# Materials Joining Technology Advancements for Future Pipelines

<table>
<thead>
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<tbody>
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## Pipeline Welding Circa 1980’s

<table>
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<tr>
<th>Application</th>
<th>1980's</th>
<th>Predicted Technologies</th>
<th>2005 Reality</th>
</tr>
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<tbody>
<tr>
<td>Short Pipelines</td>
<td>SMAW</td>
<td>SMAW</td>
<td>SMAW Semi-GMAW</td>
</tr>
<tr>
<td>Tie-Ins</td>
<td>SMAW</td>
<td>SMAW</td>
<td>SMAW FCAW Semi-GMAW</td>
</tr>
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<td>Long Pipelines (Small Diameter)</td>
<td>SMAW</td>
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<tr>
<td>Plastic Pipe (Small Diameter)</td>
<td>Fusion</td>
<td>Fusion</td>
<td>Fusion ElectroFusion</td>
</tr>
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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
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
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
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

2.5-in.
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
Improved Feedback Control

- “MBML”
  - Deployed in Production Shipbuilding – 2004
Improved Mechanization

- Spin Arc / Rotated Electrode
- Lead-Lag Control
- Dual Torch Multi-Function
Hybrid Laser/GMAW
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
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.
Magnetic Pulse Clad Concept

Process Description

Capacitor bank

Coil
Magnetic Force

Inner Tube
Outer Tube

EWi
THE MATERIALS JOINING EXPERTS
Magnetic Pulse Clad Concept
Automated Plastic Pipe Welding

- Two New Concepts
  - Heated Friction Tool
  - Rotating Friction Collar
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
Where do you want pipeline welding to go?

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