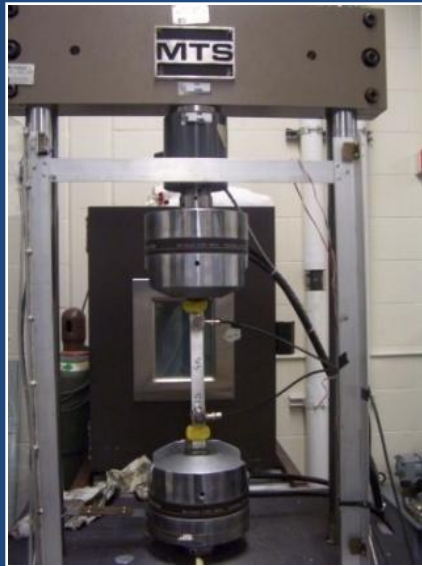


Neural Network Fatigue Life Prediction in 7075-T6 Aluminum

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Notched Tensile Fatigue Specimen with Attached AE Transducers in MTS Machine



OBJECTIVES

- Acoustic emission (AE) monitoring of fatigue cracking in notched 7075-T6 aluminum specimens
- Self-organizing map (SOM) neural network for classification of failure mechanisms
- Back-propagation neural network (BPNN) for prediction of fatigue life from AE amplitude data (30-100dB) gathered during **early cyclic loading -- up to 25% of average cyclic life**
- **Goal:** Worst case prediction error within **±5%**

APPROACH/TECHNICAL CHALLENGES

- Fatigue specimens: 15x1x0.10 inches with 0.20 inch deep 45° V-notch with 0.01 inch tip radius
- Three sets of fatigue specimens: cyclic loads of 0-4,000, 0-3,000, and 0-2,000 lbf ($R=0.0$)
- **Multiple hit data** (noise) and sparse data sets (<250 hits) limit BPNN prediction accuracy

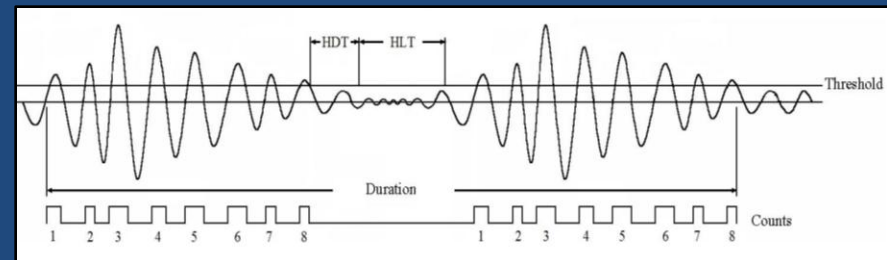
RESULTS/ACCOMPLISHMENTS

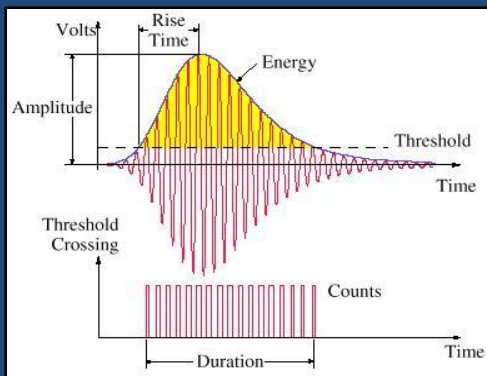
- Worst case prediction errors: **16.4%**, **-13.9%**, and **3.66%** (sparse data for first two specimen sets)

Setting HDT + HLT Too Long

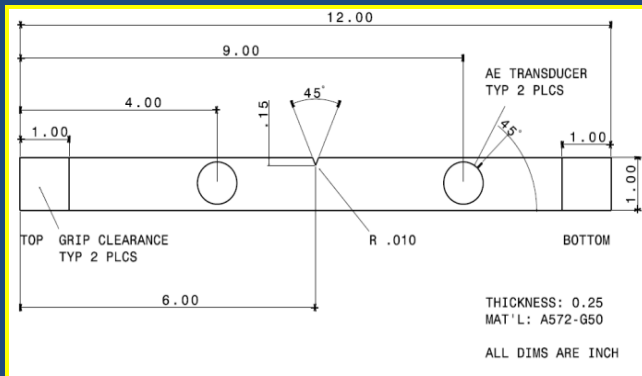


Multiple Hit Data



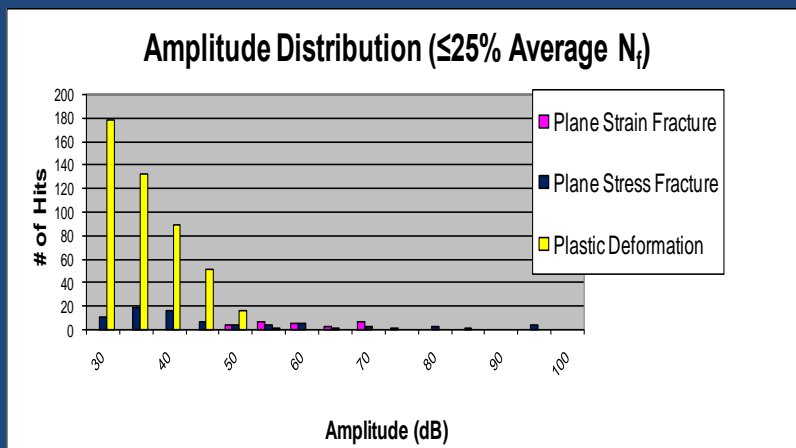


AE Amplitude Data

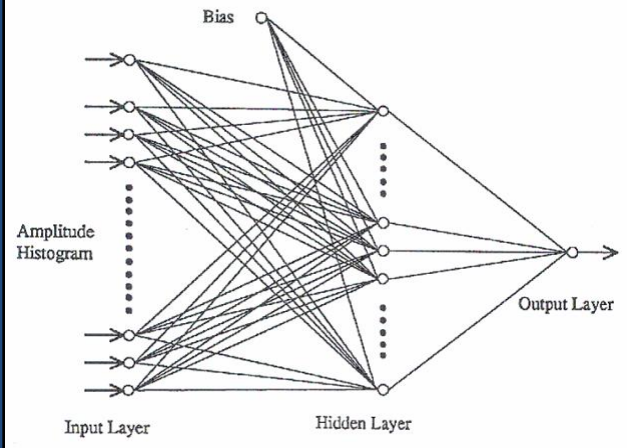


Notched Fatigue Specimen

BPNN Fatigue Life Prediction from Early Cycle ($\leq 25\%$ avg N_f) AE Amplitude Data



Normal distribution of non-zero weights for amplitudes 53-81



Cycles to Failure



Worst Case Error: 3.66%

NeuralWorks Professional II/PLUS® Software

Conclusion: Fatigue life highly correlated with plane strain fracture mechanism