EWI®

THE MATERIALS JOINING EXPERTS

Materials Joining Technology Advancements for Future Pipelines

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Pipeline Welding *Circa 1980's*

Application	1980's	Predicted Technologies	2005 Reality
Short Pipelines	SMAW	SMAW	SMAW Semi-GMAW
Tie-Ins	SMAW	SMAW	SMAW FCAW Semi-GMAW
Long Pipelines (Small Diameter)	SMAW SAW (Pre-Fab.)	SMAW Mechanical Joining MIAB Flash	SMAW GMAW / FCAW Mech-GMAW SAW (Pre-Fab.)
Long Pipelines (Large Diameter)	SMAW Mech-GMAW SAW (Pre-Fab.)	Mech-GMAW Hot Wire GTAW Flash	SMAW GMAW / FCAW Mech-GMAW SAW (Pre-Fab.)
Plastic Pipe (Small Diameter)	Fusion ElectroFusion	Fusion ElectroFusion	Fusion ElectroFusion
Plastic Pipe (Large Diameter)	Fusion ElectroFusion	Fusion ElectroFusion	Fusion ElectroFusion

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The Future *Circa 2005*

- Will Not Get Easier
  - Technology Advancements Follow Technology Requirements
    - X80 → X100 → X120 → ?
    - Ambient Temp → Arctic Temp → Cryogenic Temp
    - Ambient Temp → 200 °C → ?
    - Plastic Pipe → 200 psi → >800 psi
    - Increasingly Corrosive Applications
      - CRA Solid Pipe and Clad Pipe
    - Trenchless Repair and Installation
    - Increasing Productivity Targets

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New Viable Technology

- Iterative Process Improvements
- Mechanized Processes
  - Statistical Process Control / Data Logging
  - Improved Feedback Control
  - Improved Mechanization
- New Processes
  - Hybrid Laser / GMAW
  - Tandem GMAW (Single & Dual Torch)
  - Magnetic Pulse Coating Solution
  - Automated Plastic Pipe Welding

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Iterative Process Improvements

- Consumables Development
  - High Strength Pipeline Materials Reciprocate High Strength Consumables
    - Hurdles
      - Toughness
      - Diffusible Hydrogen
      - Strength
- SMAW is Here to Stay
  - Next Generation SMAW
    - Oxygen <500 ppm,
    - H2 - Diff Hydrogen
    - >100 ksi
  - Low Hydrogen Vertical Down vs Cellulosic

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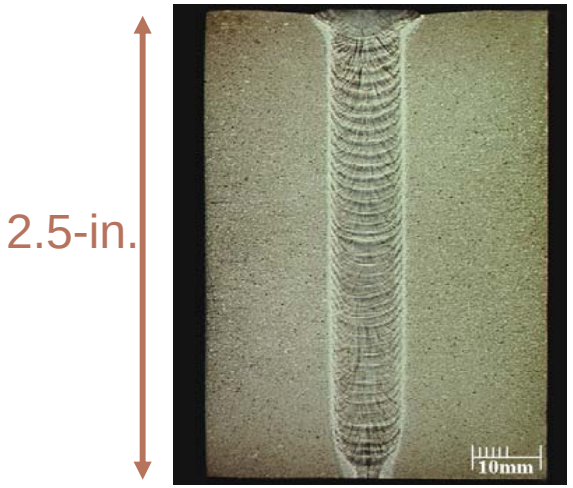
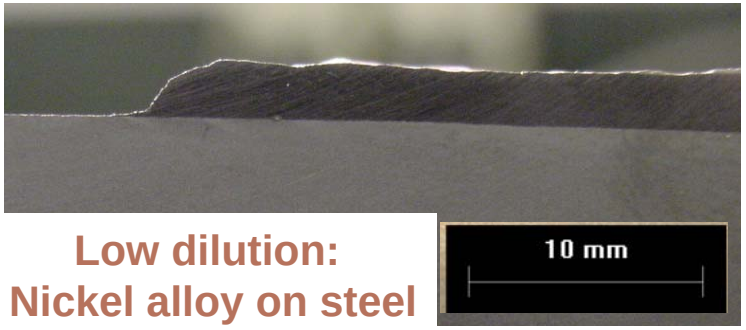
Iterative Process Improvements

- Equipment Improvements
  - Power Source Technology
  - Seam Tracking Technology
  - Better Integration
  - Lighter Weight
  - More Stability (Predictable Outputs)





Low dilution:
Nickel alloy on steel

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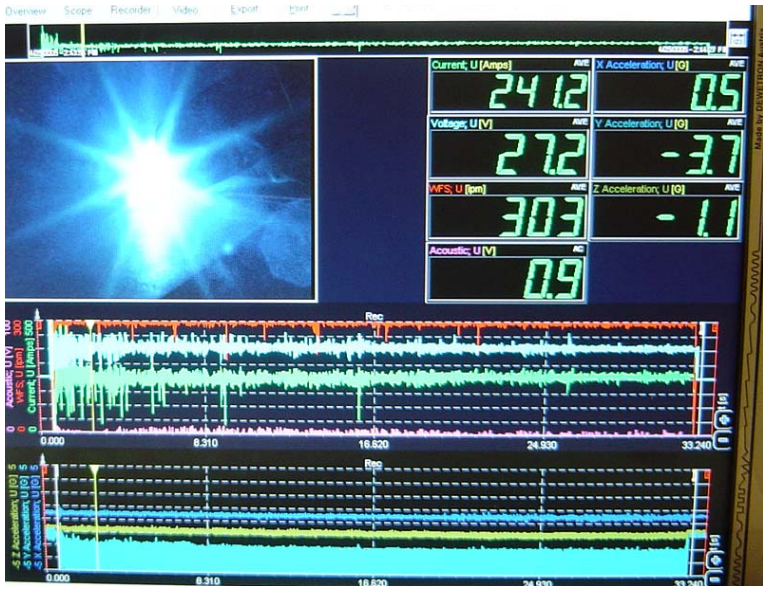
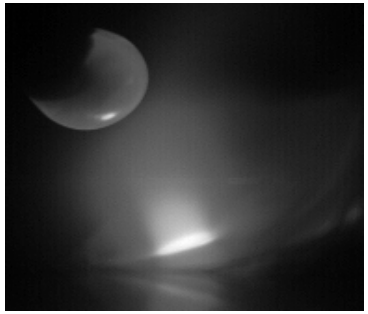
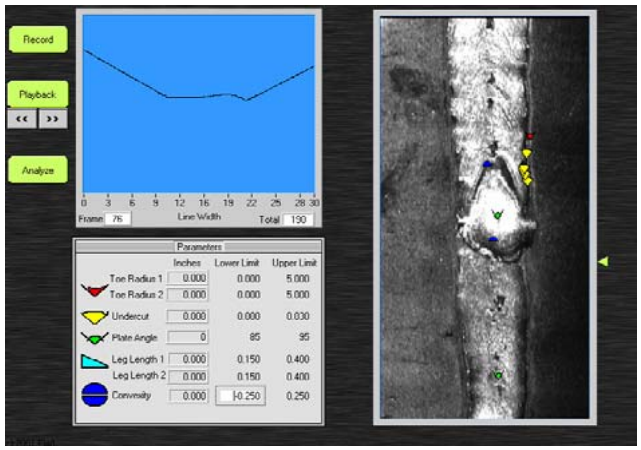
Statistical Process Control

- High Speed Data Acquisition
  - Video >60,000 frames/sec
  - Weld Data > 500 Hz
- More Variables Collected
  - Single Sensor Differential Thermal Analysis (SS-DTA)
  - Audible Noise
  - Joint Geometry (Pre-Weld)
  - Weld Geometry (Post-Weld)

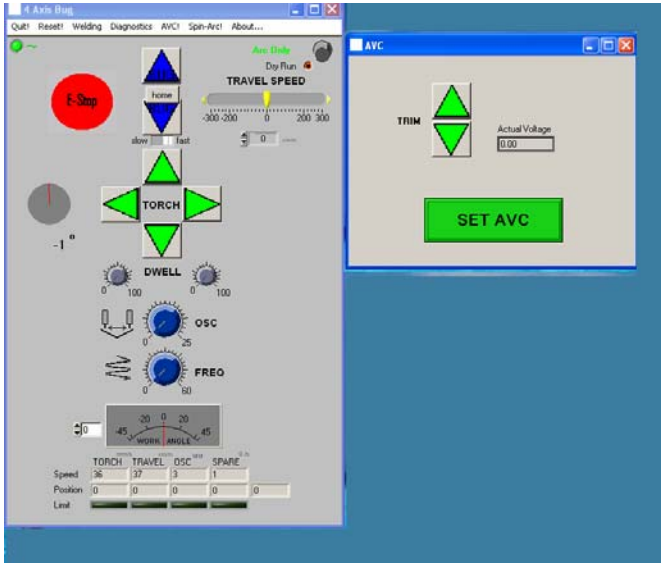


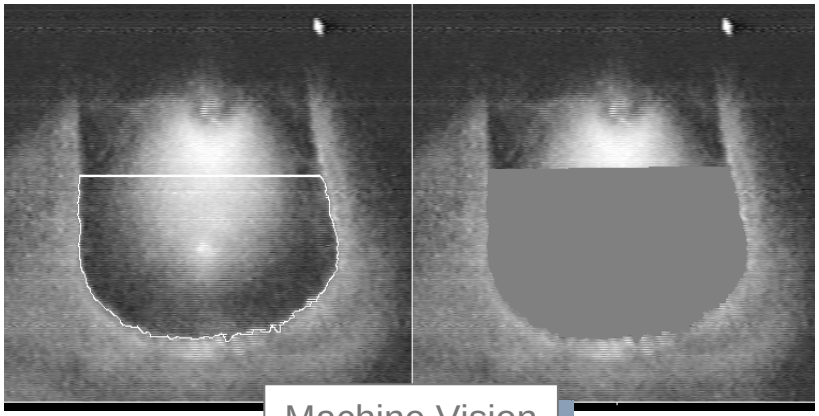




Improved Feedback Control

- CTWD Control
- Torch Force (X,Y,Z)
- Weld Pool Geometry
- Weld Pool Oscillation
- Laser Profilometry
  - Pre/Post Weld





Machine Vision

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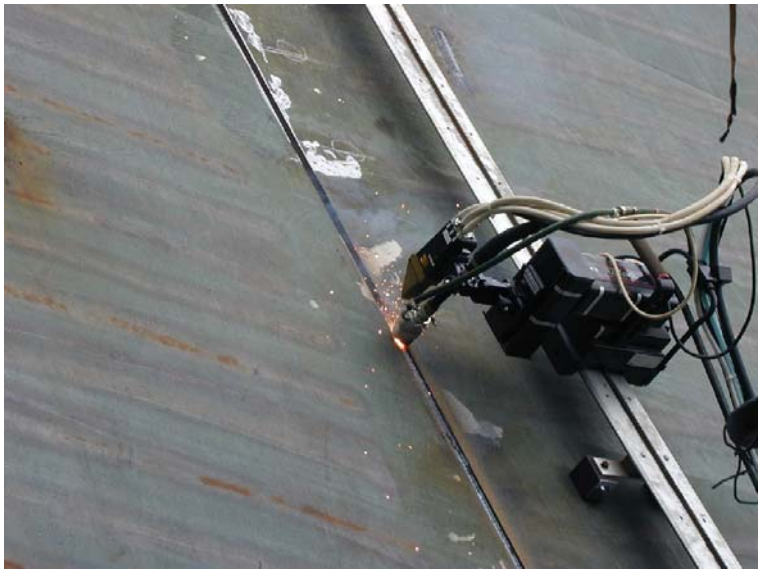
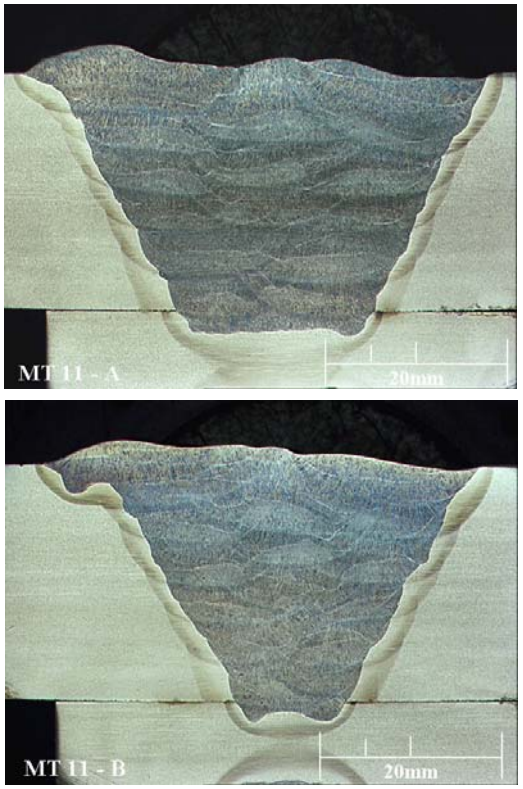
Improved Feedback Control

- "MBML"
  - Deployed in Production Shipbuilding – 2004





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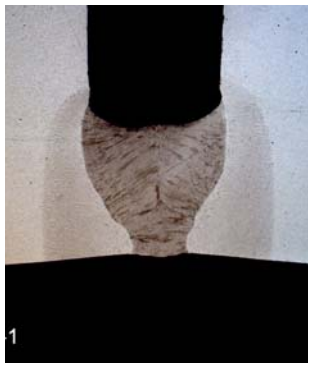
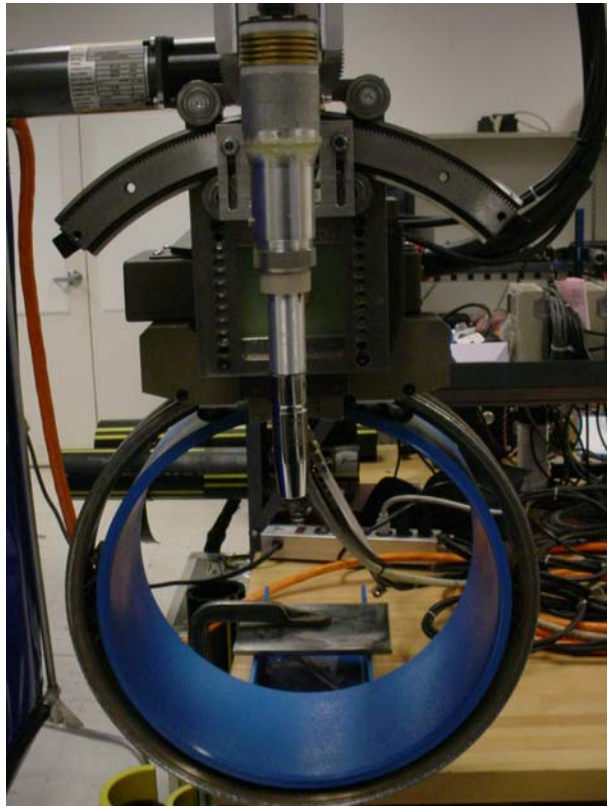
Improved Mechanization

- Spin Arc / Rotated Electrode
- Lead-Lag Control
- Dual Torch Multi-Function





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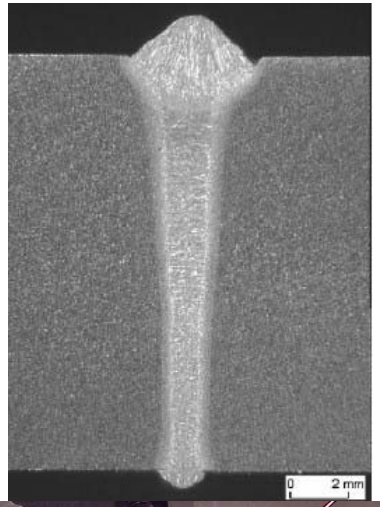
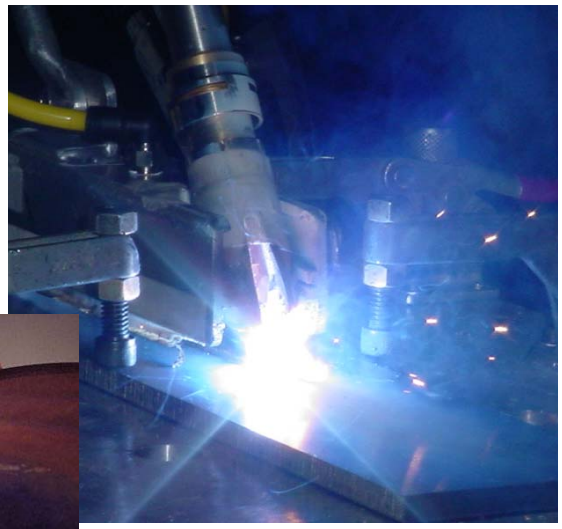
Hybrid Laser/GMAW





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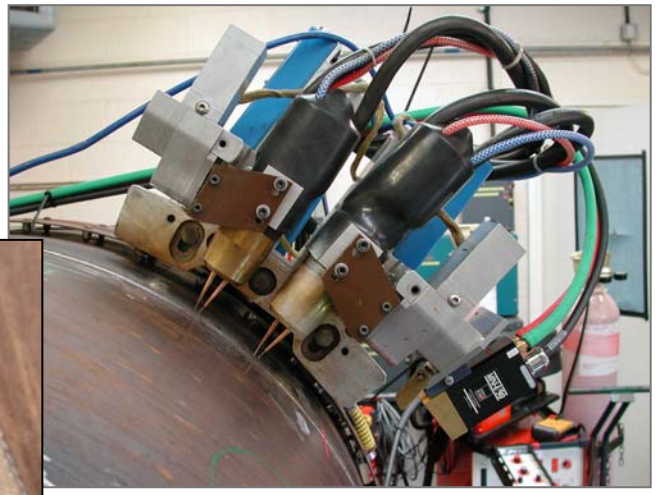
Tandem GMAW

- BP / TCPL funded development of dual tandem at Cranfield University using Fronius synchronized power sources 2001 - 2002

Dual torch operational field trial
Edmonton March 2003



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Tandem GMAW

Single tandem employed by CRC with IWM & P-GMAW HP on the TCPL

Godin Lake X100 loop 2004

CRC and Serimer have completed consistency trial on X80 for McKenzie.

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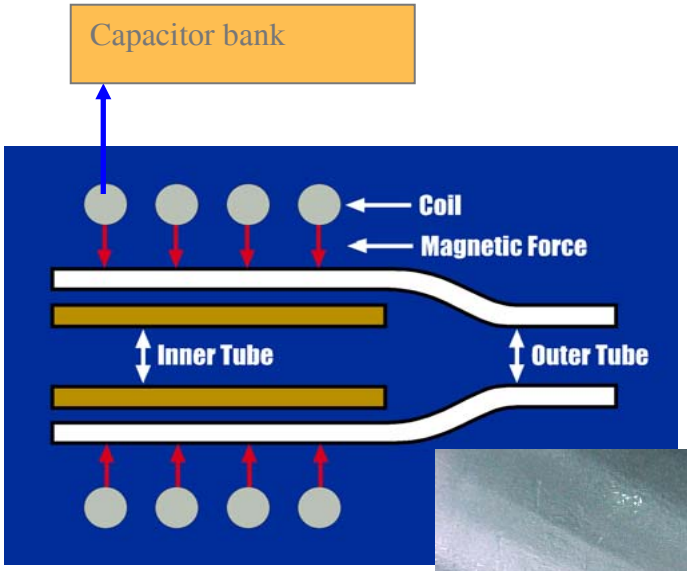
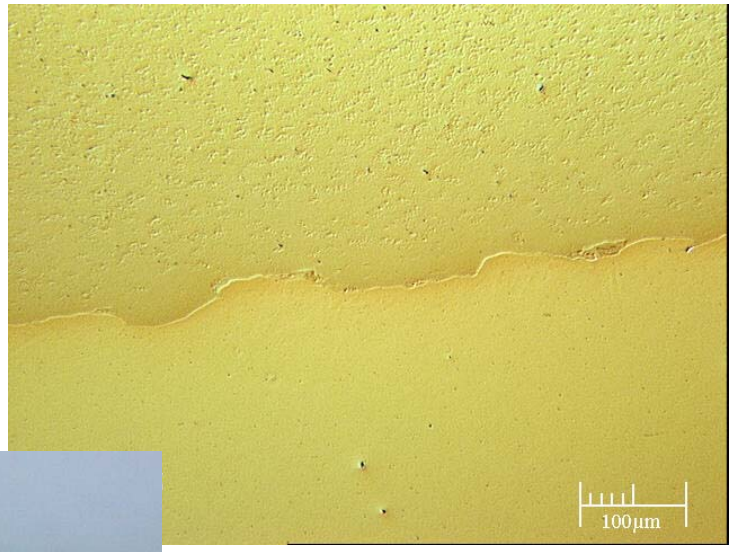
Magnetic Pulse Clad Concept

Process Description





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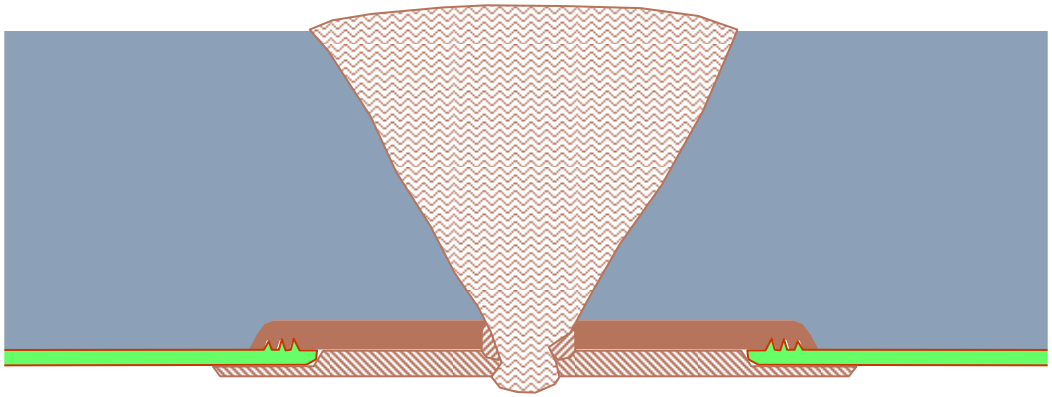

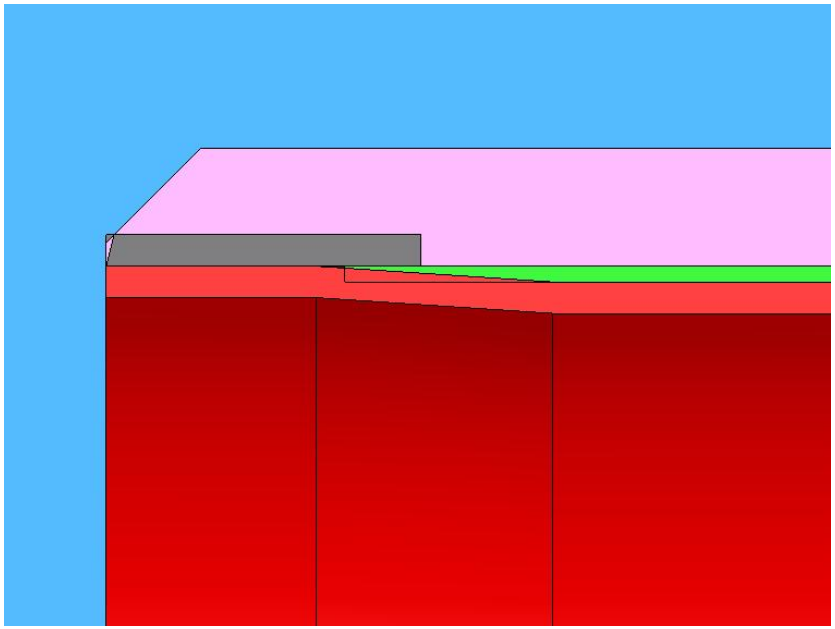

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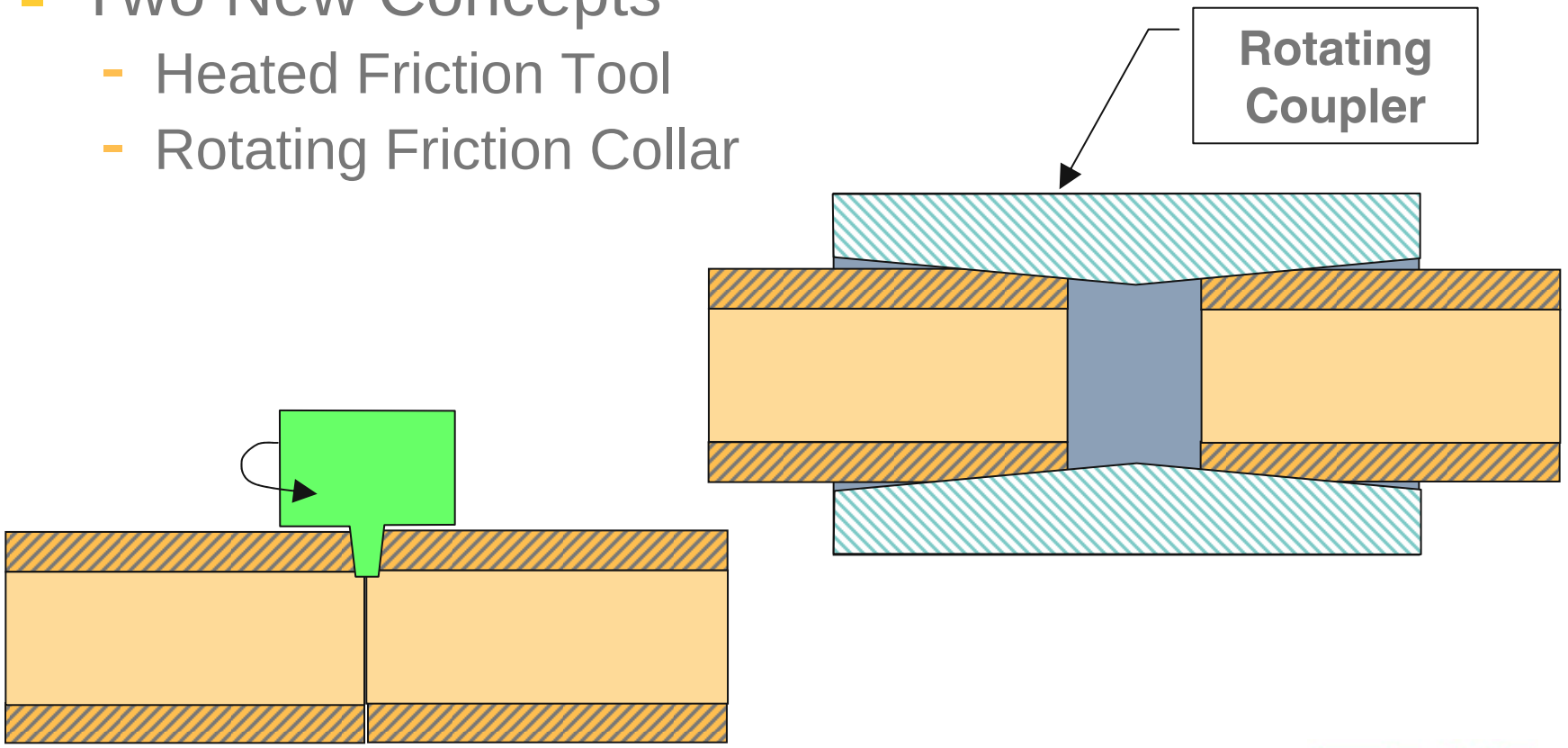
Automated Plastic Pipe Welding

- Two New Concepts
  - Heated Friction Tool
  - Rotating Friction Collar



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Concluding Remarks

- What Welding Technology is the Next Big Thing
  - Reality – We don't know
    - Demographics & Unions
    - Pipe/Steel Development
    - Application Requirements
  - High Probability
    - Dual Tandem
    - Hybrid Laser/GMAW
      - Utilizing Advanced Seam Tracking
    - PE and PA Pipe
      - Related Joining Technologies

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Where do you want pipeline welding to go?

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