Friction Stir Welding Defects, Analysis and Correction: History and Defects of Solid-state Welding

Alex Wulff (South Dakota School of Mines and Technology)
Faculty Advisors: Dr. Michael West, Dr. Antonette Logar, Dr. Edward Corwin, Dr. William Cross, Dr. Bharat Jasthi, and Dr. Alfred R. Boysen

Objectives

1. Isolate and catalogue defects.
2. Ascertain reasons for defect development in friction stir welds.
3. Develop correctional methods for a “Right Every Time” solution.

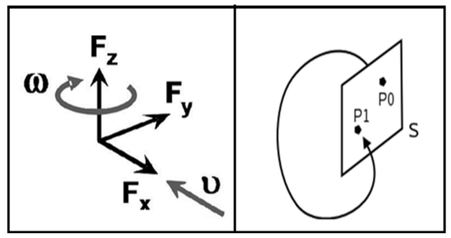
Impacts

1. Defective welds can significantly reduce the structural integrity of the resulting product.
2. Variable materials can be mapped by trend of defect. This will allow for defect free welds regardless of the materials fused.

Procedure

1. Capture weld-sensor data on defective welds.
2. Analyze samples of defective welds.
3. Correlate defects to specific behaviors of the FSW machine.
4. Create relational table of behaviors to effects and determine rates of defect expansion and termination for priority tracking.
5. Create a computational correction system to avoid and correct defects in processing.

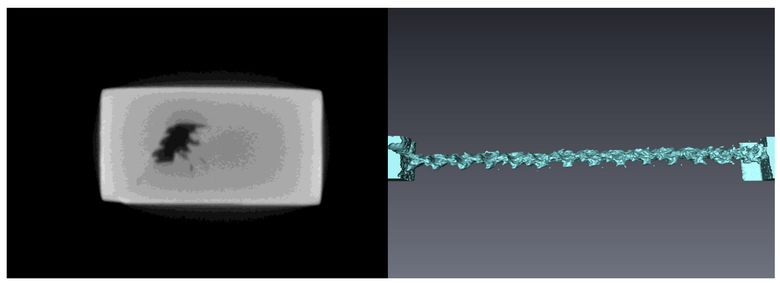
Process of Friction Stir Welding



Friction Stir Welding works by traversing a welding tool across butted materials. The direction of the weld, F_x, Forge pressure, F_z, and movement into either piece of material, F_y, (shown left) have been found to be the most important parameters in the recreeation of defect free welds. Evaluation of the variance of F_y was mapped using phase space mapping (right) due to its cyclic nature.

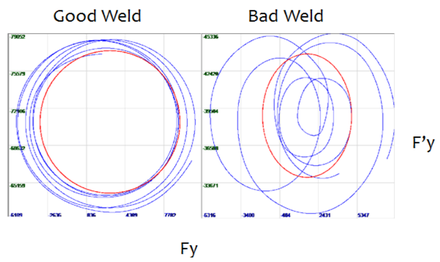
Results

Weld Defects (1 & 2)

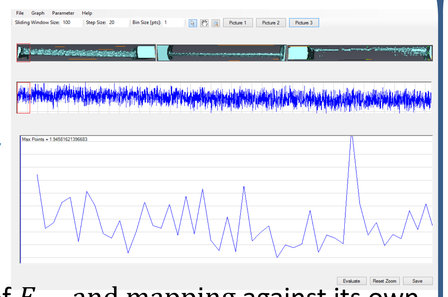


After the a weld is created, X-Ray tomography (left) and computation and computational negation (right) are used to assist with directly interpreting the nature of the weld defect. This gives us the immediate ability to estimate weld integrity.

Sensor analysis and relations (3)



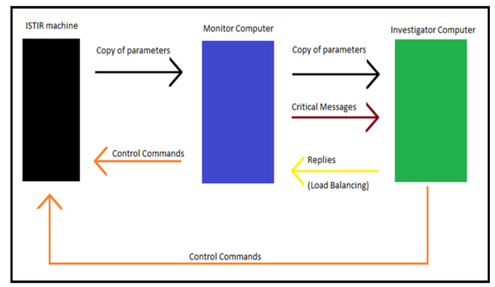
F’y



By evaluating phase space analysis of F_y, and mapping against its own rate of change, a visual representation of a defected weld can be visualized (left). This data supports our hypothesis of material flow being constricted at this particular time stamp – perhaps by temperature of the material.

Combined imaging and sensor data software allows us to focus on correlations between defect shape and sensor data (right).

Proposed correctional system (4 & 5)



When data / defect correlation is completed, a table of parameter changes with relation to defect formation and termination will be developed. This table will be combined with a computer monitoring and interpreting system to modify weld behavior at run time. Should the behaviors of defect formation be universal amongst materials, this addition will result in amore perfect weld for any materials homogeneous or otherwise.

Acknowledgments:

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