Nelson Mandela Memorial Sculpture
David Dearth, P.E. – Owner “Applied Analysis & Technology”

Company first started in 1982.

The primary focus of my consulting firm is in finite element analyses, FEA, and computer aided design, CAD, and prototype development, environmental testing.

Engineering consulting company involved in design and analyses projects covering a vast array of industries. Client lists include leading companies in aerospace, computer peripherals, medical devices, dental implantology, nuclear & fossil fuel power plants... etc. In addition to high tech industries, client lists include general manufacturing, injection molded & die cast component design, custom software and test equipment development... etc. Our customer base extends mostly throughout the U.S.A. and sometimes as far away as Europe and South America, Germany & Brazil. I have several associates that I bring onboard as specialized consultants in traditional design, metallurgy, failure analysis, conventional mechanical analyses and environmental testing and other disciplines as required to achieve the desired technical evaluation or design.

Beta tester for MSC Nastran/Patran software, Femap, NX Nastran & SolidWorks

Taught both undergraduate & graduate courses at CSULB for 15 years

Over 50 publications of engineering articles in technical & trade magazines.

Some of the more notable large projects are :

- Hoover Dam Visitors Center: fatigue analysis & redesign of rotating amphitheater support system
- 767 Tanker Air Refueling system design & analysis
- Boeing 787 redesign of the center fuselage/wing structural interface
- X-47B Northup/Grumman NLG & MLG durability and damage tolerance
- JSF X-35 aircraft Lockheed Martin, Random Vibration analysis
- Concrete Delamination analysis, Crystal River Nuclear Plant, FL
Nelson Mandela Memorial Sculpture
Background - Introduction

The Nelson Mandela Memorial Design Competition was won by an Ohio native Brian Sell senior designer and architect with Columbus Ohio based Moody Nolan. Sell’s winning entry was among nearly 200 submitted by architects, artists and students from across the country. A permanent memorial to be unveiled at Skylawn Memorial Park in San Mateo, Calif. in late 2016.

Applied Analysis & Technology was contracted by Correia Consulting, Huntington Beach, CA to perform structural analysis of the design concept. The purpose of the structural analysis was to provide interface loads & reactions at the base pedestals for use in designing the concrete foundation pedestals and to evaluate design stress & deflections for 23 load case combinations of the following:

- Static dead weight (DL)
- Temperatures
- Wind
- Seismic loads
- Fundamental resonant vibration frequency
- Buckling factors
Nelson Mandela Memorial Sculpture: Design Sketch

- Design available in electronic format?

- The design “drawings” arrived in AutoCAD *.dwg file format exported from a sketching program. However, the “drawings” did not have any surfaces or solids... only lines and points in 3D space. The design was big... 20’ x 20’ steel plates 1” to 1.5” thickness.

- The 1st task was to convert the lines & points into 3D solids. This was accomplished using Boolean addition and subtraction methods available in Femap & SolidWorks.

**Total Assembly Weight ≈ 21,000 lbs**

[10 tons steel] with cutouts included
The original design concept had a number of problems!

- Cut Outs Along Interfacing
- Welded Edges
- Unconnected parts in free space

3 Plates
24’-7” high x 20’ wide
Cut Outs Along Interfacing Edges

Unconnected parts in free space

1 Plate 8’-6” high x 20’ wide

CUSTOM METAL PANEL 2 (MP2)

SCALE: 6” = 1’-0”

(QUANTITY: 1 PC.)
The original design concept that won the competition had to be changed so that it could actually be constructed.

After the design sketches were modified to remove voids and free elements.

A second series of converting the AutoCAD *.dwg lines and points into usable 3D data of surfaces and solids using the Boolean operations was performed.
Completed FEA Model with 23 LC’s

139,632 3D Plates using Mid-Plane meshing
129,051 Nodes
775,300 DOF
23 Load Case Combinations Processed using MSC/Nastran
Fundamental (Free) Resonant Vibration Frequency

Note: Check “No” to message to convert formats
Freebody Loads at Center of Pedestals & Envelope Stresses from 23 LC’s

[Redacted Results – Data]

Post Processing of the 23 Load Cases was summarized as an Envelope Table that identifies the peak free body reactions at the center of each Pedestal in both (a.) Local and (b.) Global X, Y Z, coordinate systems.
Note the amount of Steel Reinforcement"