Elliott Bay Design Group
Architectural & Engineering Services for the Marine Industry

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EXPERT WELD ENGINEERING SERVICES TO ENHANCE VESSEL FUNCTIONALITY, DURABILITY AND LONGEVITY

Interview With: Matthew Wichgers, P.E.
Technical Manager

Welding technology and its application is critical to the marine industry. The art and science of welding is a pivotal component of all vessels, joining vessels into functional and durable assets. Precise, quality welds have a direct influence on a vessel's functionality, durability, and the longevity of the service life of the entire vessel as an asset.

In this article, we sit down with one of Elliott Bay Design Group's Technical Managers, Matthew Wichgers to shed light on the need for expert weld engineering services and explore the critical importance of welding technology and processes within the maritime sector. Matthew draws upon over forty-five years of experience from EBDG's team of Certified Weld Inspectors (CWI). Each member has been certified by the American Welding Society (AWS) and are licensed Professional Engineers that have cultivated a wealth of knowledge and expertise, specializing in aiding vessel operators, shipyards, and welding fabricators with their complex welding needs.

"Through my career as an engineer in the marine industry, a supporter of shipyards, and as an owner's representative, I have seen the need for mastery of welding at all stages of design and construction. Across the spectrum of marine projects, whether it be dry dockings, overhauls, new construction or repairs involving steel or aluminum vessels, the need for welding expertise is indispensable" states Wichgers.

The combination of theoretical engineering acumen and hands-on CWI expertise forms a powerful resource for ship repair facilities, fabricators, and vessel owners and operators.

Key areas of welding expertise offered by Professional Engineers and CWI experts include:

- New Build & Repair Weld Inspections: Meticulous inspection during both new builds and repairs is paramount to ensure the integrity and safety of the welds.
- Development of Welding Procedures: Crafting and fine-tuning weld procedure standards contribute significantly to the quality, reliability, and safety of weld seams, joints, etc.
- Optimized Pre- and Post-Weld Heat Treatment: Implementing well-considered heat treatment processes enhances the materials strength and structural durability while also considering the economics of welding.
- Structural Quality and Design for Producibility: Balancing structural integrity with producibility during the design phase will result in efficient manufacturing.
- USCG and ABS Approved Structure Repair Plans: Obtaining regulatory and classification approval is an important aspect.
- Forensic Analysis of Structural Failures: Analysis of failed structures results in an understanding that breeds confidence in the right path forward.
- Thermal/Structural Finite Element Analysis of Welding Heat Input and Distortion prediction: Analysis of the weld itself helps direct the development of weld procedures.

- Work in Tandem with Shipyard QA/QC Personnel as Onsite Owner's Representatives:
  Constructive collaboration between both parties to a contract can result in success for everyone involved.

- Weld Design and Sequencing:
  Plan out weld sequencing during fabrication to minimize distortion. Weld design for economical and improved fabrication.

- Practical Welding Experience at all Stages of Vessel Design:
  Practical experience provides a pool of understanding to draw from in solving today's welding challenges.

THEORY- ENGINEERING ANALYSIS

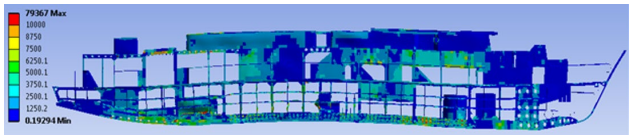
As the maritime industry continues to advance, the significance of precision welding extends beyond mere joining of materials. The lifespan, safety, and operational effectiveness of marine vessels are factors explored by professional engineers through technology. EBDG leverages their analysis background to better inform the science of welding, using structural and thermal Finite Element Analysis (FEA).

Structural Analysis

Structural analysis using FEA enables a deeper understanding of complex loading and structural configurations. EBDG has the capability to quickly model the target structure in three dimensions, apply design loadings, and iterate through structural design. Both smaller scale and large-scale structures can be treated in this manner, from minor structural features like mooring bitts all the way up to complete hull analyses of vessels.

The scope of a structural analysis can include static structural, modal/vibration, and fatigue. Often FEA is used as a forensic tool to find root causes of in-service failures or to design structural detailing that eliminates failures due to fatigue effects. Finding solutions to these issues ultimately saves the operator from expensive down time and recurring repair bills.

Why keep making the same crack repairs year after year when a redesign of the structural detail could supply decades of trouble-free service?



Thermal Analysis

EBDG has used thermal FEA to better understand heat input and cooling rates for complex weld procedures. A transient thermal analysis can capture the effect of an arc weld traveling along a joint, showing the dynamic thermal contours in the material that gives insight into the heat affected zone and resulting material microstructure after a joint is completed. This can have a profound effect on the resulting strength of the base material after welding.

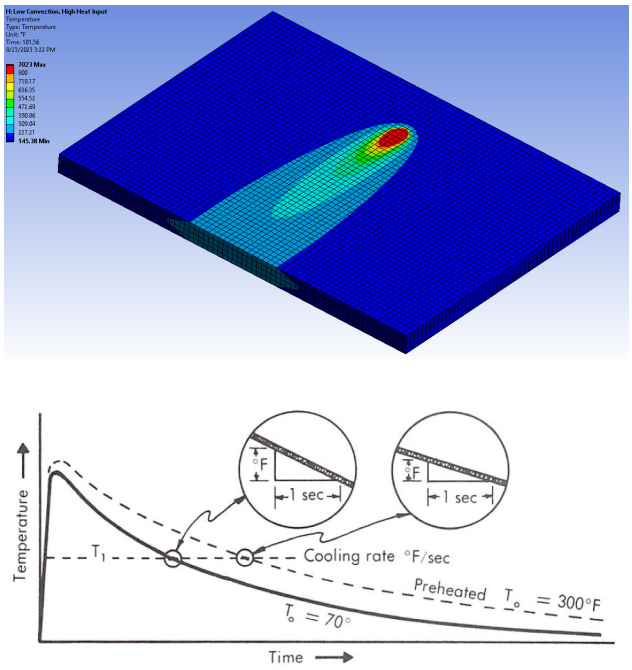


Figure 1 - image credit: "Design of Welded Structures" by Omer Blodgett and the James F. Lincoln Arc Welding Foundation

PRACTICE- WELDING PROCESS IMPROVEMENTS

The heart of a good weld is the process used by the fabricator. These processes can range from the ad-hoc experience of each individual welder, up to a

formally approved weld procedure accepted by the cognizant class or regulatory body. The weld procedure, whether formal or informal, is the recipe through which a skilled fabricator can make a quality weld. Through this spectrum of practice "where the arc meets the metal" there are opportunities to create "better" welds. The definition of "better" is project and even joint specific:

- Higher quality - appropriate to the service of the structure
- Easier for the welder to execute
- Cheaper - in materials or labor or both
- Fewer defects = less rework
- Reduced time to create

Joint Design

Metals much thicker than 3/8" (9.5 mm) typically require some level of joint preparation to create a complete penetration weld. This type of weld completely fills the joint and is critical for butt joints in hull plating. The joint preparation in this situation opens up the cross section of the weld and allows the welder to access the "root" of the joint and build the connection from the inside out via multiple weld passes.

The joint preparation allows for this access by providing a chamfer or other cutaway on the edge of the adjoining plates. The decision of what type of joint preparation style can have a profound impact on the economics of the weld. Chamfers are easier to create but require more weld passes to fill the resulting gap. J-cut edge preparation needs more expensive machine tooling but could more than pay off through reduced welding time, labor, and inputs. A change or upgrade in welding machines could allow thicker materials to be used without any edge preparation at all!

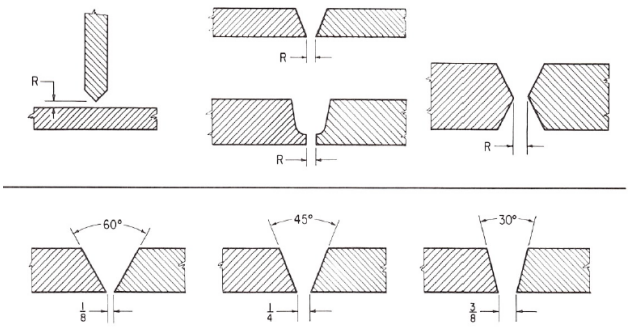


Figure 2 - Image credit: "Design of Welded Structures" by Omer Blodgett and the James F. Lincoln Arc Welding Foundation

Heat Treatment

Some alloys or material thicknesses require heat treatment either before or after the weld is made. This heat treatment stage could be as simple as preheating the joint a certain amount above ambient temperature, up to a complex multistage post weld heat treatment that occurs over multiple days. Any of these activities add time and cost to the welding operation. Taking the time to revisit a tried-and-true weld procedure may allow a reduction or even elimination of the previously required heat treatment.

The subject of welding is both deep and broad in scope. It is an intricate blend of practical skill, the science of metallurgy, and the artistry of skilled craftsmanship. Welding technology continues to evolve and mature, with new tools and new practices available for all ranges of fabrication. EBDG's team of Professional Engineers and Certified Weld Inspectors stand ready to contribute our insights and expertise to the continuous evolution of welding technology within the maritime realm.

Consider applying new analysis and fresh perspective to improve your welding practices.

OUR TEAM IS YOUR TEAM

ELLIOTT BAY DESIGN GROUP

Elliott Bay Design Group is a full-service, employee-owned naval architecture and marine engineering firm that supports owners, operators and shipyards. Our team of naval architects, engineers and analysts have expertise with designing and supporting all types of vessels and marine structures as well as analyzing the feasibility of marine transportation.

MATTHEW WICHGERS, P.E.

Matthew joined EBDG in 2007 and serves as the Technical Manager for Vessel Structures. He has a high degree of expertise in the company's sophisticated analysis tools, particularly computational fluid dynamics (CFD) analysis and structural analysis, and in the implementation of analytical results in project design. In addition to being a professionally licensed engineer, Matthew is a certified weld inspector (CWI) through the American Welding Society (AWS). Prior to joining EBDG, Matthew served in the US Coast Guard as a Machinery Technician second class aboard the USCG cutter STURGEON BAY.