



*National Shipbuilding Research
Joint Panel Meeting, Washington, DC
September 30, 2010*

*Virtual
Welder*

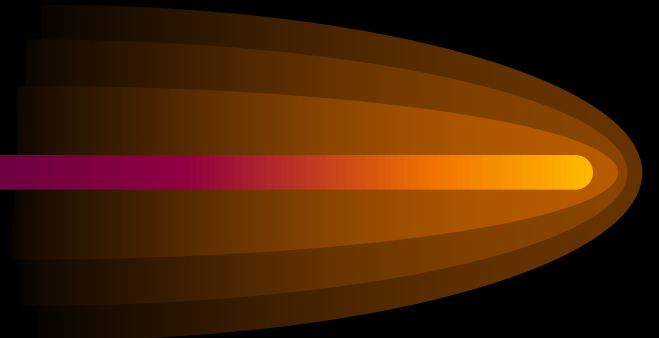
*Jerry E. Jones
Ken Fast*



Fidelity of the Virtual Environment

Virtual

Welder



Fidelity of the Virtual Environment

*Virtual
Welder*



Fidelity of the Virtual Environment

Welding Hardware



System Modification:

- Wii Camera issue
- New cameras
- New software

Fidelity of the Virtual Environment Graphic Reproduction

LOW COST

Fidelity of the Virtual Environment Graphic Reproduction

Elements of the Virtual Graphic

- **Weld Shape**
- **Torch**
- **Weld Joint**
- **Weld Pool**

Fidelity of the Virtual Environment

Graphic Reproduction

Elements of the Virtual Graphic

- **Weld Shape**
- **Torch - CAD drawing of actual torch**
- **Weld Joint**
- **Weld Pool**

Fidelity of the Virtual Environment Graphic Reproduction

Elements of the Virtual Graphic

- **Weld Shape**
- **Torch - CAD drawing of actual torch**
- **Weld Joint - Transparency**
- **Weld Pool**

Fidelity of the Virtual Environment

Graphic Reproduction

Elements of the Virtual Graphic

- **Weld Shape**
- **Torch - CAD drawing of actual torch**
- **Weld Joint - Transparency**
- **Weld Pool - Prototype operational**

Fidelity of the Virtual Environment

Graphic Reproduction

Elements of the Virtual Graphic

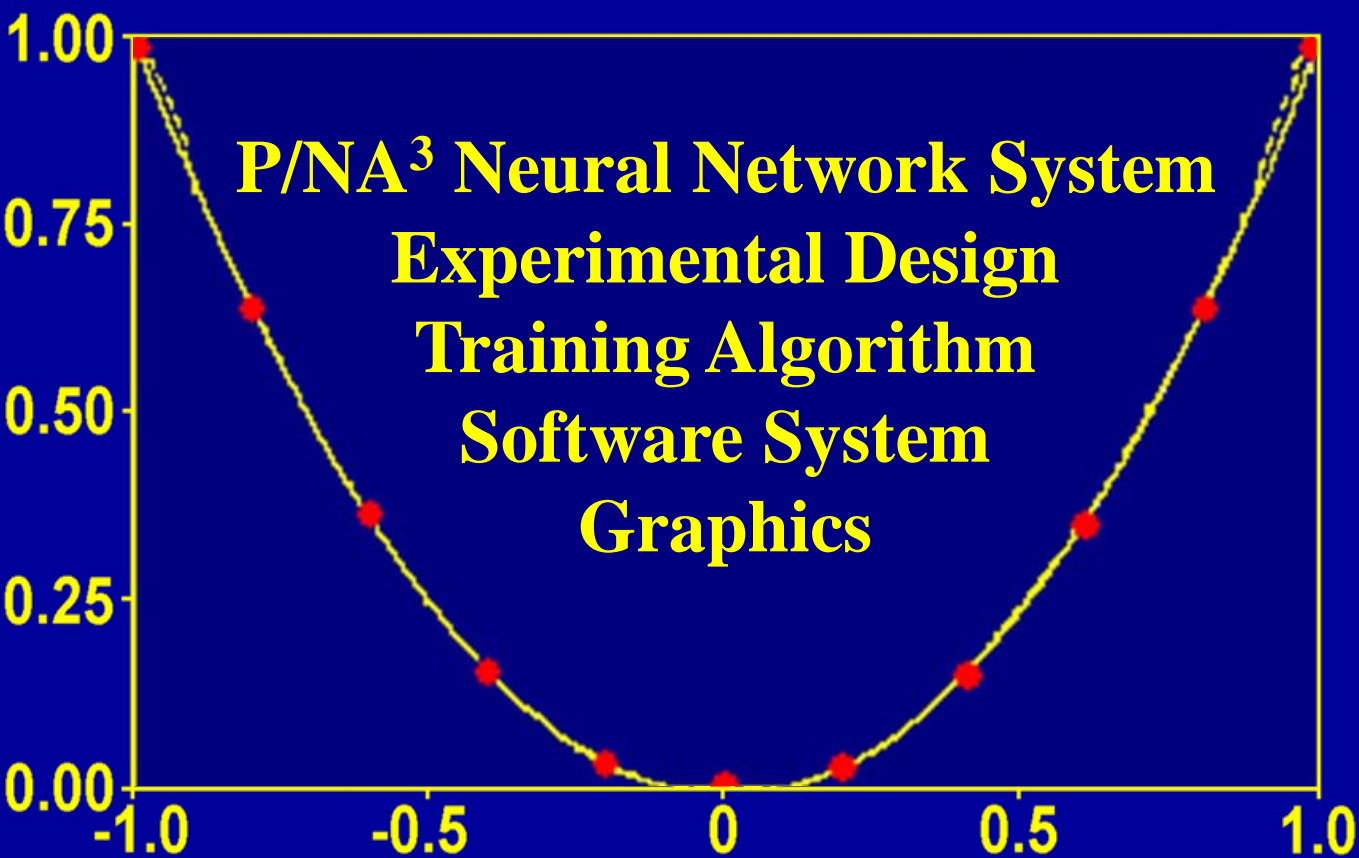
- **Weld Shape - P/NA³ Neural Network**
- **Torch - CAD drawing of actual torch**
- **Weld Joint - Transparency**
- **Weld Pool - Prototype operational**

Fidelity of the Virtual Environment Graphic Reproduction

Weld Shape – P/NA³ Neural Net

- **Neural Network Algorithm**
- **Experimental Procedure**
- **Data Analysis**
- **Graphical Representation**

Fidelity of the Virtual Environment Graphic Reproduction



Fidelity of the Virtual Environment Graphic Reproduction

N. N. Model – N-Optimal Design

- Experiments Partially Completed
- V, I, WS, Gas Flow and statistical data (e.g. Average, Standard Deviation, etc.) collected in real-time (20 kHz)
- Welds all Video
- Welds all Audio
- Samples Cut, Ground, Polished, Etched
- NAME^S™ Measurements Taken
- P/NA³ Neural Network Database Generated

Fidelity of the Virtual Environment Graphic Reproduction

- **Experimental Design – Initial Testing / Screening**

SEQUENTIAL AUGMENTATION OF DESIGN IN: 6 Variables, 28 PARAMETERS, 55 RUNS

Date Created: 8/10/2008

16:26 Experiment Name: VW01

Rev No.: 2

| Var. Name | Var. No. | Var. Abbr. | Levels | Value1 | Value2 | Value3 | Value4 | Value5 |
|------------------------------|----------|------------|--------|--------|--------|--------|--------|--------|
| Wire Feed Speed | 1 | WS | 5 | 205 | 235 | 265 | 295 | 325 |
| Travel Speed | 2 | TS | 5 | 10 | 11 | 12 | 13 | 14 |
| Voltage | 3 | V | 5 | 24.5 | 25 | 25.5 | 26 | 26.5 |
| Lead/Lag Angle | 4 | Lead | 5 | 0 | 4 | 8 | 12 | 16 |
| Side-to-Side Angle | 5 | Angle | 5 | 40 | 42.5 | 45 | 47.5 | 50 |
| Contact Tip to Work Distance | 6 | CTWD | 5 | 0.5 | 0.625 | 0.75 | 0.875 | 1 |

Fidelity of the Virtual Environment Graphic Reproduction

N. N. Model – Model Data



Clean



Grind



Weld



Grind

Cut



Etch

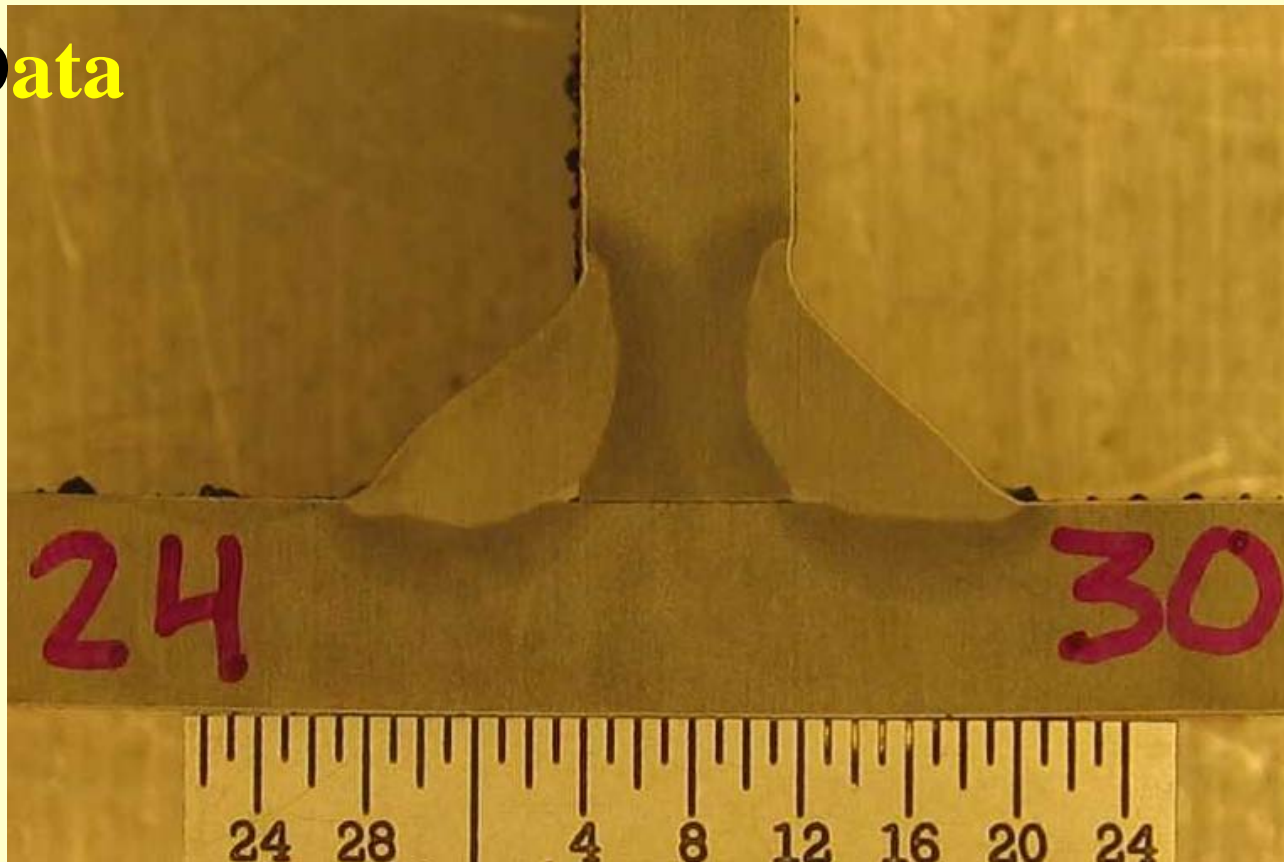


Polish

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N. N. Model – Model Data

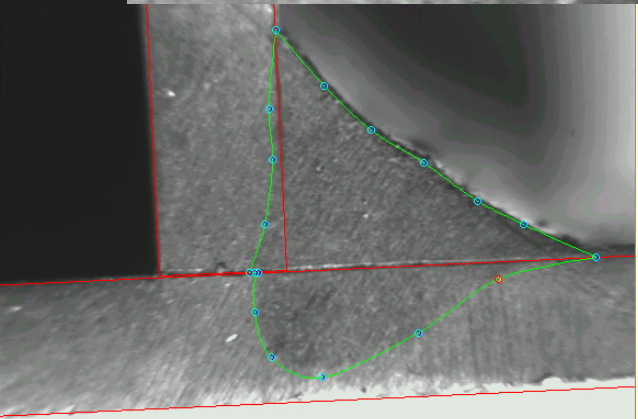
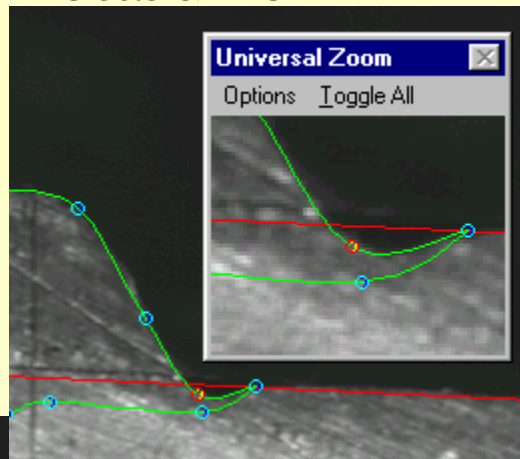
- **Weld Data**



Fidelity of the Virtual Environment Graphic Reproduction

N. N. Model – Model Data

- Measure

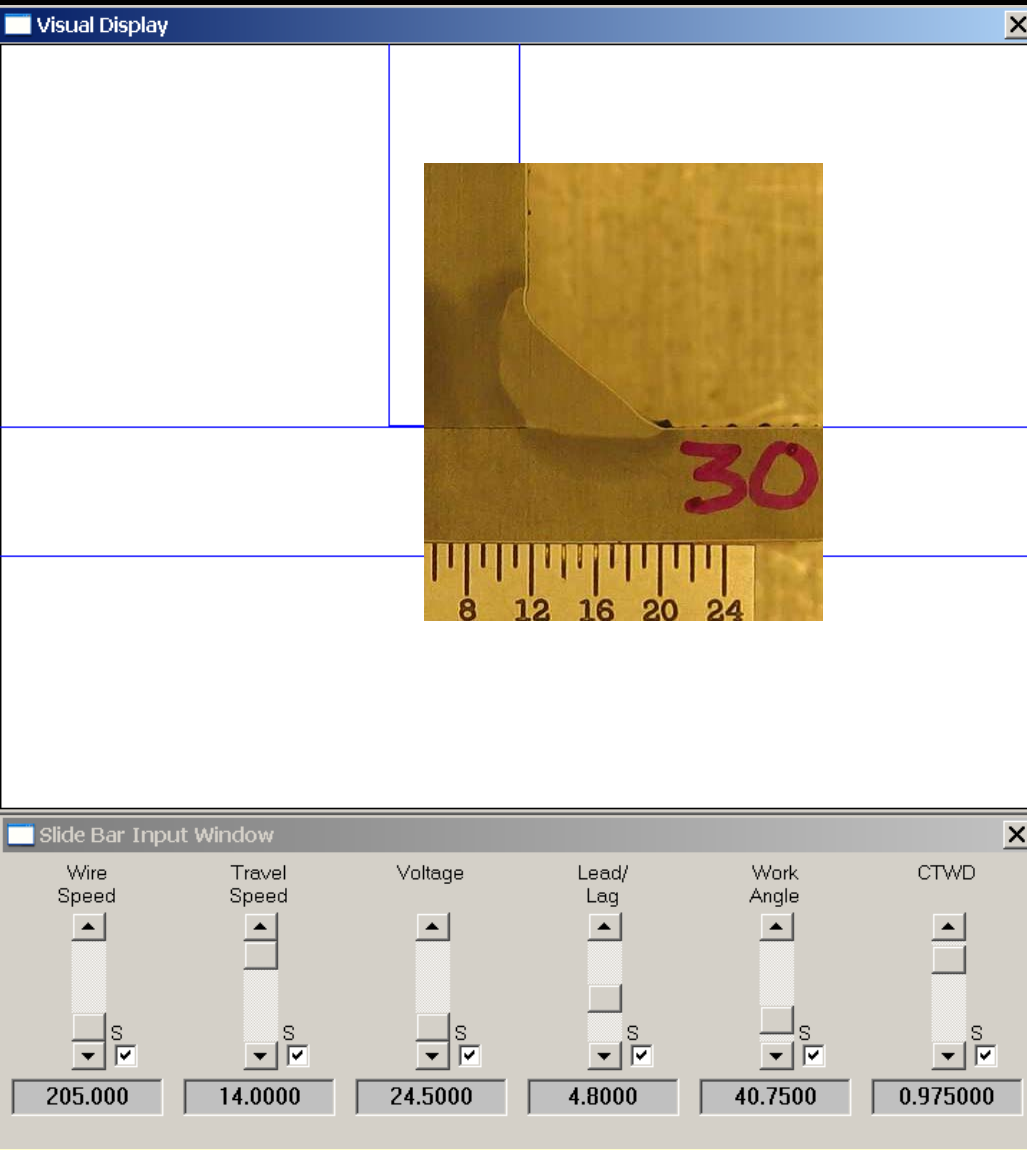


The screenshot shows the NAME5 software interface. The main window displays a weld joint with a green outline and red measurement lines. The software title bar reads "j02.NAM - NAME5". The menu bar includes "File", "Edit", "Options", "Project Options", "Image", "View", "Special Windows", and "Help". The toolbar contains icons for file operations and measurement tools. The right-hand panel shows the following data:

- File: 053C2.PCX
- Weld Type: Lap Weld
- Plate: Plate 4
- Top Thickness: 0.456570
- Bottom Thickness: 0.624279
- Scale Length: 2.000000
- Non-Square Upper Plate
- Scribe Dist (Lower): 1.2300000

The bottom of the interface features a navigation bar with buttons for "Plate", "Weld", "Net", "Last", "Next", and "Weld". A status bar at the bottom reads "For Help, Choose the menu 'Help', then 'Help on Using NAME5...'"

Fidelity of the Virtual Environment Graphic Reproduction



Wobbel

Fidelity of the Virtual Environment Graphic Reproduction

The screenshot displays the 'Fillet3D' software interface. The title bar reads 'Untitled - Fillet3D'. The menu bar includes 'File', 'Reports', 'Rendering', 'Advanced', and 'Help'. The main interface is divided into several sections:

- Training Module:** A dropdown menu set to 'T-Fillet - Horizontal - 3/16th A36'.
- Username:** A text field containing 'Demo'.
- Monitoring Mode:** A dropdown menu set to 'Travel Speed' with a 'Customize' button next to it.
- Voltage:** A text field set to '25.5'.
- WFS:** A text field set to '265'. A note below reads: '(Note: Set these using the knobs on the wirefeeder suitcase)'. There is also a 'Customize' button next to the WFS field.
- Buttons:** 'Start New Weld', 'Stop New Weld', 'Graph Weld', and 'Run NN'.
- Weld View:** A 3D rendering of a welding torch creating a weld on a metal plate. The torch is yellow and red, and the weld is a bright red line.
- Weld View Controls:** A 'Realtme Display On' button and a 'Teach Torch Visible' checkbox (checked).
- Plate Transparency:** A slider set to '1.00'.
- X Rotation:** A slider set to '14.59'.
- Y Rotation:** A slider set to '45.78'.
- Z Rotation:** A slider set to '0.00'.
- Scale:** A slider set to '1.20'.
- Realtime Data Collection:** A section with 'Start Realtime Cameras' and 'Stop Realtime Cameras' buttons. Below them is a '# of Cameras Connected:' field set to '0'. There are also input fields for 'Left Camera', 'Middle Camera', 'Right Camera', 'Helmet Camera', 'Torch Camera', and 'Helmet Fixed Camera', all set to '0'. At the bottom, there are buttons for 'Wii 1 On', 'Wii 2 On', 'Wii 3 On', and 'Wii 4 On'.

Welding

