

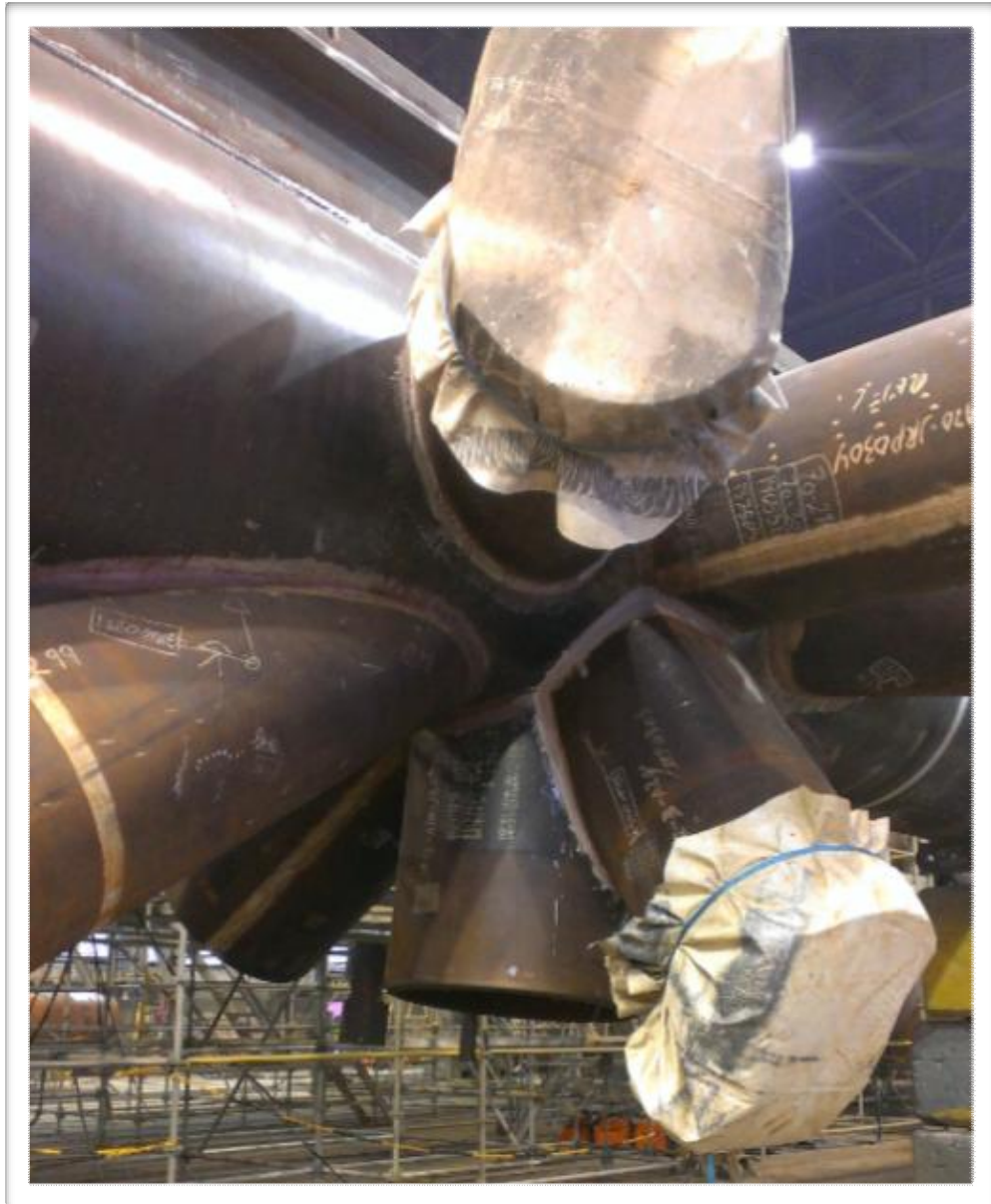
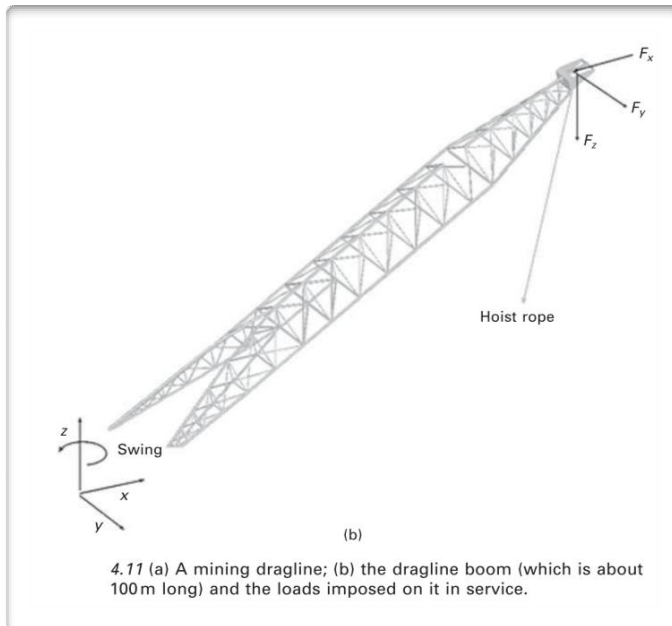
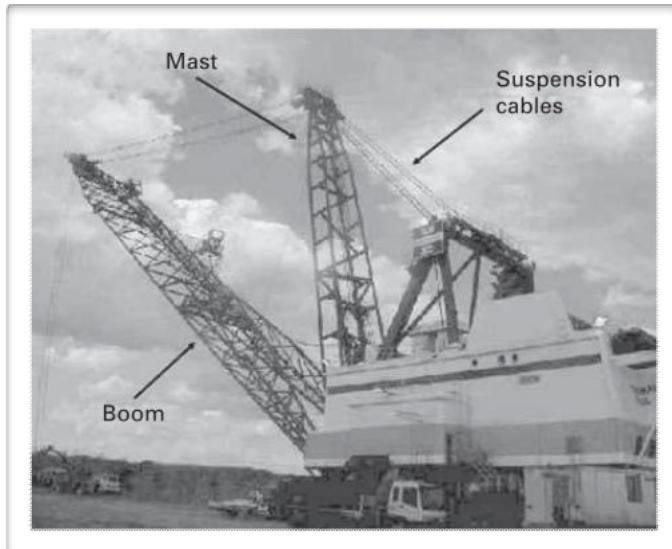


Computational Mechanics of Welds and Fatigue Life

John Goldak, President, Goldak Technologies Inc.

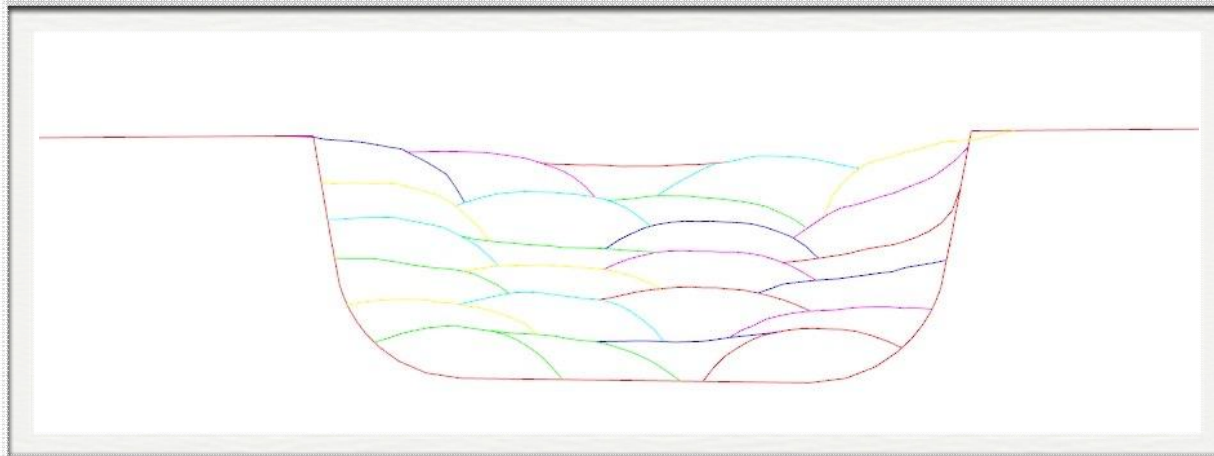
Distinguished Research Professor
Mechanical & Aerospace Eng
Carleton University

Designing Multi-Pass Weld Joints



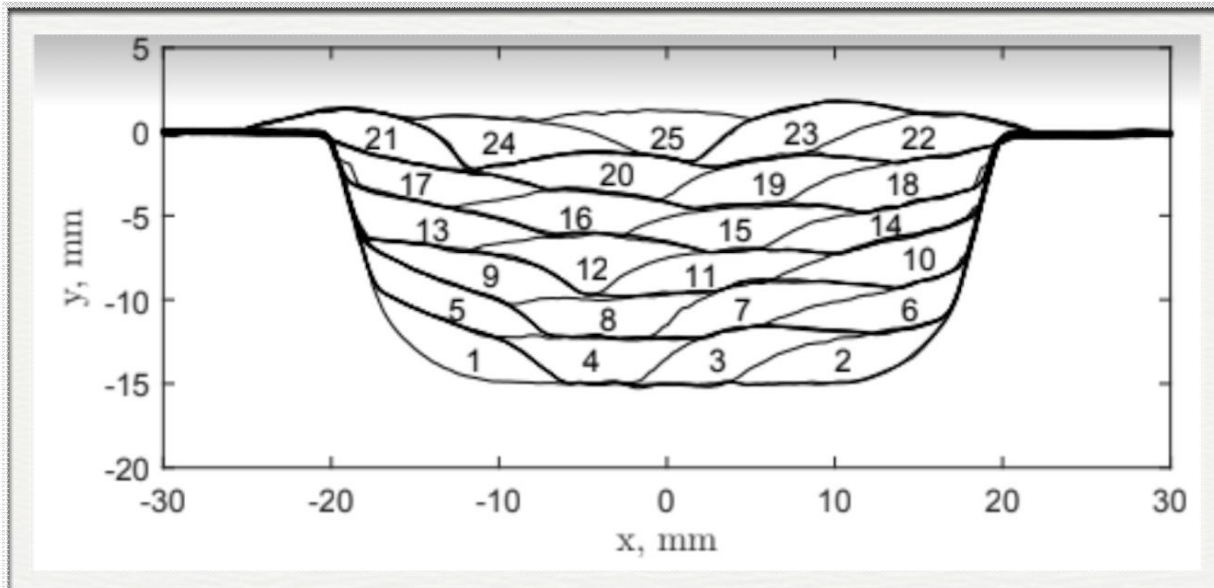
Design of a 25 Pass Weld Joint

Virtual

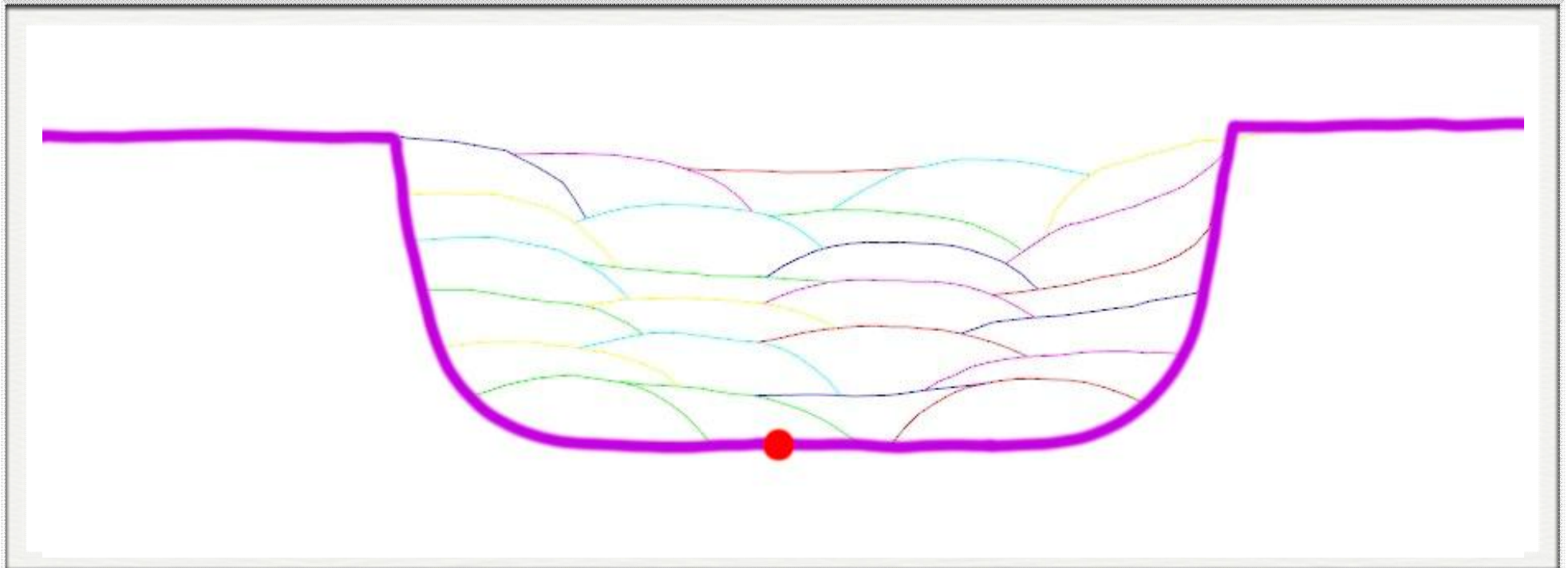


Input is weld joint geometry and the weld procedure that includes an estimate of the number of layers and number of weld passes in each layer and the weld procedure.

Real

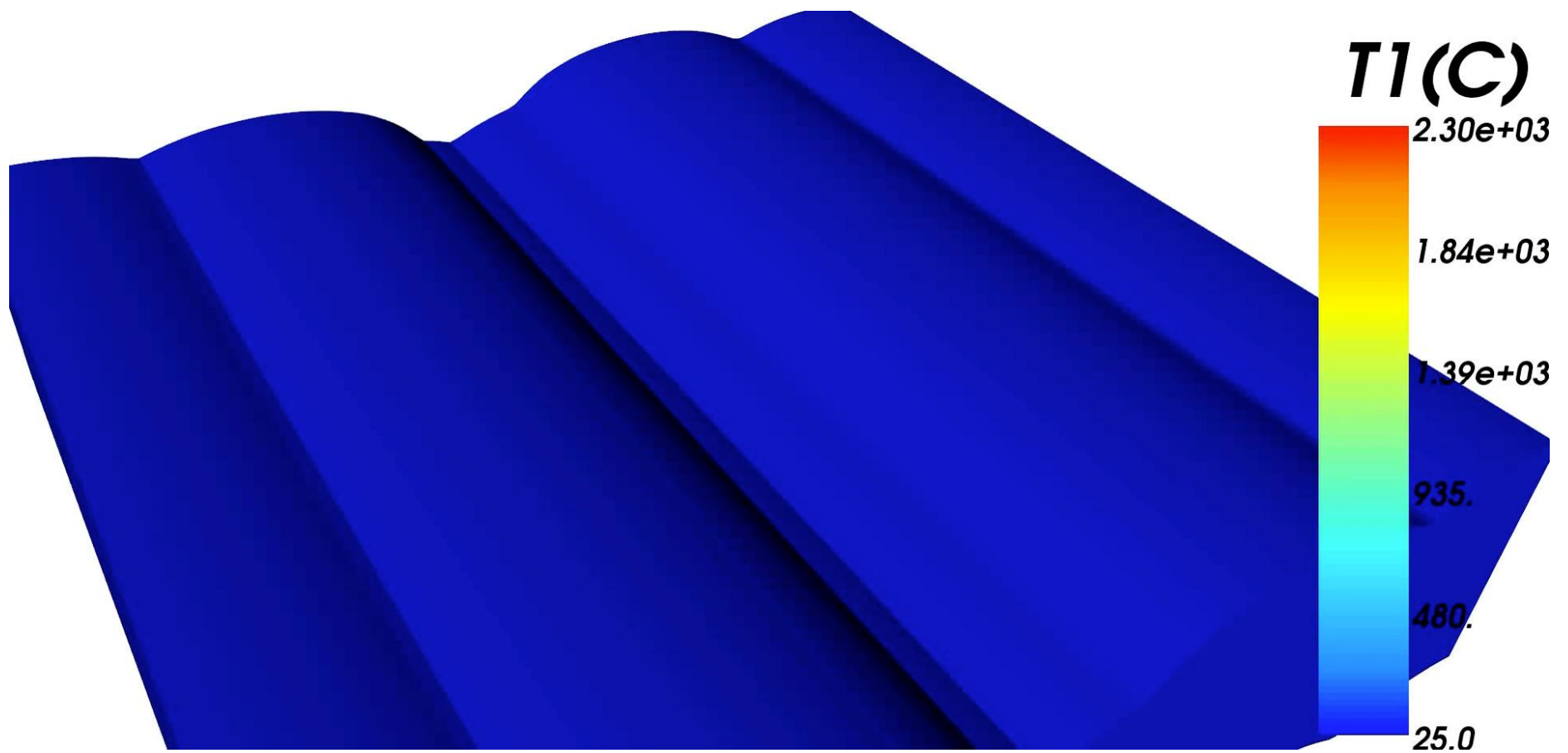


Transient Analysis of Last Weld Pass



Solves conservation of energy, mass and momentum with pressure from arc, thermal flux from the arc, mass flux from electrode, electrode tip to weld pool surface distance, surface tension and gravity for welds with a specified weave pattern.

Transient Temperature in Last Weld Pass



Transient Phase Fractions Near the Weld Pool

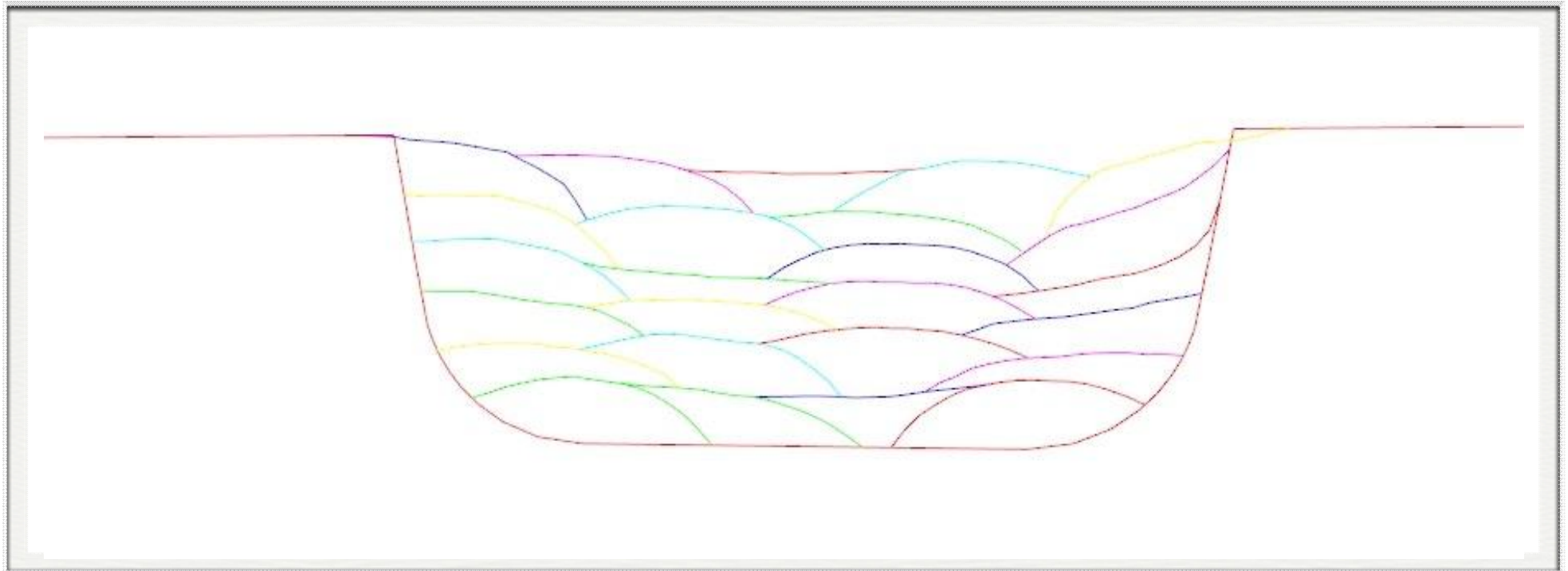


Transient Mushy Zone: Melting & Solidifying Zone



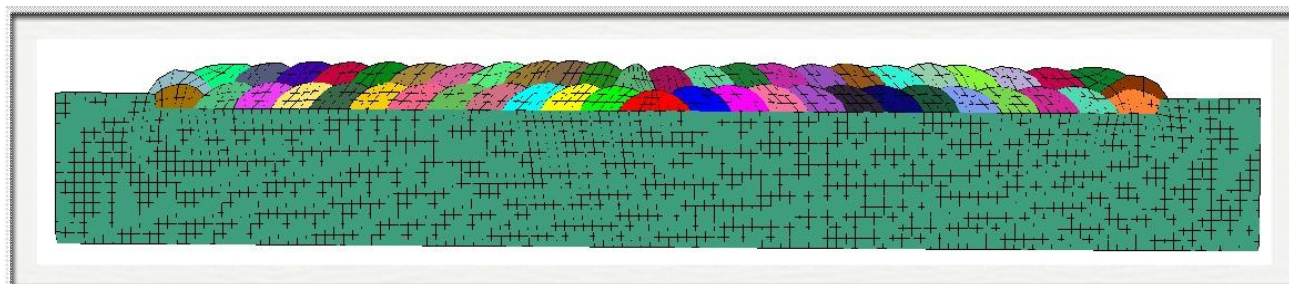
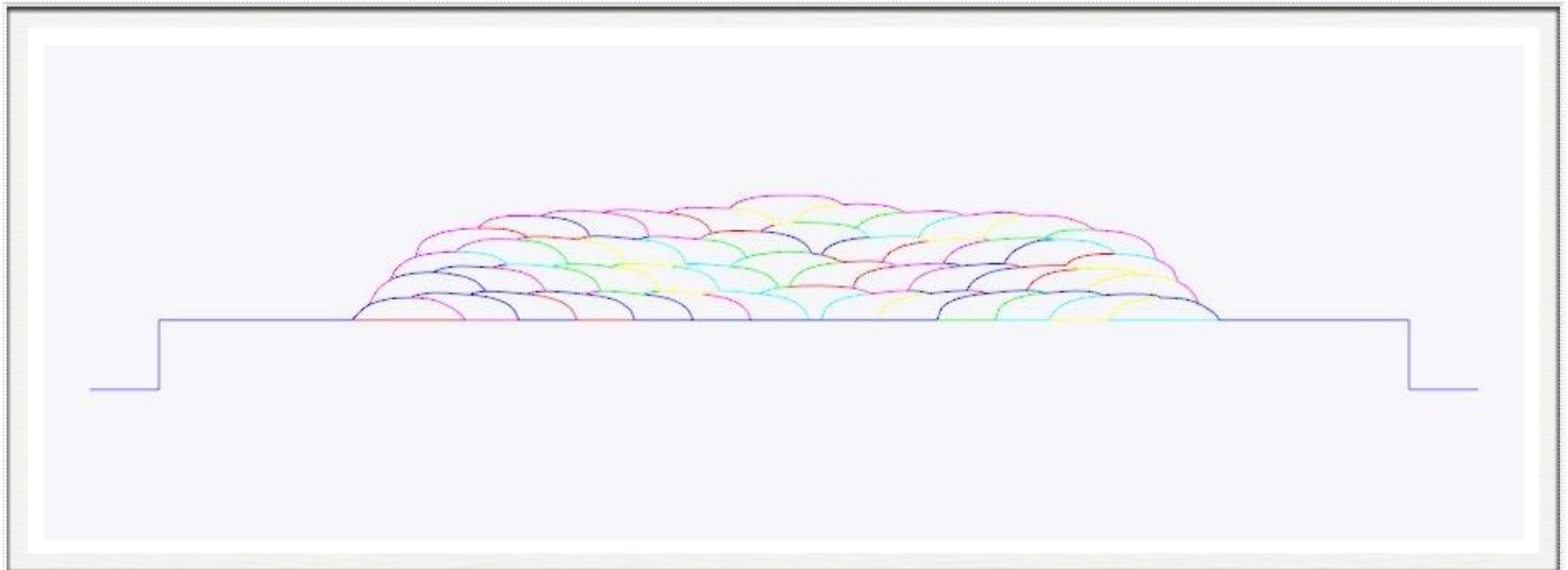
The transient iso-therm 5 degrees below the melting point is shown in blue and isotherm 5 degrees above the melting point is shown in red. The distance between the isotherms is the mushy zone. This is the transient weld pool. There is no weave in this weld.

Transient Thermal Analysis of Last Pass



Total computer time: 25 minutes
Total user time to set up the analysis is 2 minutes.

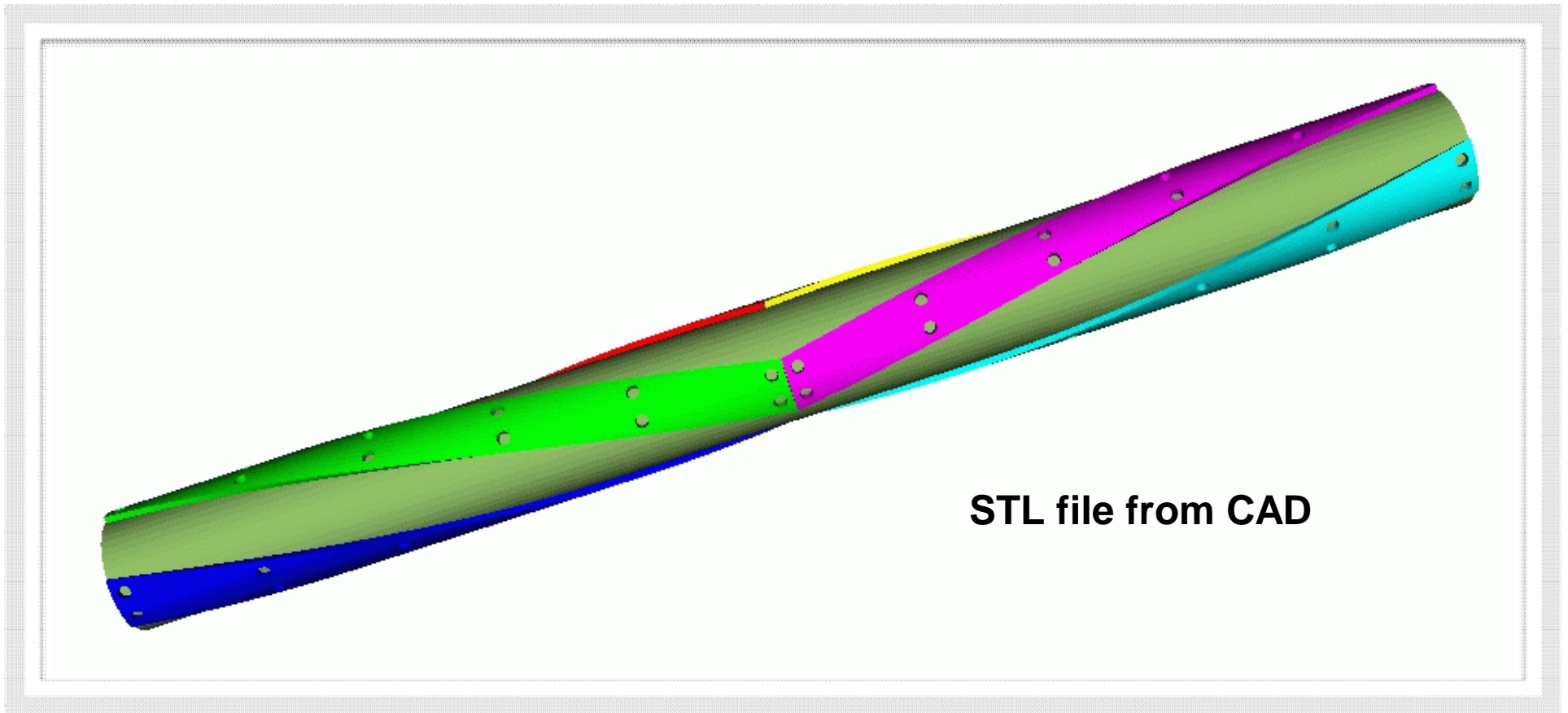
Multipass Overlay Weld



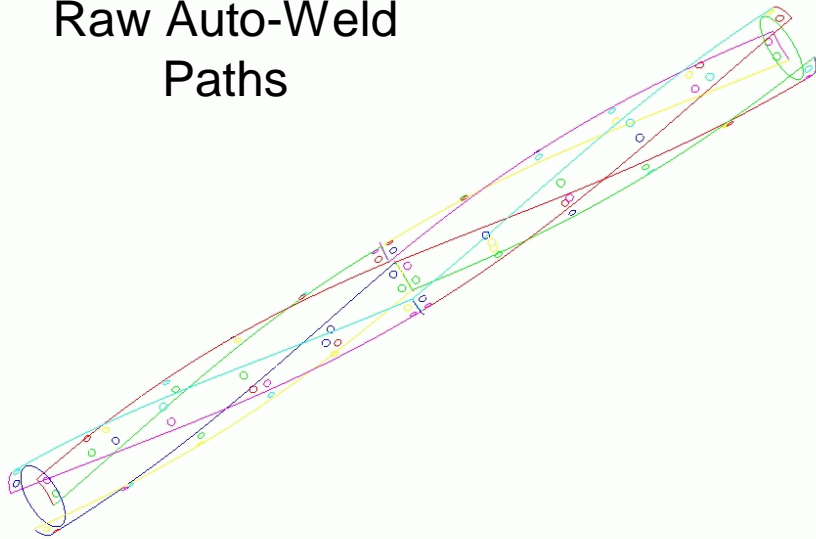
Summary

- Quick: Each weld pass requires one minute of computer time
- Simple input
 - Curved line defining weld joint geometry
 - Center point locating the root weld pass
 - Weld Procedure Data Sheet ID - WPDS
- Short step to off line programming of robots
- Not a big step to real-time control of the welding process
- Best done in the very early stages of design

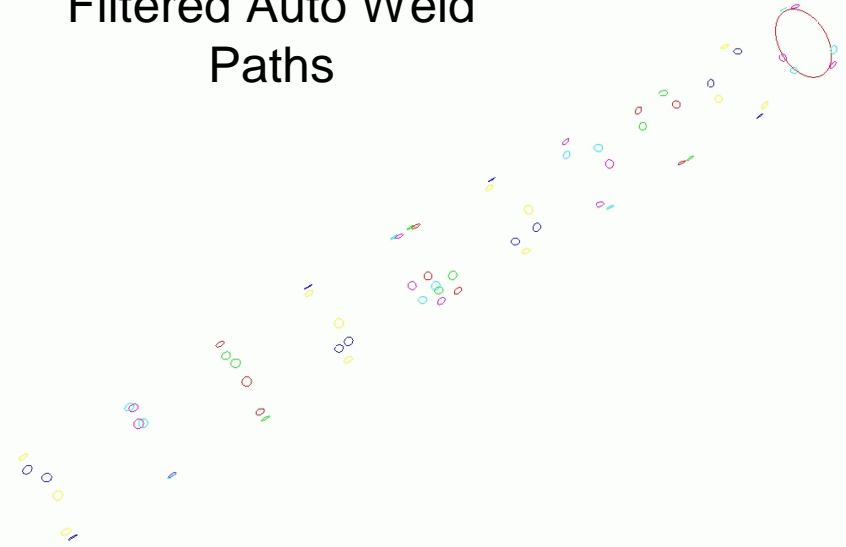
Automatic Analysis of Welds



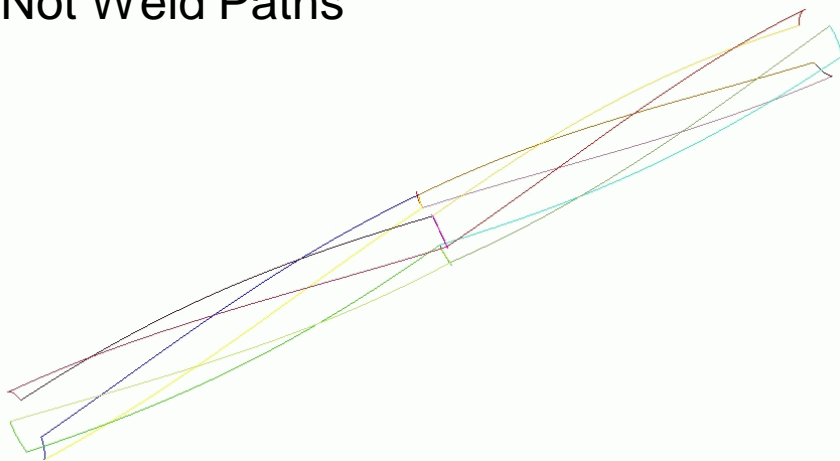
Raw Auto-Weld
Paths



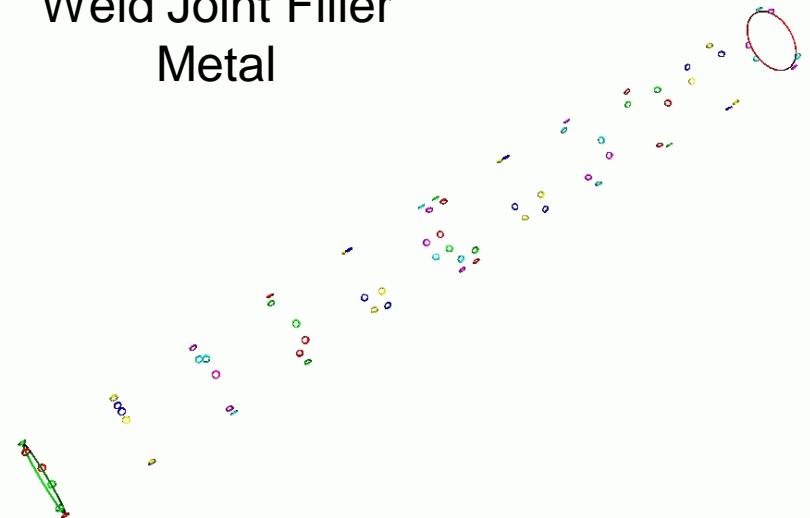
Filtered Auto Weld
Paths



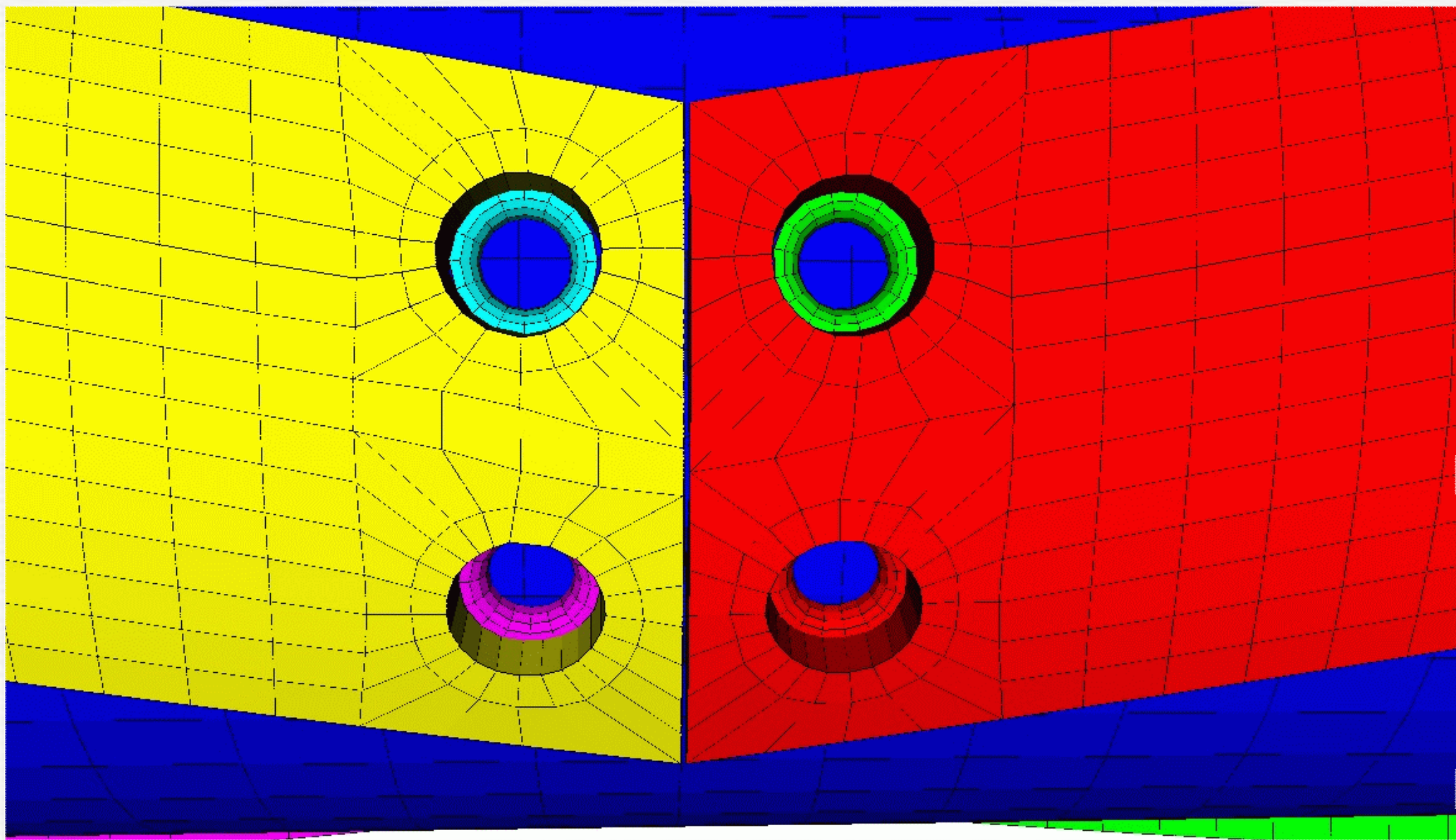
Not Weld Paths



Weld Joint Filler
Metal



FEM Mesh



To be trusted

Predictions must be validated by experimental data

ASME V&V Standard

