Heat Management in Welding –
Heating and Cooling developments required to address 3 areas of industrial welding challenges

- Low distortion and low heat input Joining
- Joining of crack susceptible and highly alloyed materials
- Joining ultra-high specific strength materials

Based on industry examples from Gestamp, Subsea 7, BAE and collated by BOC UK.

Presenters:

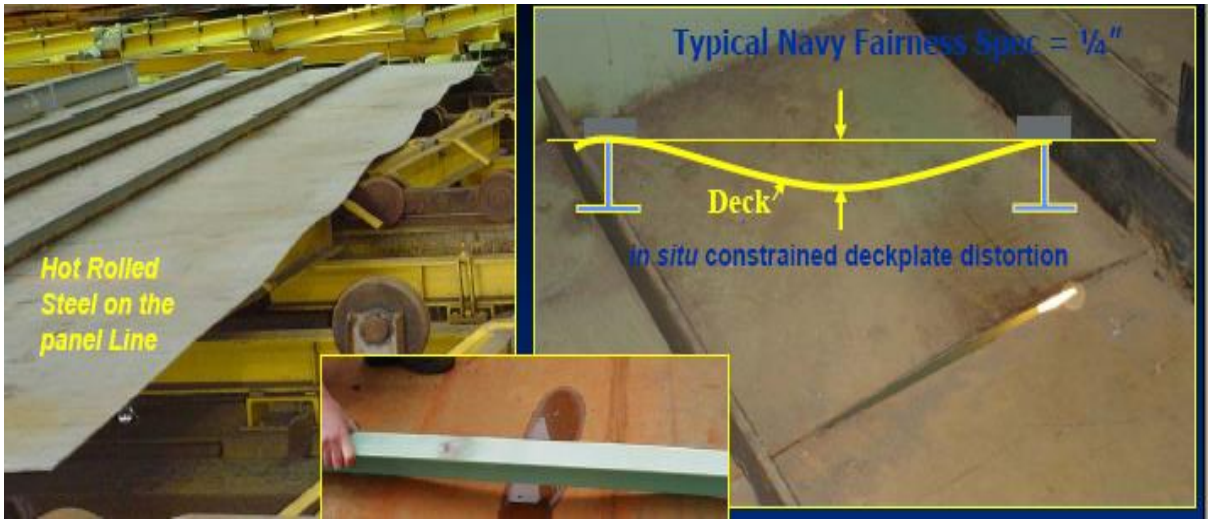
- Roger O'Brian, Director AMAP, Institute for Automotive and Manufacturing Advance Practice, University of Sunderland
- Walter Veldsman, Senior Welding Expert, BOC UK

$340 K direct costs per ship ----- Total costs $3.4 million per ship

USA Navy forced to comply with USA - NAVSHIPS 0900-000-1000 Fabrication, welding and Inspection of Ship Hulls specification,

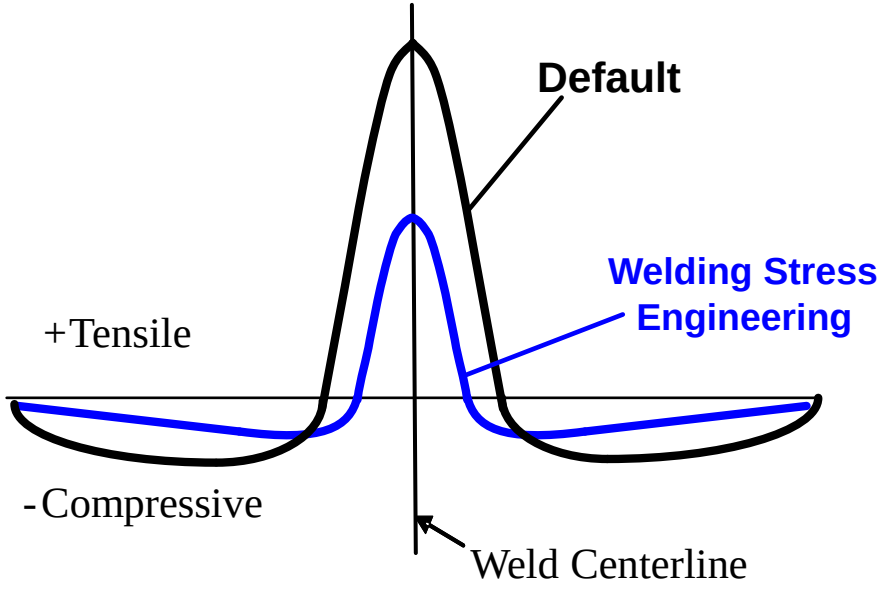
Which states that welded panels must be no more than 1 inch unfairness (distorted) and AWS D3.5 Specification “Hull Welding Manual”

CHALLENGE: distortion control and rectification technologies





One possible solution: Thermal Tensioning Technique (TTH)







Promising first Lab tests –
But research work is required,
to reach industrial maturity



The development of an industrial Dynamically Controlled Low Stress No Distortion (DC-LSND) welding system suitable for achieving real world applications

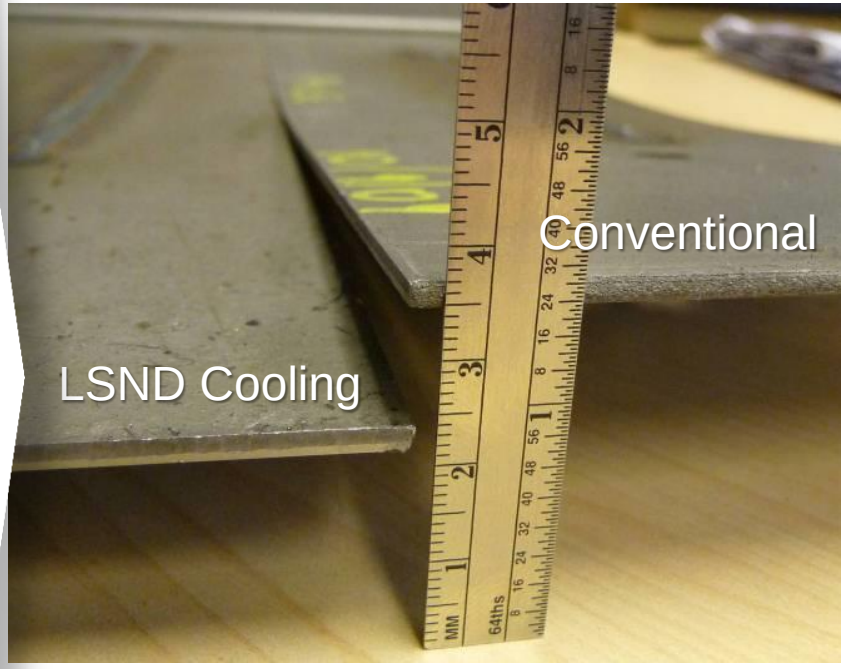
Why is there interest in exploring DC-LSND welding techniques?:

Cryogenic Cooling has the potential for controlling:
- Residual stresses
- Weld microstructure
- Distortion (Reduction)
- Hot cracking prevention (may be possible: more experimentation required)

Commercial Drivers:
A technology that potentially delivers cost reduction through:
- Lighter-weight construction (less material needed to resist distortion)
- Simple and lighter plus less complex fixtures, hence lower cost (less distortion to resist)
- Increased productivity in some applications
- Less rework
- Increased product performance levels
- Can avoid additional process steps being needed
  (negate straightening, post assembly machining, etc., to recapture tolerance/geometry)

LSND Welding Challenges

- Develop an industrial prototype system for automated, single sided, Low Stress No Distortion (LSND) welding.
- Separation of the cooling and the welding gases so as to maintain weld quality without disruption of the welding arc or contamination of the weld – not previously been done on Robot welding system or on complex components when cooling on the same side as the weld torch
- Previous systems only generally in labs, and then primarily using cooling on the opposite face to the weld which is not practical for real components or on simple unrealistic geometry and flat straight welds
- Relatively new method and technology - no system is in production
- Maintaining or improving weld performance
- Developing a system to be mounted on a robot
- Integration of the systems, including safety and cooling control



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BACK UP slides –

option to be used during afternoon workshop session, if room allows beamer use.



e.g. SUBSEA 7 Oil & Gas Pipeline Industry

CHALLENGE: controlled cooling

- Excessive cooling times required to reach imposed inter-pass temperatures in multilayer welding (e.g. pipeline welding)
  => lower productivity

- Excessive heat input during Cladding and Welding crack susceptible and highly alloyed materials (e.g. Ni based alloys)
  => material damage







Promising Lab test results with CO_2 direct impingement cooling - but further Research work is required, to reach industrial maturity

Promising Lab test results – But further Research work is required, to reach industrial maturity

BOC
A Member of The Linde Group

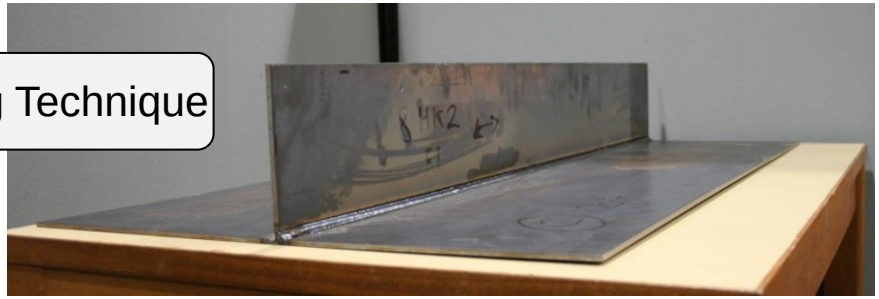


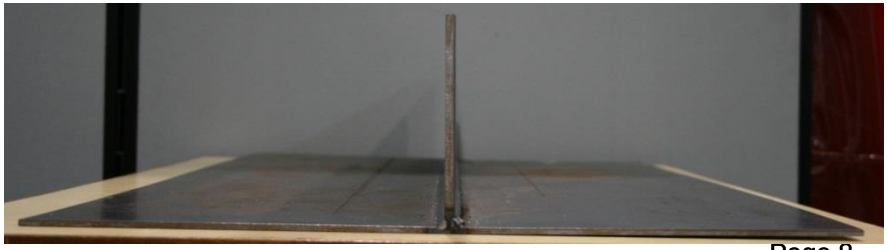
Normal weld





Thermal Tensioning Technique

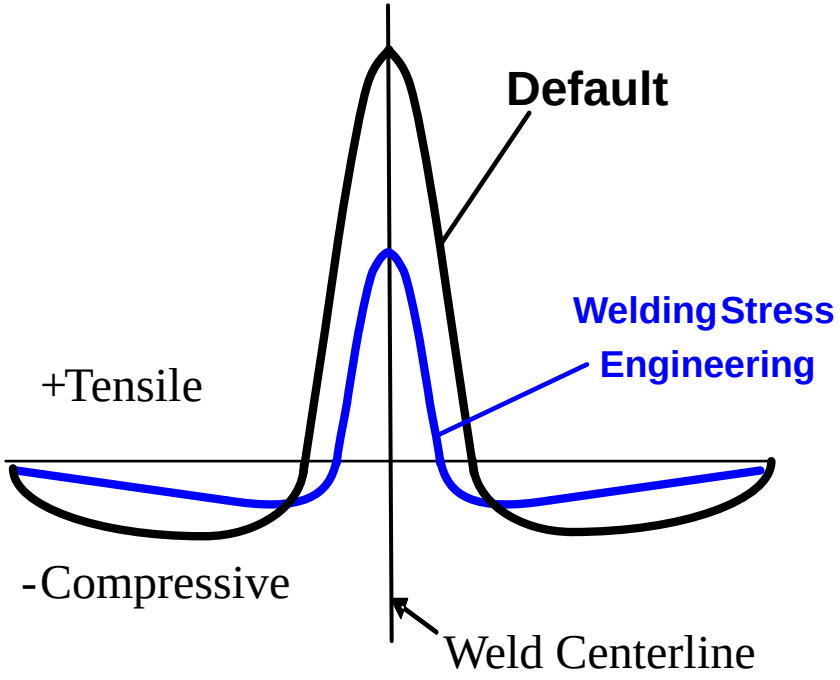


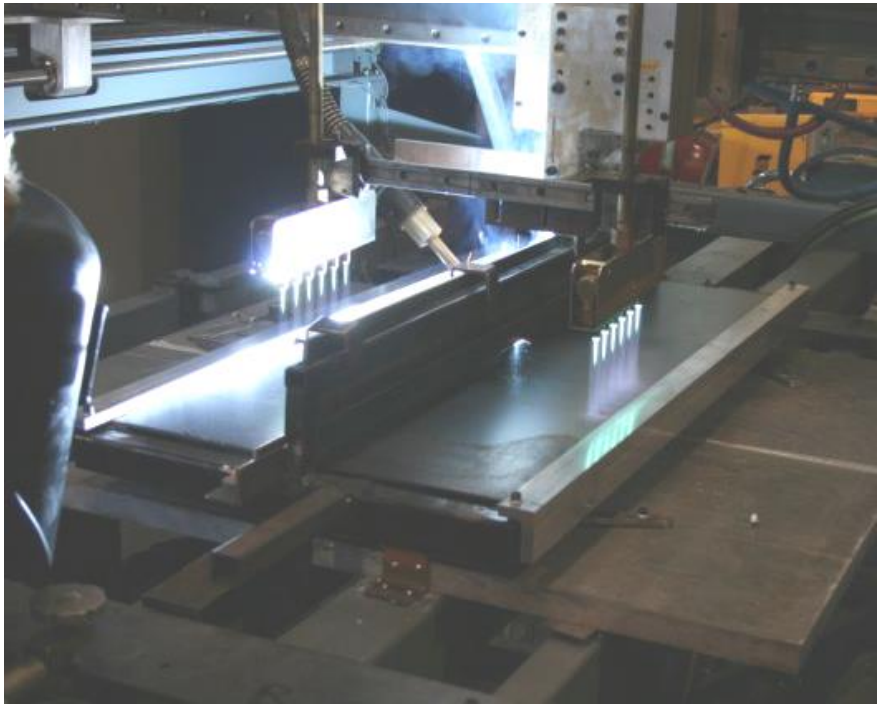


Summary and Conclusions

- A prototype robot mounted DC-LSND GMAW system with a cooling head and welding torch on the same side of the welded joint has been integrated and demonstrated successfully in an industrial facility.
- Welds have been produced with acceptable weld quality, and no significant observed metallurgical discrepancies when compared to standard samples.
- Distortion has been reduced by up to 40%-50% on simple components.
- The system has been shown to successfully avoid the disruption of the welding arc and GMAW process when the cooling is applied to the same side.
- Repeatability of the welding results on butt welds and simple profile joints and sections has been demonstrated.
- The process has been successfully applied and demonstrated on a number of real component example geometries
- Further refinement and development of the system would be required for full production and acceptability in a general industrial manufacturing environment.

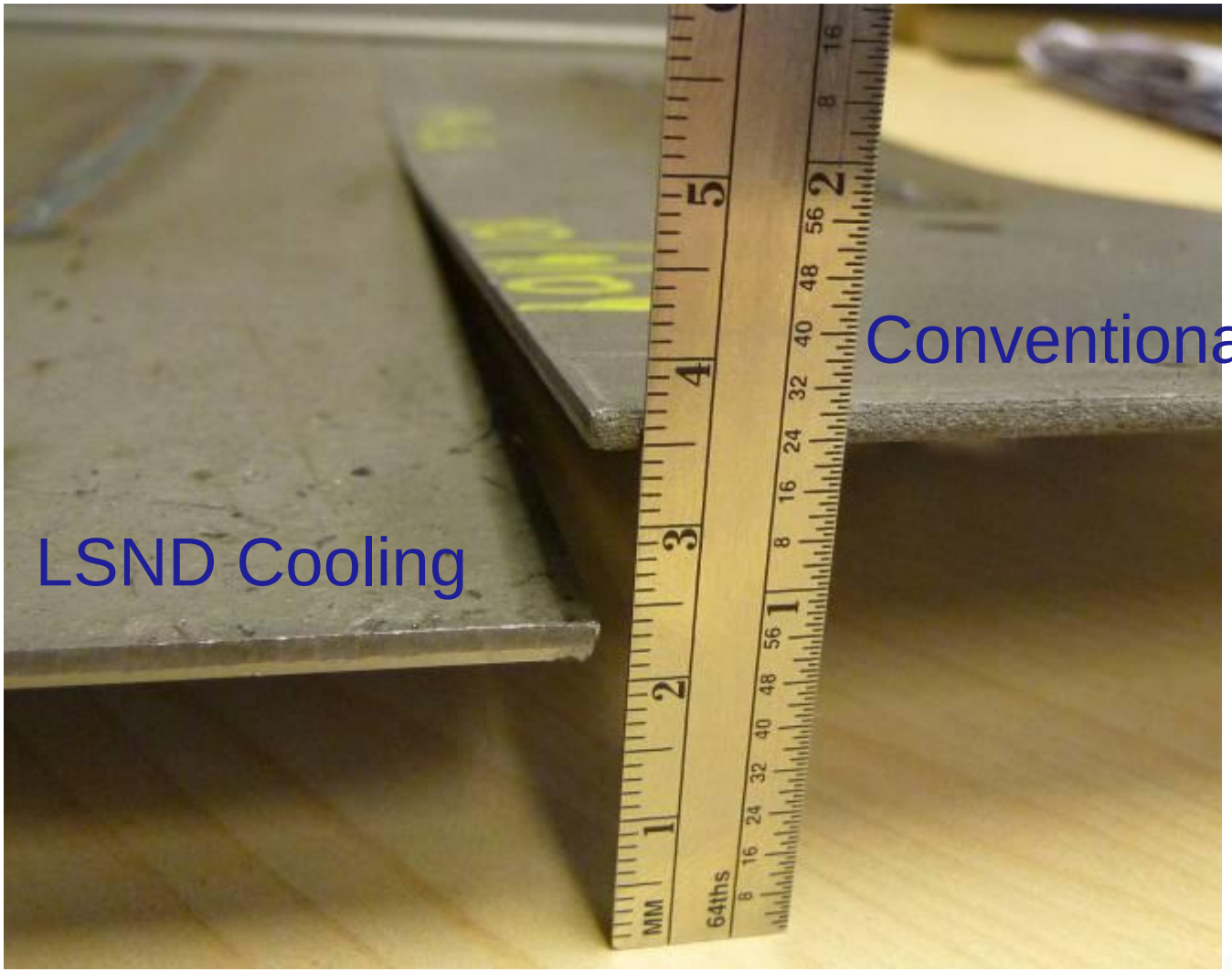
One possible solution: Thermal Tensioning Technique (TTH)





Applied on Ship Panels - Experimental set up Cranfield University

Results from the Industrial Trials: Bead on Plate Studies



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