COMPUTER WELD TECHNOLOGY, INC.

Computer Weld Technology, Inc.

10702 Old Bammel N. Houston Rd.
Houston Texas, 77086

Phone 713-462-2118 Fax: 713-462-2503 Web: www.cweldtech.com

The Leader in Automating, Controlling and Monitoring the Arc Welding Process.

Our mission at Computer Weld Technology is to provide you with state-of-the-art products for automating, controlling and monitoring the welding process.

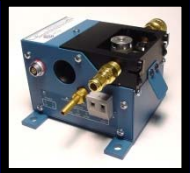
General Product Groups

- Weld Sequence Controllers
- Weld Monitoring Systems
- Adaptive Weld control systems using CWT patented Thru-Arc™ Seam Tracking Technology
- OEM Custom Controls

Weld Control Products

- WSC – Weld Sequence Controller
  - WSC-1000, MWC, WSC II, UWC
- ATC – Automatic Torch Controller
  - AVC or ACC torch height control
- VSA – Vertical Slide Assembly
  - 6”, 12” 100 lb. Stepper motor slide
- HSA – Horizontal Slide Assembly
  - 3”, 6”, 12” 45 lb. Stepper motor slide

Product Lineup

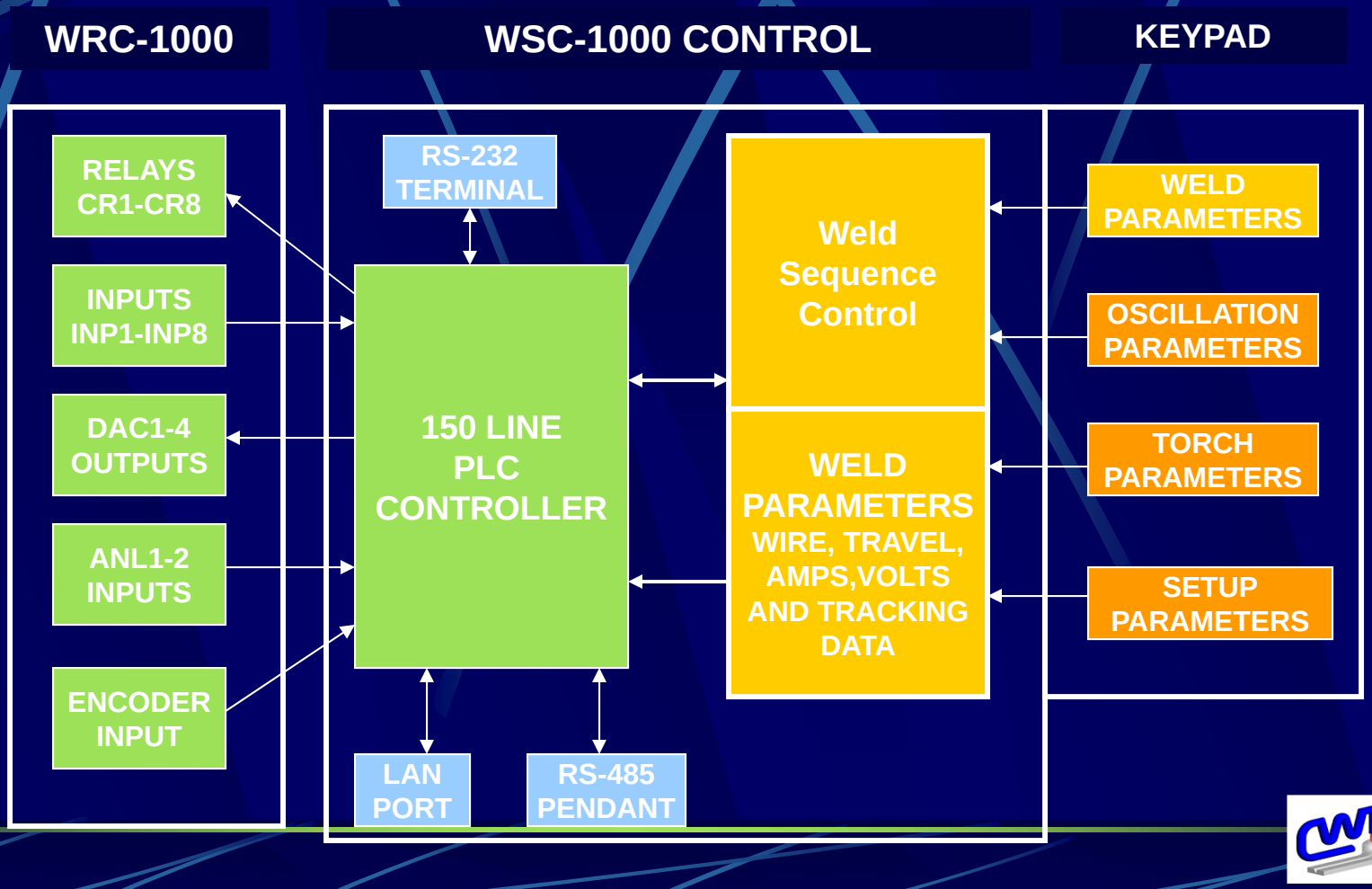


Weld Sequence Controller Configuration Options

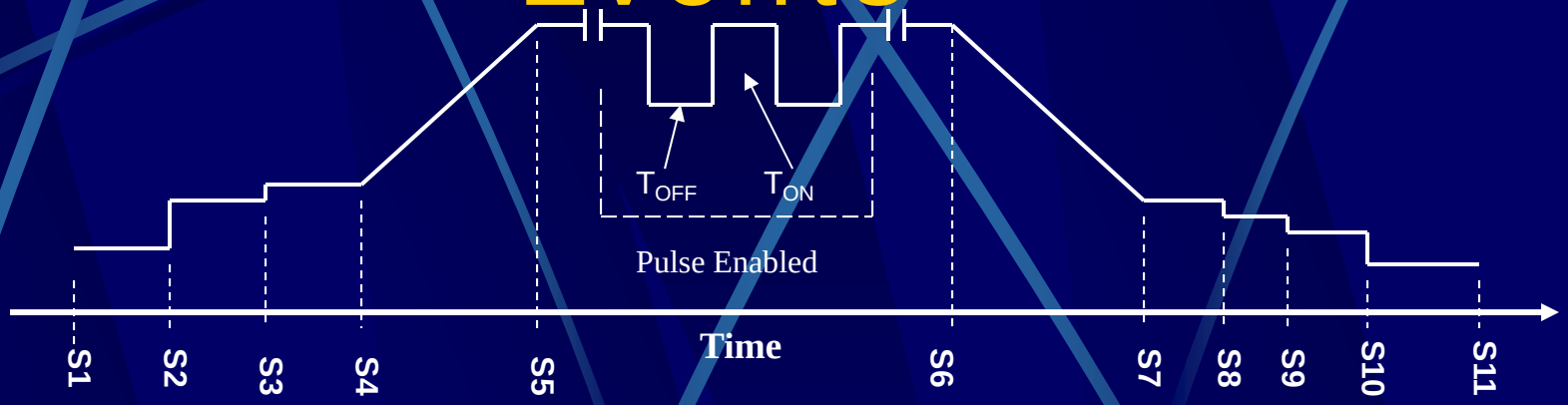
- WSC-1000 weld sequence control in NEMA 4 rated enclosure with WRC-1000 remote I/O.

- MWC modular weld control with integrated remote I/O module and optional DMC-500 motor controller.

WSC-1000/MWC Control System



Weld Sequence Control Events



S1 = Cycle Start

S1 - S2 = **Event 1** - Prepurge Gas Flow Time

S2 - S3 = **Event 2** - Arc Start Parameter Time

S3 - S4 = **Event 3** - Arc Active Delay Time

S4 - S5 = **Event 4** - Ramp Up Time

S5 - S6 = **Event 5** - Weld Time (spot or manual)

S6 - S7 = **Event 6** - Ramp Down Time

S7 - S8 = **Event 7** - Crater Fill Parameter Time

S8 - S 9 = **Event 8** - Wire Retract Time

S9 - S10 = **Event 9** - Burn Back Time

S10 - S11 = **Event 10** - Post Purge Time

Weld Sequence Control Features

- Provides closed loop control for voltage and current values and will adjust the external welding devices to regulate and obtain the programmed values.
- Programmable control for arc voltage, arc current, wire feed speed, travel speed and event time.
- Setting the event time to zero will disable the specific event. In addition to the specific weld events the user can specify a pulse mode of operation.
- The control will pulse the arc voltage, arc current, wire feed speed and travel speed.
- If an external oscillator (horizontal) axis is enabled, the user can synchronize the pulse mode to an oscillation pattern.
- The user can disable the pulsation of any single parameter.

WSC-1000 with WRC-1000 Controller

Motion Controllers DMC-500 and MSC II

- **MSC II™** Micro-Step controller is a microprocessor based stepper motor controller designed to operate 2 phase step motors.
  - Current Range 1.0- 7.0 amps per phase.
  - Full, Half and 10 step/step micro stepping.
  - 10-8000 steps/second velocity
- **DMC-500™** DC motor speed control for DC motors up to ¼ h.p.
  - Armature Voltage - 0-90 VDC
  - Field voltage 100 VDC

VSA-2000/HSA-2000 Slides

- **VSA-2000™** Series Vertical Slide Assembly.
  - Load Capacity 100 lbs @ 6.0” from Face of slide
  - Stroke Length 2.75”, 7.5”, 12.00” and 26.00”
  - Velocity 3.00 inch/sec
  - Resolution 0.00 inch
- **HSA-2000™** series Horizontal Slide assembly.
  - Load Capacity 35 lbs @ 6.0” from Face of slide
  - Stroke Length 2.75”, 7.50”, and 12.00”
  - Velocity 6.00 inch/sec
  - Resolution 0.001 inch

Operator Control Pendant

- Provides User Jog and weld sequence control inputs as defined by system PLC code.
- WRP-1000 pendant for weld process control
- Provide Joy-Stick control of Torch position.
- Provide Weld Start, Stop and jog functions
- Includes System ESTOP control for system shut down

WF-100 Capstan Feeder

- Compact Lightweight Design
- Plastically Deforms Wire
- Positive Wire Feed Force
- Eliminates Surface Damage
- Suitable for “Cold” and “Hot” Wire
- Mount on Robot Wrist Automated Fixture
- Exceptional Feeding of “Soft Wire” (Alum).

CWT Capstan Wirefeeder

Adaptive Thru-Arc™ Tracking

Technology Overview

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Seam Tracking: The Need

- Poor part fit up and part preparation
- Reduce dependence on operator skills
- Lower cycle time and increase productivity
- Improve weld quality and consistency
- Reduce scrap parts

Seam Tracking: The Technology

- Tactile probe
  - Mechanical probe
- Optical
  - Laser
  - Vision
- IR sensors
- Eddy current
- RF proximity sensors
- Acoustic emission
- Through-the-arc

Through-the-arc Sensor Technology

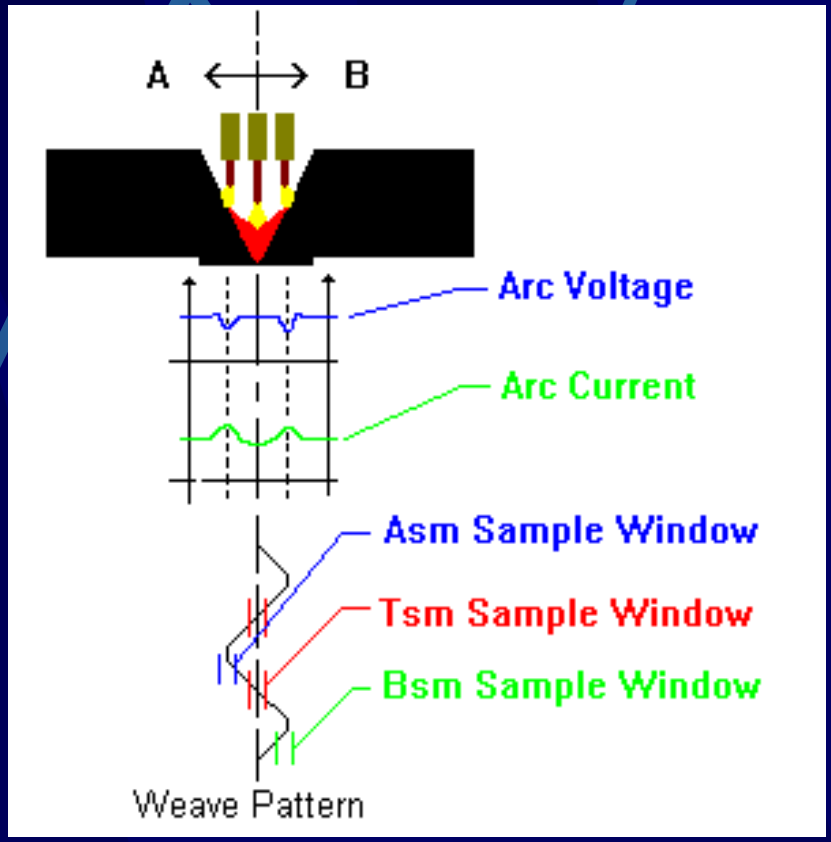
- Every arc offers impedance to the flow of current.
- The impedance is inversely proportional to density of the charge carriers and their mobility.
- Plasma column impedances are calculable as a function of temperature.
- Total impedance depends on radial and axial disturbances of carrier density.

Thru-Arc™ Torch Height Control

- Melting rate fixed by wire speed and wire diameter.
- Current density set by wire speed.
- Melting rate equation can be used to determine electrode extension.
- $L = (I_{REF} - I_{ACT})/(I_{REF}) * 100 * \alpha$
  - L = change in electrode extension
  - I_{REF} = reference current
  - I_{ACT} = actual current
  - α = percent current change per wire length, for 1.2 mm dia steel electrode = 1.44 mm/%I

Thru-Arc™ Centerline Control

- For center position correction vector the torch must be oscillated
- Samples taken at center and A/B sidewall positions
- $C_{VEC} = (A_{SM} – B_{SM}) * \alpha$
  - CSM = center correction vector
  - ASM = A side sample
  - BSM = B side sample
  - α = constant of proportionality for center correction vector



A=B Tracking Implementation

- Motion controller must provide the following:
  - A and B position timing
  - Ability to change center position of weave pattern
  - Torch height correction perpendicular to weave pattern
  - Weave pattern must be consistent within working envelope
- Method used in most robotic implementations
- Simple retrofit to existing hard tooled fixtures

A=B Tracking Applications

- A=B is used with most robotic systems.
- Requires balanced joint geometry or bias offsets.
- Good for single pass heavy weldments.
- Used for fillet, lap, v-groove joint geometry.
- Difficult to use with single side wall applications.

Thru-Arc™ Width Control

- Use impedance to determine arc penetration.
- Use center sample and percent penetration value to establish integration
- Halt torch motion when value is obtained.
- Calculate new width, center position and cross seam correction vector.
- Use last center sample to generate torch height correction vector.

Thru-Arc™ Fill Height Control

- Use wire speed, travel speed and starting width to calculate volume fill.
- Use new width and fill height to generate new travel.
- Set max/min heat input to control adaptive fill limits.
- Use torch height to extend adaptive fill limits at max/min heat input.

Thru-Arc™ Adaptive Procedure Control

- Based on initial width, weave speed, dwell time, wire speed, volt and amps calculate work function for center and sidewall positions.
- Use center work and new width and travel speed to control weave speed.
- Use sidewall work and travel speed to adjust dwell time.
- Use impedance profile to control bead geometry.

Adaptive Tracking Implementation

- Motion controller must provide the following:
  - Continuous torch position information
  - Ability to change center position and amplitude of weave pattern
  - Torch height correction perpendicular to weave pattern
  - Weave pattern must be consistence within working envelope
  - Adjustable weave and travel speed during welding
  - Provide weld schedule data for reference and control
- Method has been integrated to robotic controllers
- Retrofit to existing hard tooled fixtures using dedicated weld system controller

Adaptive Tracking Applications

- Technology adapted to advanced robotic controllers
- Provides single side and adjustable width control
- Good for single and multiple pass heavy weldments
- Requires minimum of 2 wire diameters joint definition for all weld process
- Used for fillet, lap and v-groove joint geometry
- Can be used with GMAW, SAW, PAW, GTAW welding processes

Thru-Arc™ Technology Summary

Benefits:

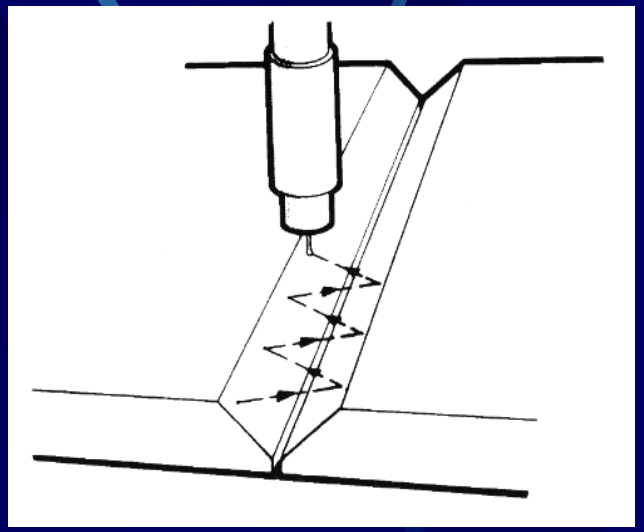
- No additional sensors
- Maintains true arc position
- Provides adaptive fill capabilities
- Simple retrofit to existing fixtures
- No special maintenance requirements

Limitations:

- Minimum oscillation of one wire diameter
- Requires stable arc process
- Changes in weld procedure must be made by controller
- Max travel speed 40 – 50 ipm
- 2 wire diameter joint definition

Centerline Thru-Arc Tracking Mode

- Target is to maintain the same impedance on both sides of the weave
- Definable torch to work (stick-out) as height reference
- A bias can be applied to the impedance measurement to adjust position of the weld in the joint



Robotic Application using Center Line Tracking Mode

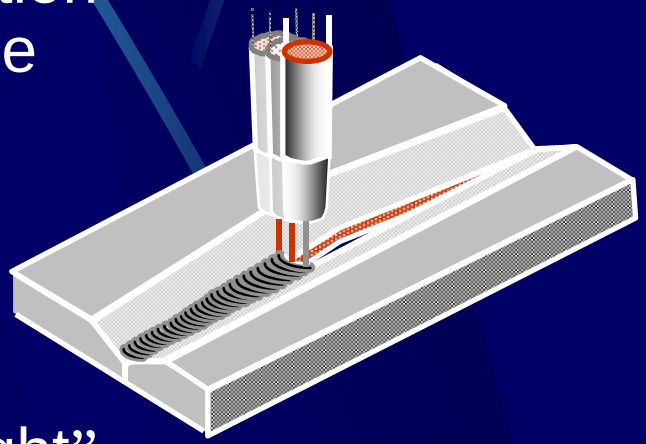
Single Side Thru-Arc™ Tracking Mode

- Allows user to set side-wall penetration as percent of stick-out length change
- Uses torch-to-work (stick-out) as reference
- Application:
  - Lap joints
  - Multi-layer passes
  - Joints where one side is uneven

Robotic Application Using Single Side Tracking Mode

Variable Width Tracking with Constant Fill Height Mode

- Uses torch-to-work (stick-out) as reference
- Allows user to set side-wall penetration as percent of stick-out length change
- Automatic variable weave width
- Variable welding speed based on weave width
- Forward travel speed is adjusted to maintain a constant “volume fill height”



Variable Width Tracking Mode With 50% Volume Change

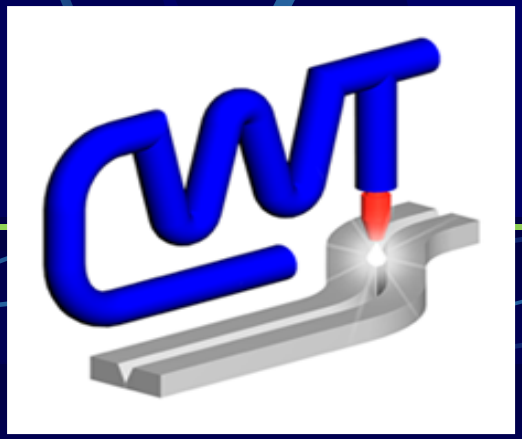
- Three Pass single bevel using constant volume fill

- Three pass V-groove using constant volume fill

Fixed Automation Thru-Arc™ System Components

- Weld Sequence Controller with Thru-Arc tracking and adaptive weld process control.
- Vertical/Horizontal Slides for torch motion.
- Micro-step Slide Controllers.
- DC motor controllers for wire drive and travel speed.
- User supplied power source and wire drive system.
- Optional remote operator control pendant.

Non Robotic Applications of Adaptive Thru-Arc™ Tracking



Through-the-arc Sensor Technology

- Use Impedance from voltage and current sensor readings to track the joint and control the welding process.
- Economically replace mechanical and tactical probes.
- Track and control the Arc for 1/3rd the cost of a typical Laser or Vision System.
- Perfect for heavy fabrication, long weldments (5-80ft), and replacing labor intensive (1-2 man/torch) applications.
- Improve quality, increase production, and reduce labor with almost immediate payback.

WSC-1000 Thru-Arc™ Tracking System

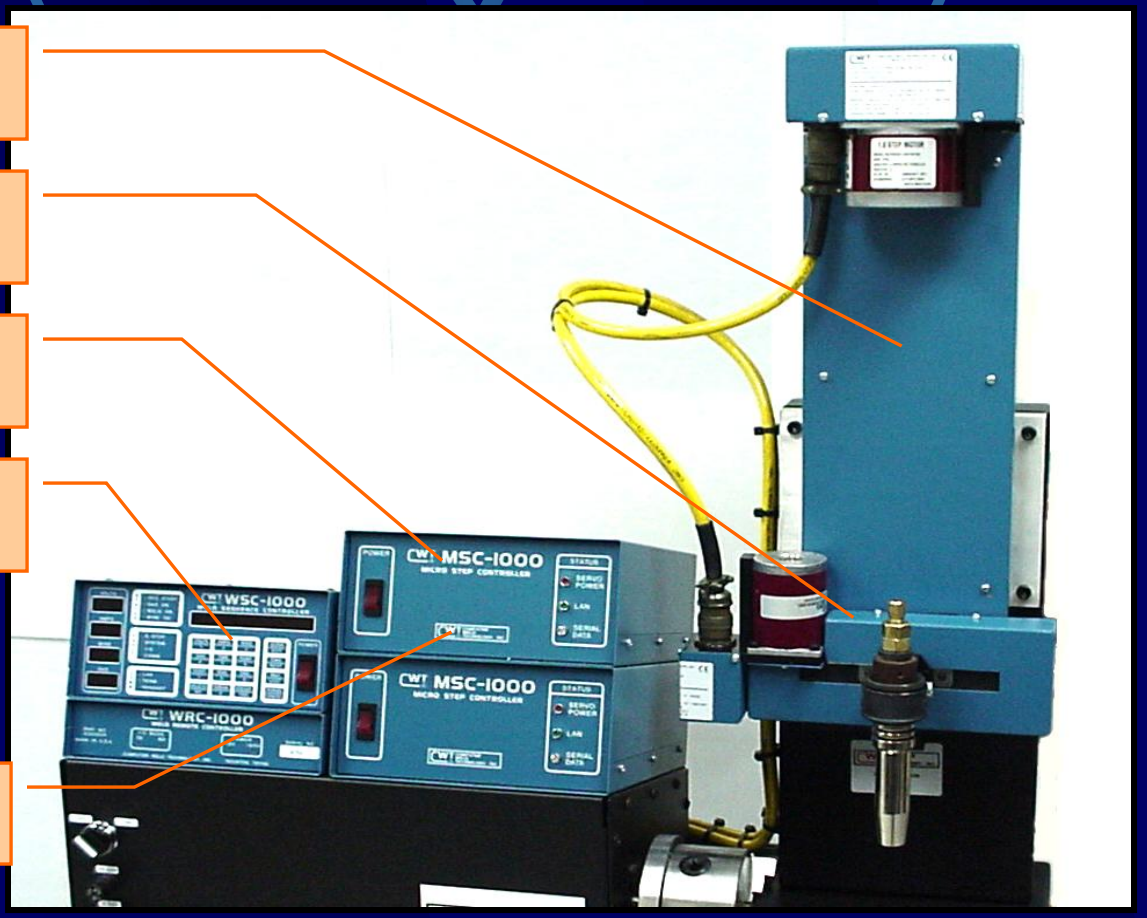
VSA-2000 Vertical Slide Assembly

HSA-2000 Horizontal Slide Assembly

Vertical Slide Control MSC-1000™

WSC-1000 Weld Sequence Controller

Horizontal Slide Control MSC-1000™

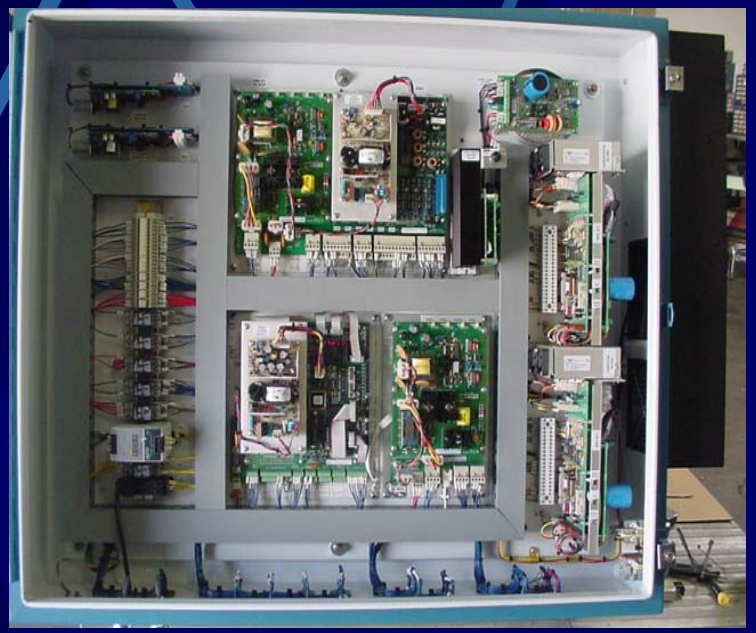


CWT Custom Thru-Arc™ System Enclosures

- Weld Sequence Controller with Thru-Arc tracking and adaptive weld process control.
- Vertical/Horizontal Slides for torch motion.
- Micro-step Slide Controllers.
- DC motor controllers for wire drive and travel speed.
- User supplied power source and wire drive system.
- Optional remote operator control pendant.

Thru-Arc™ System Components

- Weld Sequence Controller with Thru-Arc tracking and adaptive weld process control.
- Vertical/Horizontal Slides for torch motion.
- Micro-step Slide Controllers.
- DC motor controllers for wire drive and travel speed.
- User supplied power source and wire drive system.
- Optional remote operator control pendant.



VSA-2000/HAS-2000 Slides

- **VSA-2000™** Series Vertical Slide Assembly.
  - Load Capacity 100 lbs @ 6.0” from Face of slide
  - Stroke Length 2.75”, 7.5”, 12.00” and 26.00”
  - Velocity 3.00 inch/sec
- **HSA-2000™** series Horizontal Slide assembly.
  - Load Capacity 35 lbs @ 6.0” from Face of slide
  - Stroke Length 2.75”, 7.50”, and 12.00”
  - Velocity 6.00 inch/sec

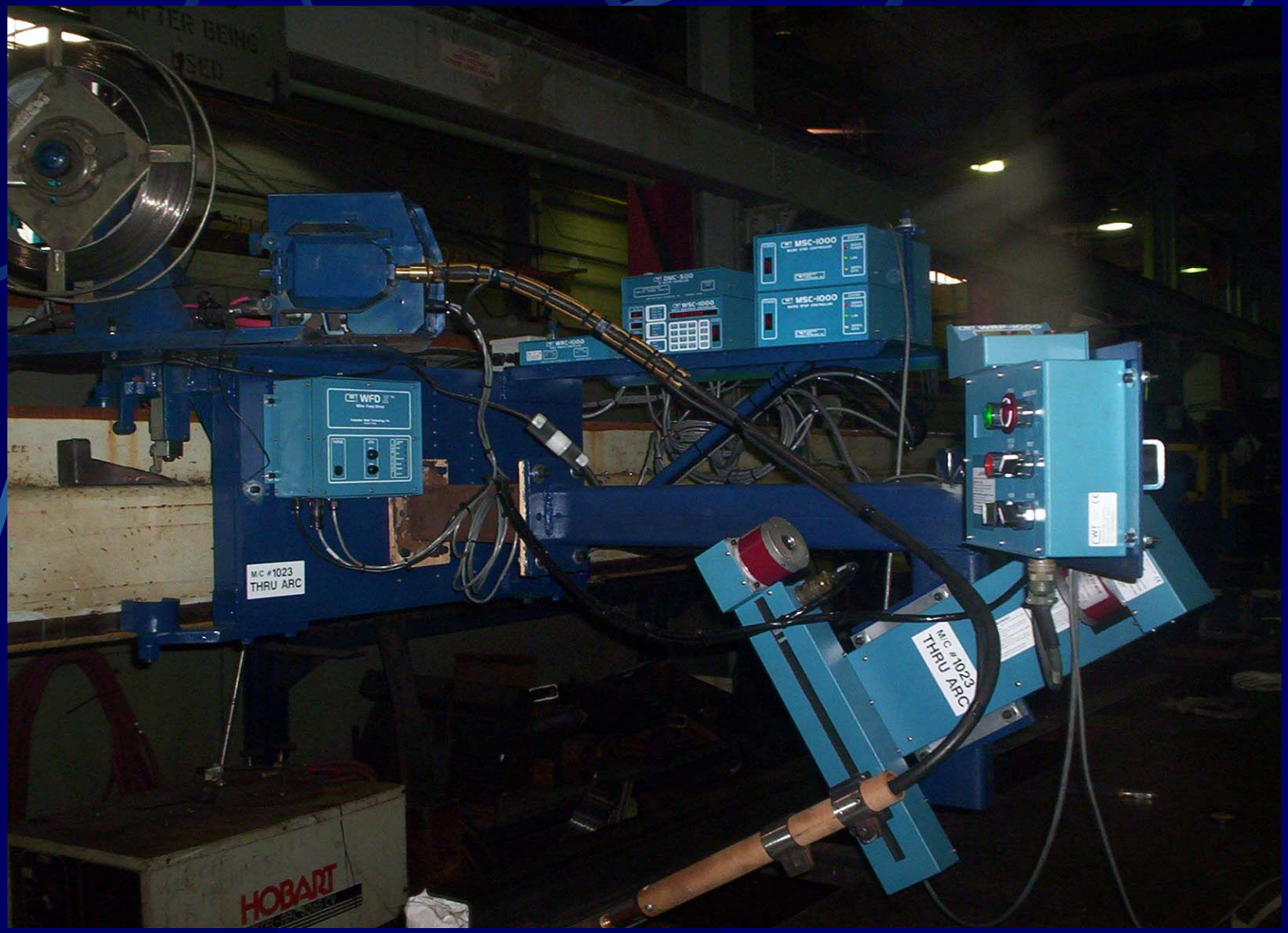
Implementing CWT Thru-Arc™ Seam Tracking "Kits" at NSC Summary and Open Discussion

Benefits:

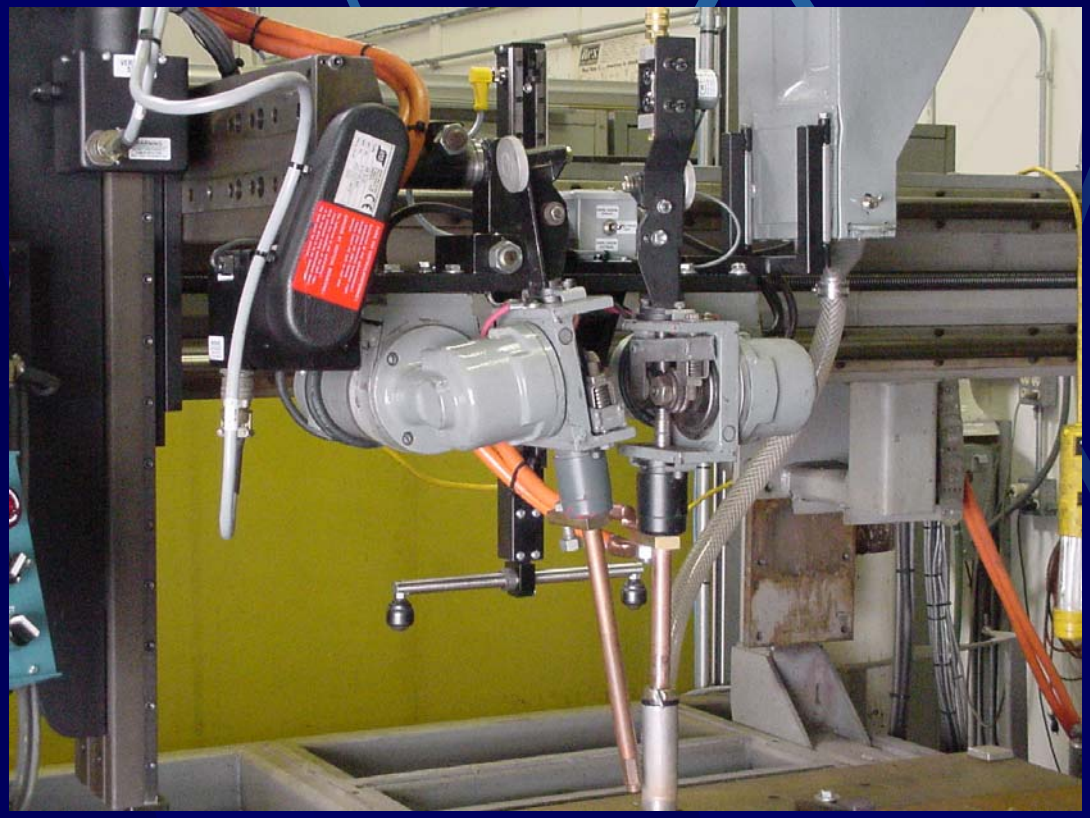
- No additional sensors
- Maintains true arc position
- Simple retrofit to existing fixtures
- Controls tracking, weld process, and indexing.

Goals:

- Standardize and upgrade your "automatic" lines.
- Improve productivity and quality.
- Reduce labor and cost justify.


MSC-1000
MSC-1000
WFD
M/C #1023
THRU ARC
M/C #1023
THRU ARC
HOBART

Hard Tooling Applications Sub Arc System with CWT Controls and ESAB Slides

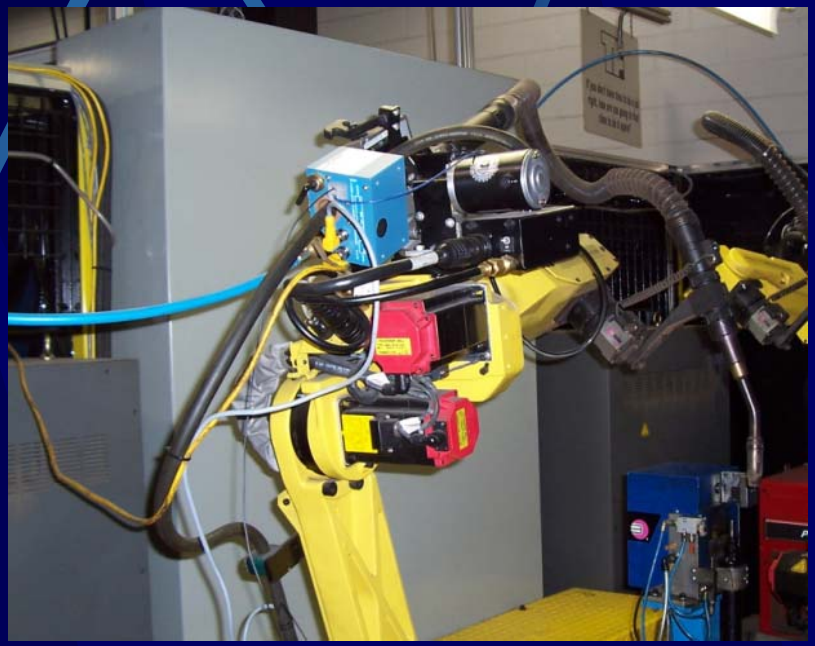


Weld Monitoring Products

- ADM – Arc Data Monitor
  - ADM, uADM, Smart Sensor
- WDL – Weld Data Logger
  - WDL , Intelli-Dart
- WireTrak – Wire speed sensor
- GFM – Gas Flow Monitor

GMAW Welding System

- Welding power source
- Wire feed drive system
- Welding torch and gas shielding system
- Torch motion control system
- Part positioning and clamping fixture



Weld Process Parameters

- Adjustable process parameters:
  - Arc voltage
  - Arc current
  - Wire speed
  - Travel speed (arc time and weld length)
  - Torch position and part location
- Fixed process parameters:
  - Base material and wire diameter
  - Metallurgical weld properties
  - Weld process (GMAW, GTAW, SAW, etc.)

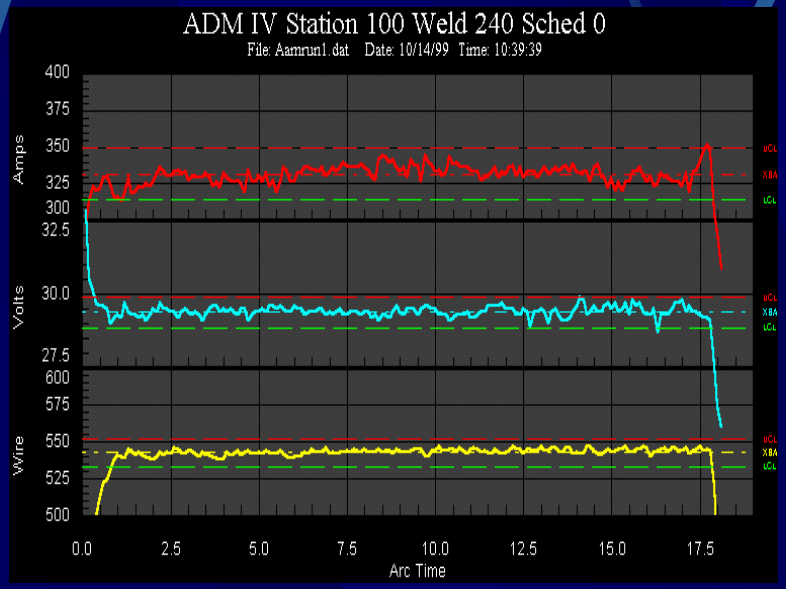
CWT Arc Data Monitors

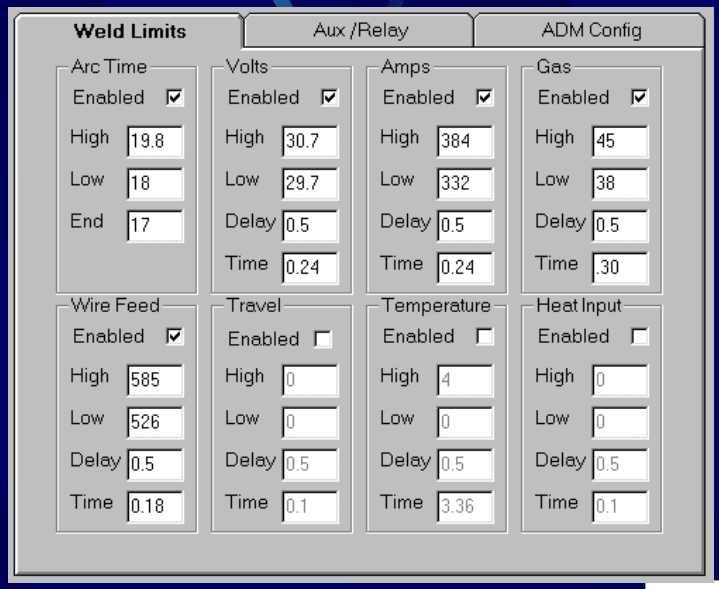
Past and Present Generations

- ADA™ - 1982
- ADM I™ - 1984
- ADM II™ - 1989
- ADM III™ Model A - 1989
- ADM III™ Model B - 1990
- ADM III™ Model C - 1991
- ADM III™ Model D – 1994
- ADM IV™ - 1999
- Micro ADM™ - 2004
- Smart Sensor – 2010

In-process Parameter Testing (Setting Hard Limits on Volts, Amps, Wire Feed Speed, and Gas.)

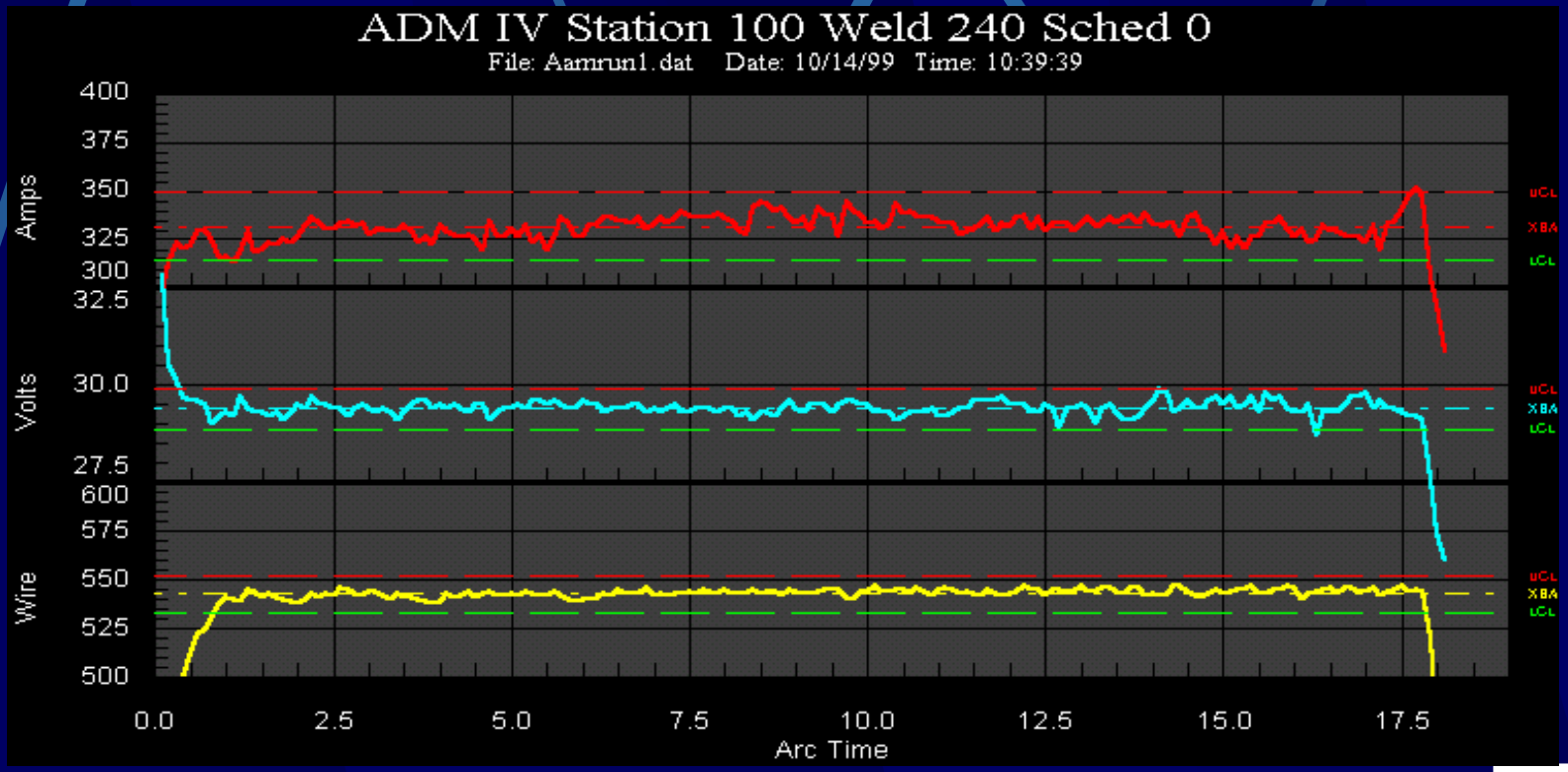
Typical Approach Adopted By Industry of Setting Hard Limits Around Specific Welding Parameters





In-Process Parameter Testing
"GMAW Production Weld "

Hard Limits Conducive To Nuisance Faults



Challenges of "Parameter" Monitoring

- Typical Objections
  - Conducive to Nuisance Faults
  - Parameter Windows get "Opened-Up"
  - Separate schedules require multiple sets of limits (hard to maintain).
  - "Can't Monitor Short Welds"
  - Hard limits trip, "Weld Looks Good"
  - Units get turned OFF!

Advanced In-Process Monitoring

- Objective
  - Use Heat Input, Weld Volume, and Time to Assure Weld Quality
  - Allow maximum parameter variation
  - Simple user interface for automatic operation
  - Provide part testing with good/bad part indication
  - Self taught testing limits and configuration

Advanced Weld Monitoring Methodology I

- Use arc density algorithms to evaluate actual weld bead characteristic.
- Create arc density values based on in-process RMS volt, amp and wire speed and arc time.
- Generate per weld values for accumulated arc density.
- Apply SPC calculations to generate upper/lower control limits for each weld.

Advanced Weld Monitoring Methodology II

- Using learn mode generate heat input and arc density maps for each weld on part.
- Generate a part template with SPC generated upper and lower control limits for accumulated arc density.
- Provide a part pass/fail output based on total volume, accumulated arc density and weld count.

Advanced Weld Monitoring System Requirements

- User supplied input to indicate new part.
  - Must be active during complete part weld cycle.
- In-process monitoring of arc voltage, arc current and wire speed.
- End-of-weld pass/fail output based on weld volume and arc density.
- Weld summary data storage with fault status for SPC process control charts.

Micro ADM™ Sensor Overview

- Lightweight; Compact, multi-sensor unit designed for monitoring Heat Input, Weld Volume Applied, and Time.
- Embedded micro-controller to provide data acquisition, signal processing and Modbus™ communications firmware.
- Provides “Production Friendly” means of testing and remote logging of Arc Welding Process and SPC Weld Summary Data.

General Specifications

Dimensions:
5.25”L x 5.38”W x 3.81”H
(133mm x 137 mm x97mm)

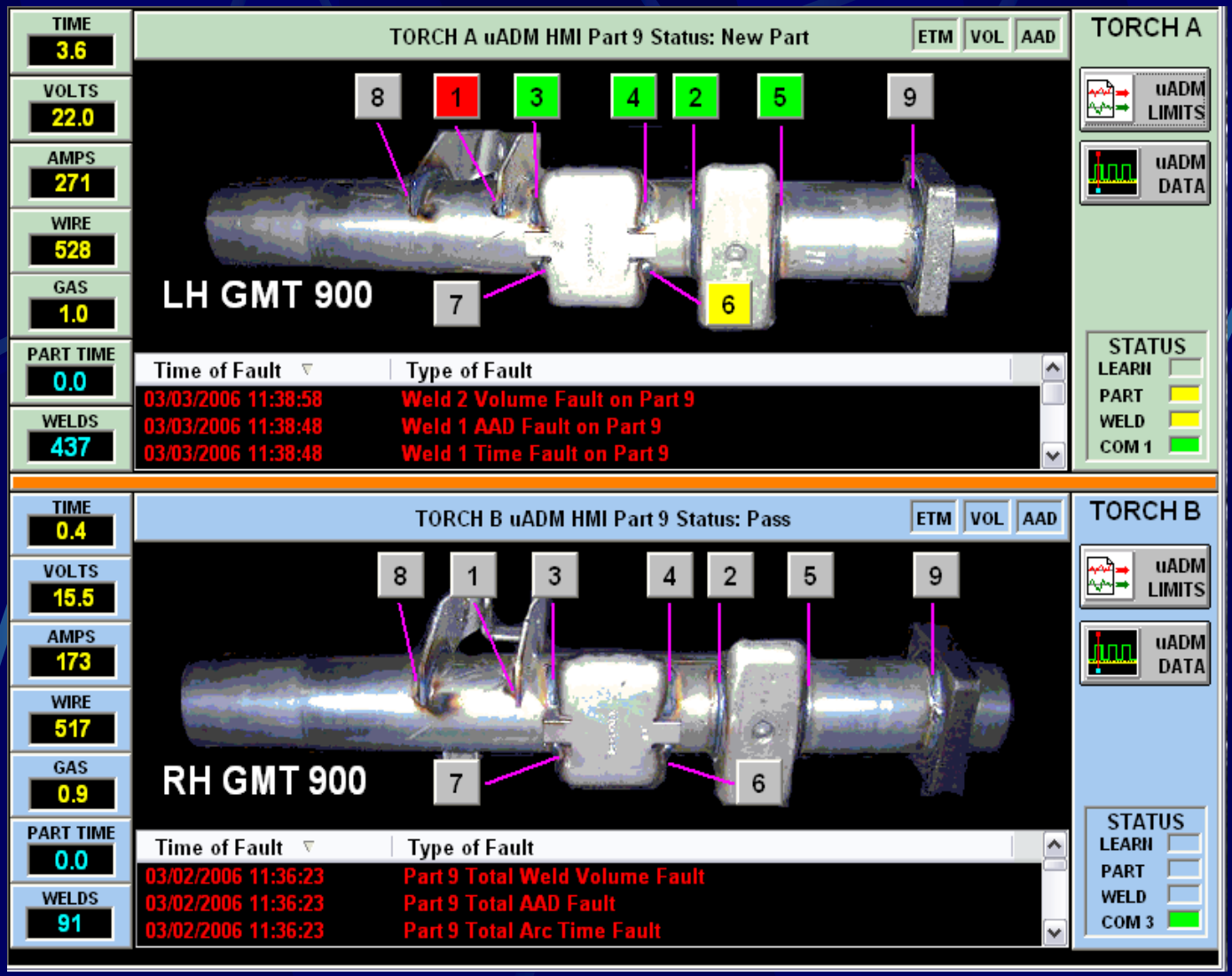
Weight: 2.7lbs (1.2 kgm)

Communications:
RS-485 ModBus™ RTU protocol

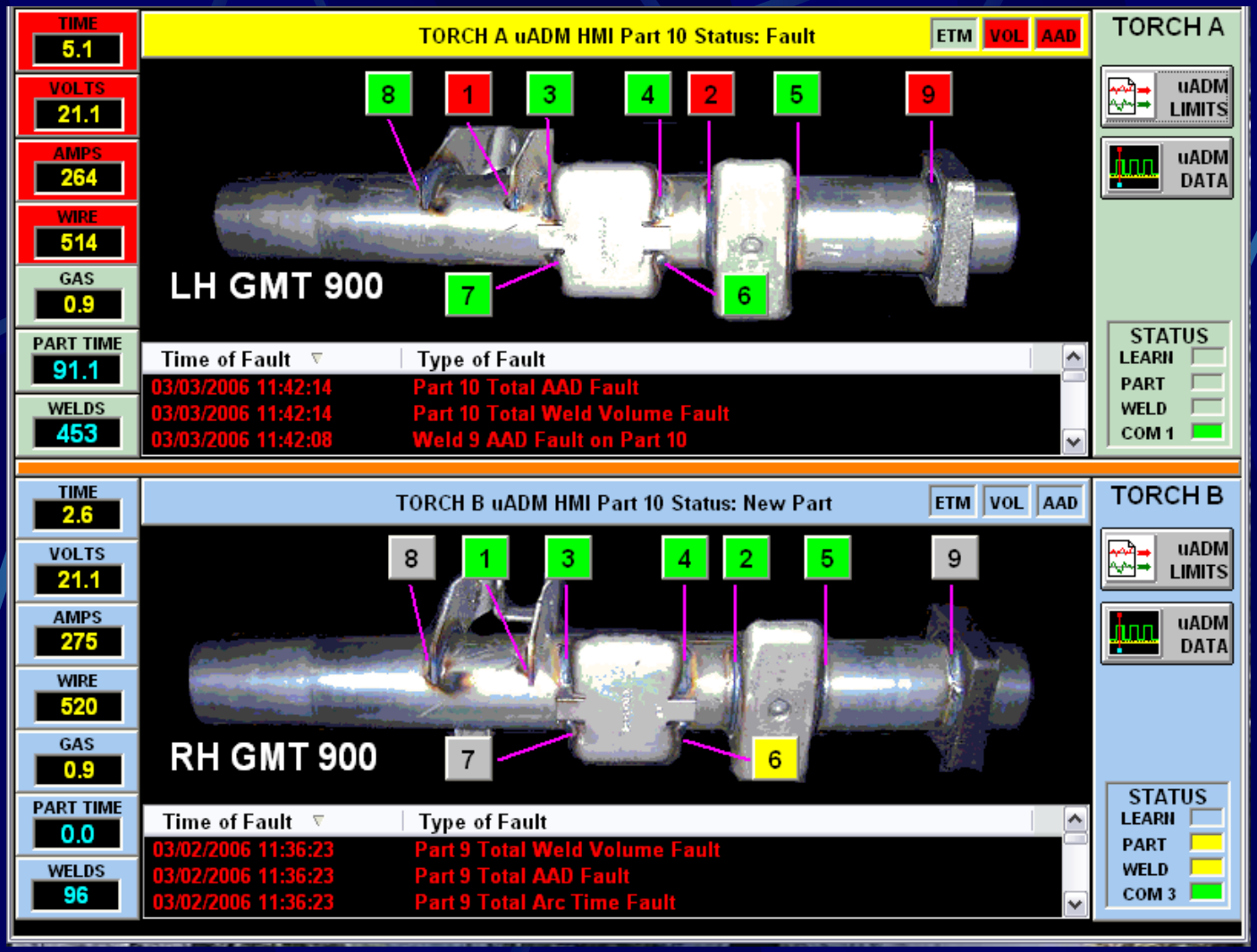
INTERFACING OPTIONS: ArcTrack Plus Software and CWT's WPM/HMI

- Network multiple Micro ADMs to a single PC and utilize ArcTrack Plus Software and SPC Data Collection.
- Introduce CWT's WPM/HMI suitable for single and dual torch applications.

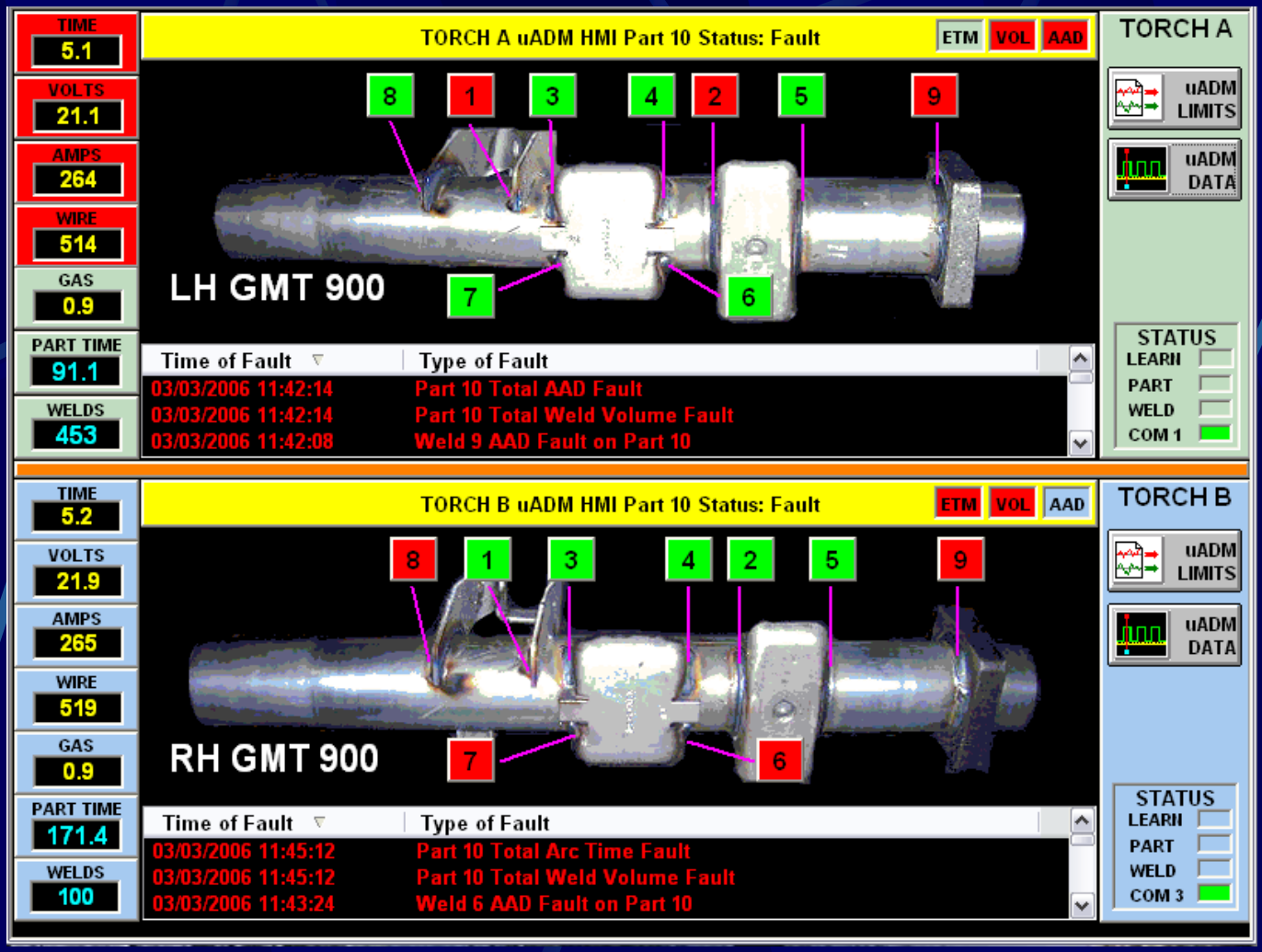
CWT Micro ADM WPM “Mini-HMI”



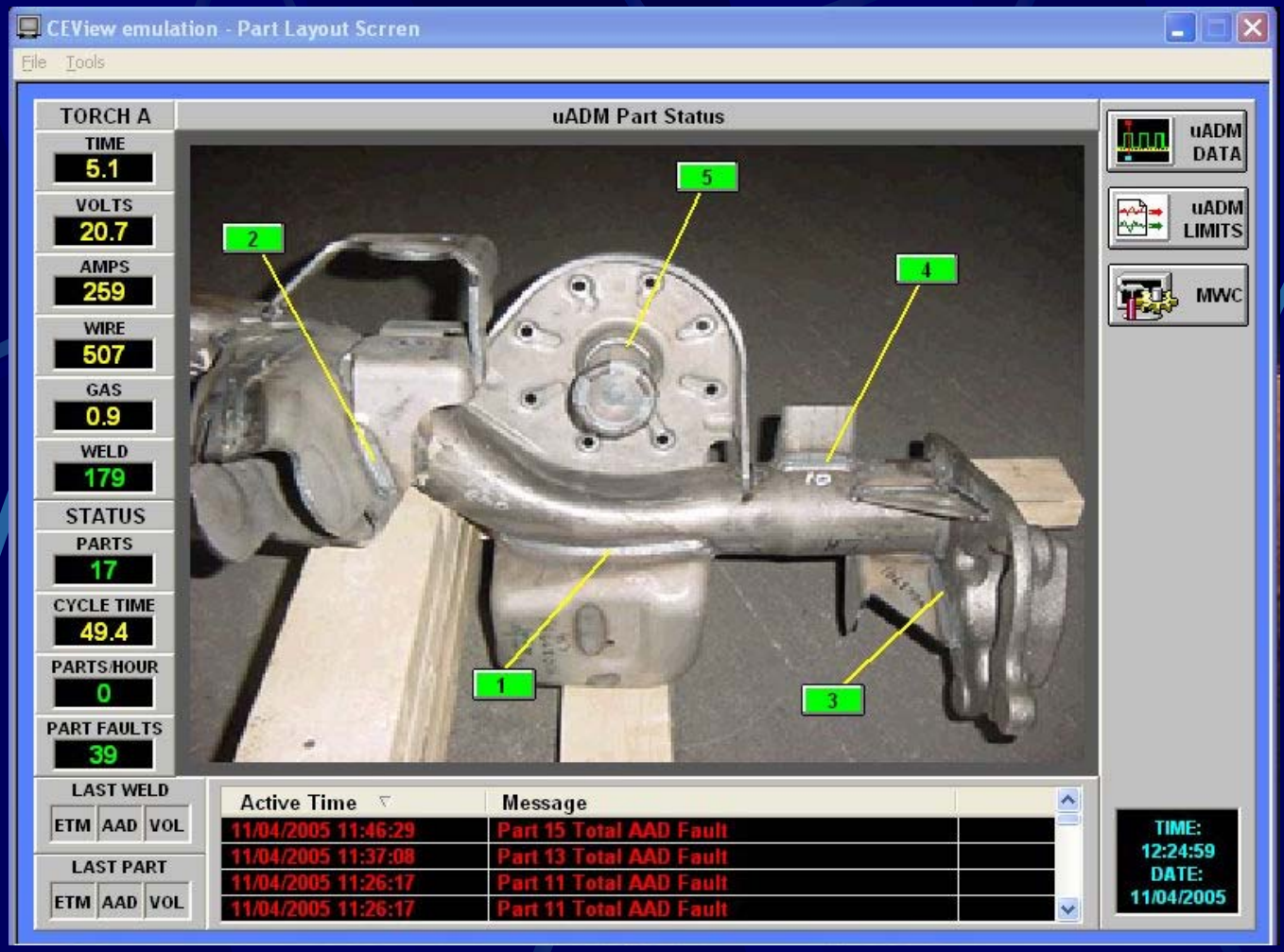
REAL TIME IN-PROCESS FAULT MONITORING



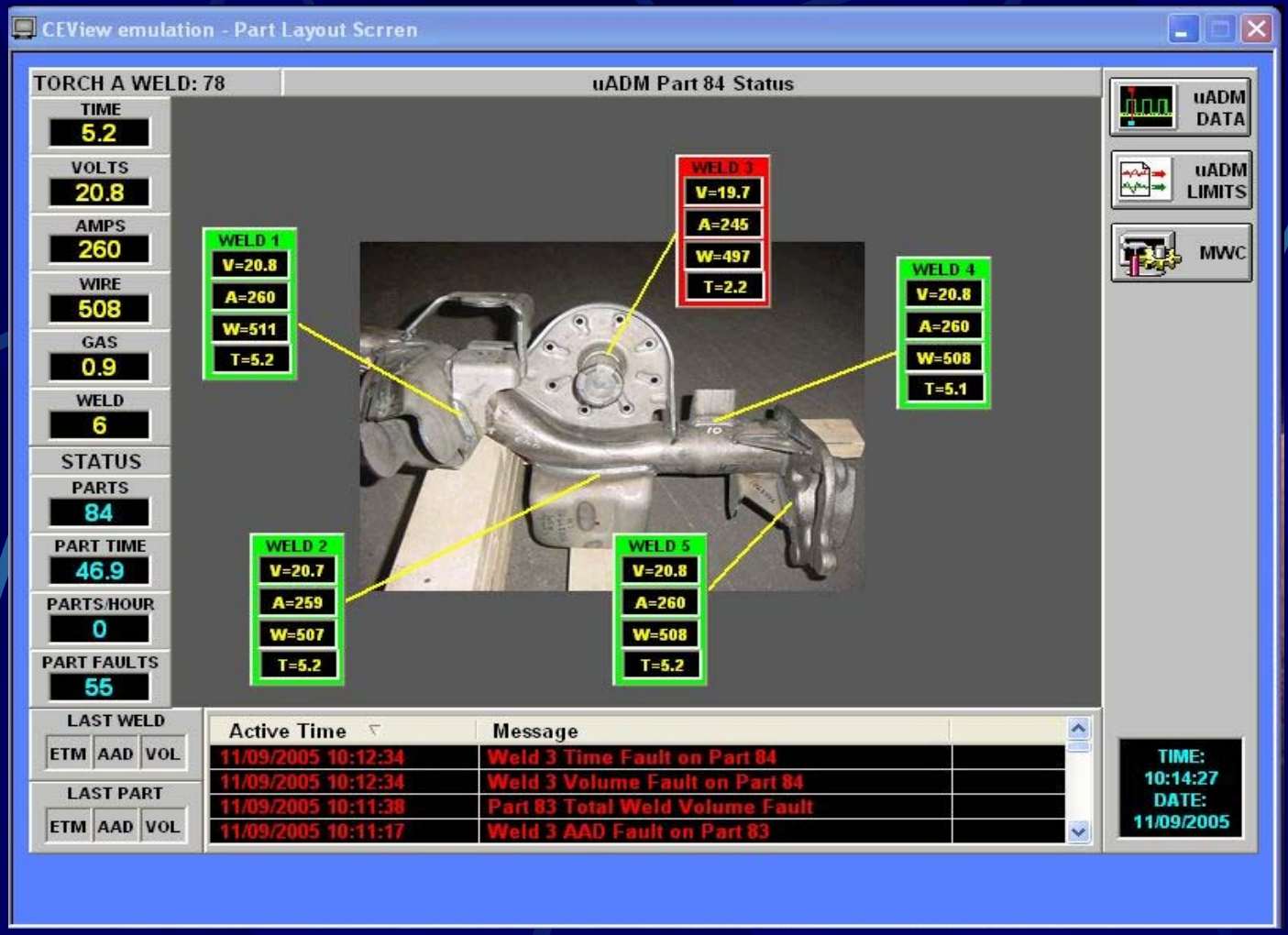
1st Weld Part Test result and 2nd Weld Status



1st and 2nd Weld Complete Part Test Status



Single Torch Multiple Welds on Part



Part Complete Status with Weld summary Data for each Weld

CWT Micro ADM™ Benefits II

- Procedure Very “Production Friendly”
- Provides weld tracking and part verification.
- Avoids Nuisance Faults of Parameter Tests.
- Incorporates Real-Time Heat Input vs. Weld Volume Applied (factors controlling penetration, weld bead appearance, and fatigue performance important in some of today’s newer high strength and Dual-Phase steels).

Our Customers, Our Markets, Our Applications