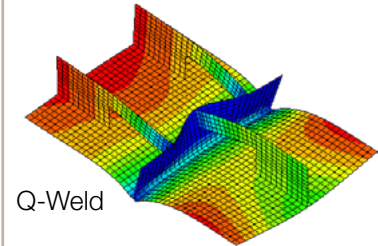
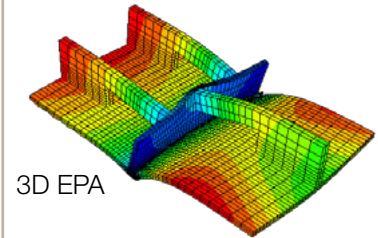
PREDICTION TOOLS AND SOFTWARE

EWI has developed three finite element-based distortion prediction tools:

- **WeldFEA:** Models welding processes in detail, predicting distortion in small welded structures.
- **Q-Weld:** Predicts distortion for large and complex welded structures.
- **EWI WeldPredictor™:** Simulates arc welding procedures for prediction of resulting microstructure, thermal profile, residual stress, and distortion.

These tools can be used to:

- Evaluate welding fixture and tooling issues
- Select welding parameters
- Optimize welding sequences
- Determine pre-bending shape and magnitudes for a given structure



Q-WELD

is hundreds of times faster than 3D TEPA (thermo-elastic-plastic analysis) without loss of significant accuracy, depending on the size of the welded structure.

SUCCESS STORY

EWI Associates have developed finite element analysis tools to predict distortion, as well as practical welding procedures to control distortion. One of these procedures is a patented thermal tensioning technique to control buckling of thin steel panels for ship bulkheads and decks.

THE SAVINGS

Control of weld distortion saved over

\$1 million

on each DDG-51 destroyer

One company reduced its scrap rate due to distortion from

60% to 0

Cost savings over a five year period are estimated to exceed

\$21 million

yielding a return on investment of more than 10:1



10 to1 ROI



Up Next: PART II FLEXIBLE MANUFACTURING

ABOUT EWI

EWI's extensive work with predictive modeling and simulation, as well as next generation advanced high strength steels (AHSS), advanced nondestructive evaluation (NDE), advanced welding and joining, emerging heavy fabrication technologies, and other innovations give our heavy manufacturing customers an upper hand in today's fiercely competitive market.

To learn more about EWI's experience helping OEMs and suppliers in the heavy manufacturing industry use technology innovation to become more competitive, contact Aaron Haines, Market Segment Manager, at ahaines@ewi.org or **614.688.5146**.



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