Modeling Methodology and Analysis of a Circuit Board
Outline

• Introduction
• Goal of the Project
• Modeling Procedure
• LSDYNA Input Cards
• Results
• Future Work
Introduction

- Army Research Laboratories
- FEA system to analyze before creating prototype
Goal of the Project

- Long term goal was to optimize the Finite Element Modeling Methodology.

- Objective of the current project
  - To create model with the given dimensions
  - Compare displacements and strains with the ARL model
Modeling Procedure

• Model geometry
## Properties

- **Circuit Board**
  - Orthotropic material
  - Density = 1.84E-4 lb-s^2/inch
  - Young’s modulus | Poisson’s ratio | Modulus of Rigidity
  - Ex = 2.86E6 psi | NUXY = 0.14 | Gxy = 5.37E5 psi
  - Ey = 2.86E6 psi | NUYZ = 0.18 | Gyz = 4.21E5 psi
  - Ez = 1.32E6 psi | NUXZ = 0.18 | Gxz = 4.21E5 psi

- **Load Platen**
  - Elastic Isotropic material
  - Young’s modulus | Poisson’s ratio | Density
  - E = 0.3E8 psi | NU = 0.3 | Rho = 0.725E-3 lb-s^2/inch

1/25/2004

Srujanbabu Sridharala

MEG 795
Discretization

- Unit length of geometry was divided into 16 divisions
Rigid cylinders

- Rigid cylinders were added in Hypermesh
Contacts

- Surface to Surface contact was used between load platen and circuit board
- Set of slave nodes for rigid cylinders
Loads
LSDYNA input cards

```
*MATOrthotropicElastic
  1 0.184E-03 0.286E+07 0.286E+07 0.132E+07 0.140000 0.180000        Card 1

0.537E+06 0.421E+06 0.421E+06 2.0
0.0 0.0 0.0 0.5 0.0 1.0
0.0 0.0 0.0 0.5 0.5 0.0 0.0

*RIGIDWALL_GEOMETRIC_CYLINDER
  6 -0.5,.5,.125,-1.5,.5,.125,0
0.124999999 2.0
```

1/25/2004
Srujanbabu Sridharala
MEG 795
LSDYNA input cards

*DEFINE_CURVE
   3  0  1.000  1.000  0.000  0.000  Card 1
   0.0  0.0
   1.95320000000000E-05 -0.0020231  Card 2

*LOAD_SEGMENT
   3  0.640  0.000  1543  1544  1920  1935

N1
N2
N3
N4
Results

- Vonmises Stress comparison at 6.8 milli seconds
Results

- Displacement comparison at 6.8 milli seconds
# Results

<table>
<thead>
<tr>
<th>Time (Millisecs)</th>
<th>Von-mises stress (psi)</th>
<th>Resultant Displacement (Inches)</th>
<th>Upper surface Effective Strain</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ARL</td>
<td>Our's</td>
<td>ARL</td>
</tr>
<tr>
<td>5</td>
<td>1.172e+3</td>
<td>7.469e+2</td>
<td>1.866e-2</td>
</tr>
<tr>
<td>5.4</td>
<td>2.13e+3</td>
<td>1.001e+3</td>
<td>2.651e-2</td>
</tr>
<tr>
<td>5.6</td>
<td>2.734e+3</td>
<td>1.124e+3</td>
<td>3.077e-2</td>
</tr>
<tr>
<td>6</td>
<td>4.004e+3</td>
<td>1.339e+3</td>
<td>3.924e-2</td>
</tr>
<tr>
<td>6.8</td>
<td>6.148e+3</td>
<td>1.549e+3</td>
<td>5.284e-2</td>
</tr>
<tr>
<td>7</td>
<td>6.51e+3</td>
<td>1.547e+3</td>
<td>5.524e-2</td>
</tr>
</tbody>
</table>
Results

Shell element model

Strain Plot of an element at the center of the circuit board

Element No

A. Lower Surface Y-strain
B. Upper Surface Y-strain-544

Time

Strain (E-03)
Comparison of Strain plot

Strain plot for an element at the center of the plate with mass added to the row of nodes to incorporate the mass of strain gage and wires attached to the circuit board and without mass.
Comparison of shell element model with ARL experimental results

![Graph showing comparison between UNLV using Shell element and ARL experimental results. The x-axis represents time in ms, ranging from 0 to 2.00E+01, and the y-axis represents strain in micro strain, ranging from -5.00E+00 to 4.00E+02. The graph includes two lines: one in blue for UNLV using Shell element and one in pink for ARL experimental results.](image-url)
Future Work

- Once the variation in the results is minimized, we have to start the optimization of the Finite Element Modeling Methodology.
- Reduce computational time associated with Simulation.
- Explore the nature of the problem to determine the most suitable optimization algorithm.
- Implement an algorithm to combine expert system techniques, in order to produce a more accurate finite element model that can reduce dependence on experimental data.
Questions ?