



USE OF ENGINEERING TOOLS CASE HISTORIES

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COMPANY PROFILE



- SMALL BUSINESS
- ESTABLISHED IN 1987
- ARIZONA CORPORATION
- EMPLOYEE OWNED WITH 35 EMPL.
- PRINTED CIRCUIT BOARD MANUF.
- MILITARY AND COMMERCIAL
- SHORT INTERVAL MANUFACTURER

CAPABILITY PROFILE

- DOUBLE SIDED THROUGH 20 LAYERS
- EPOXY, POLYIMIDE, TEFLON, KAPTON
- RIGID, FLEX, AND RIGID FLEX
- CONTROLLED IMPEDANCE
- BLIND AND BURIED VIAS
- 7 MIL PITCH AND 5 MIL LINES/SPACES
- HIGH ASPECT RATIO



CAPABILITY PROFILE

- **SURFACE FINISHES**
 - SOLDER COAT AND FUSED TIN LEAD
 - GOLD, NICKEL, TIN NICKEL
 - IMMERSION TIN
- **ELECTRICAL TESTING**
 - SIMULTANEOUS TOP AND BOTTOM
 - FIXTURED NET LIST AT 80 MIL GRID
 - FIXTURELESS FLYING PROBE



EXPERTISE

- MFG. COMPLEX PRODUCTS
- ENGINEERING SOLUTIONS
- DELIVERY IN SHORT INTERVAL
- DESIGN FOR MANUFACTURE
- PROCESS CONSISTENCY
- FOCUS ON CUSTOMER SATISFACTION



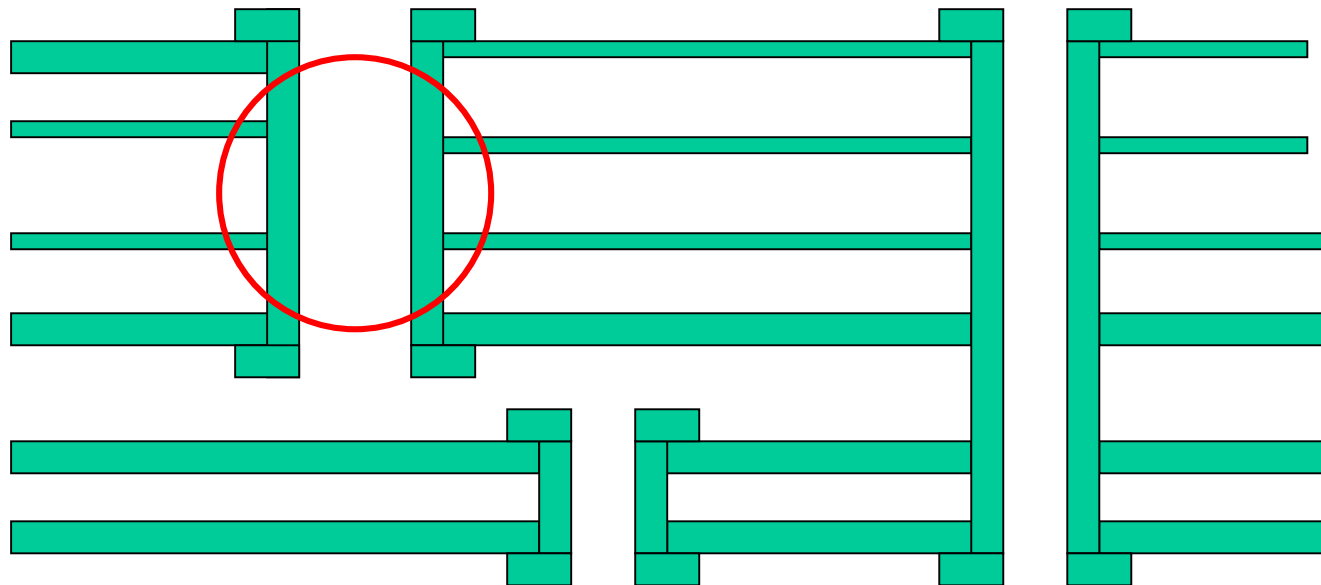


USE OF ENGINEERING TOOLS CASE 1

- SIX LAYER DOUBLE BLIND VIA
- PROBLEM OF FATIGUE FAILURE IN VIA
- CUSTOMER W/O ANALYTICAL TOOLS
- SEARCHED THE WEB FOR SOLUTIONS
- LOCATED "U-ENGINEER" AT GA TECH
- SOLICITED HELP FROM GA -TECH
- FINITE ELEMENT ANALYSIS

CASE 1 LAY-UP

- LAYER 1-4 BLIND & 5-6 BLIND



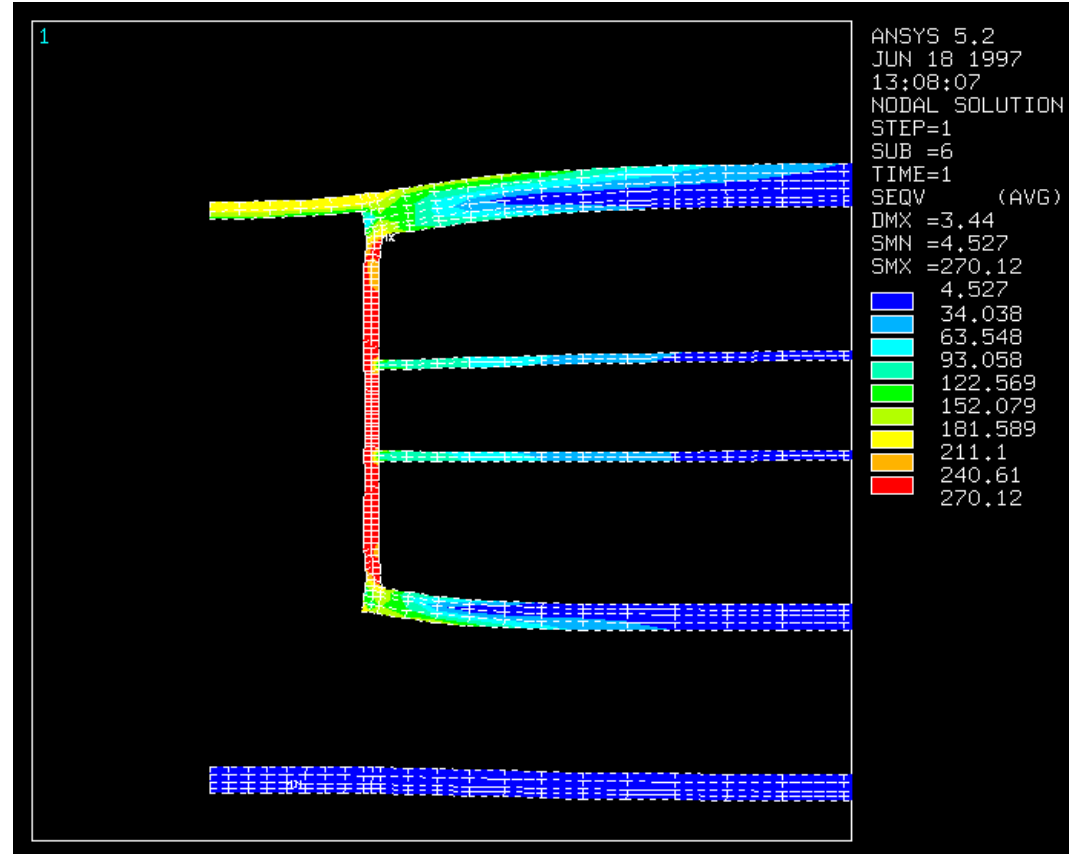
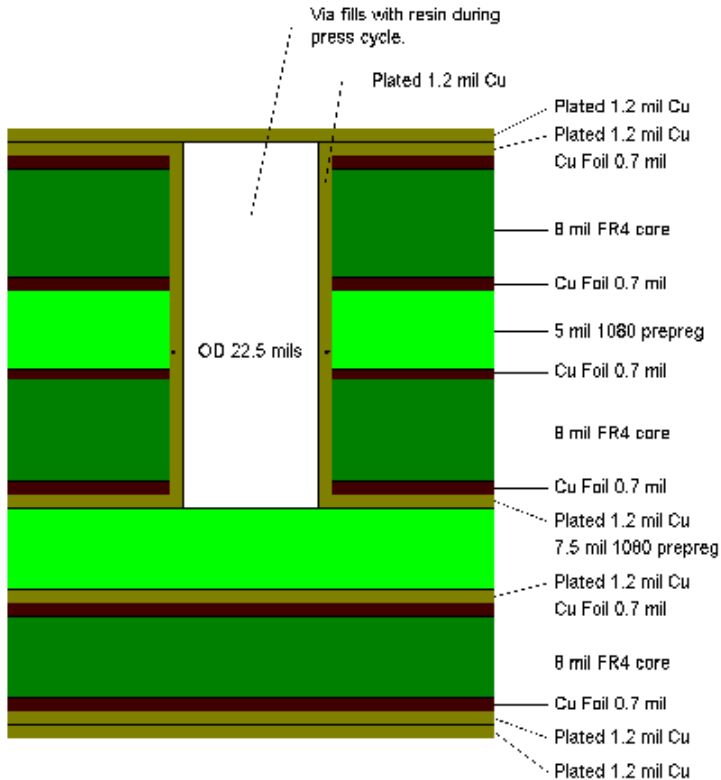


USE OF ENGINEERING TOOLS CASE 1 CONTINUED

- ANALYSIS OF PLATED THROUGH HOLES
- PREDICTED FATIGUE FAILURE OF BLIND VIA DURING 2ND PRESS CYCLE
- BOARD REDESIGNED TO REDUCE BARREL STRESSES

Case 1 Analysis Results

Plated Through Via



Barrel Stress > Ultimate Strength (~260MPa), so predicts original design will fail.

Conclusion: Analysis before mfg. would have prevented scrap & delays.

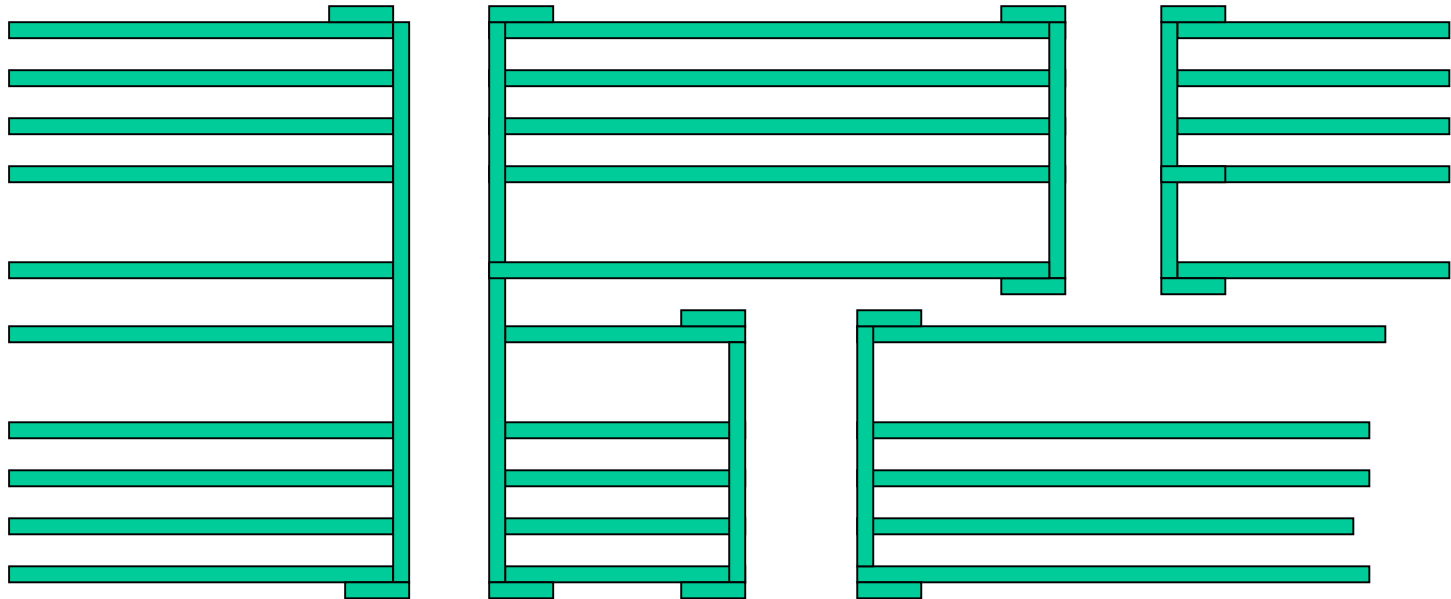


USE OF ENGINEERING TOOLS CASE STUDY 2

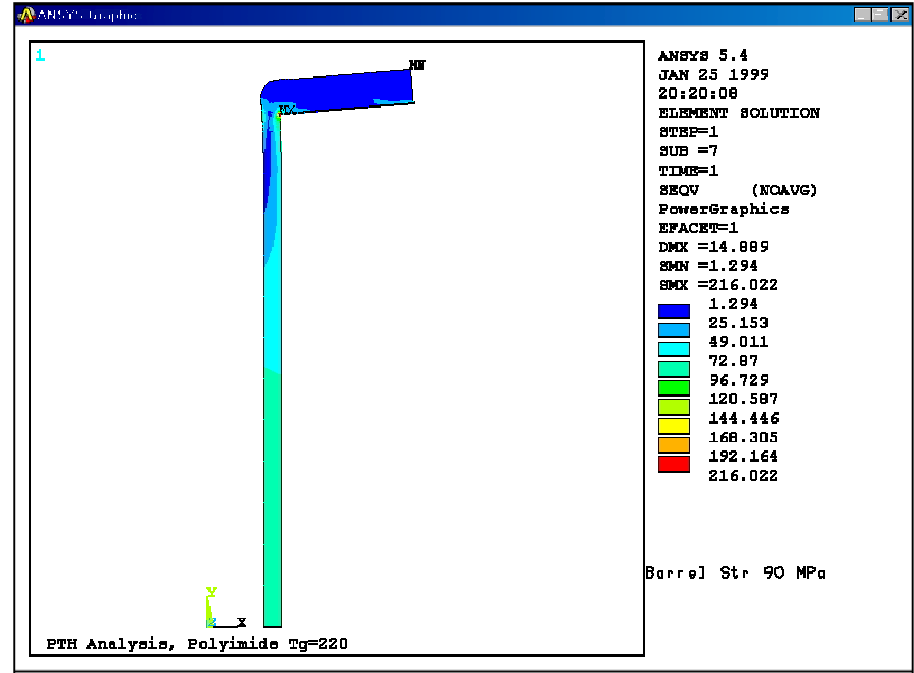
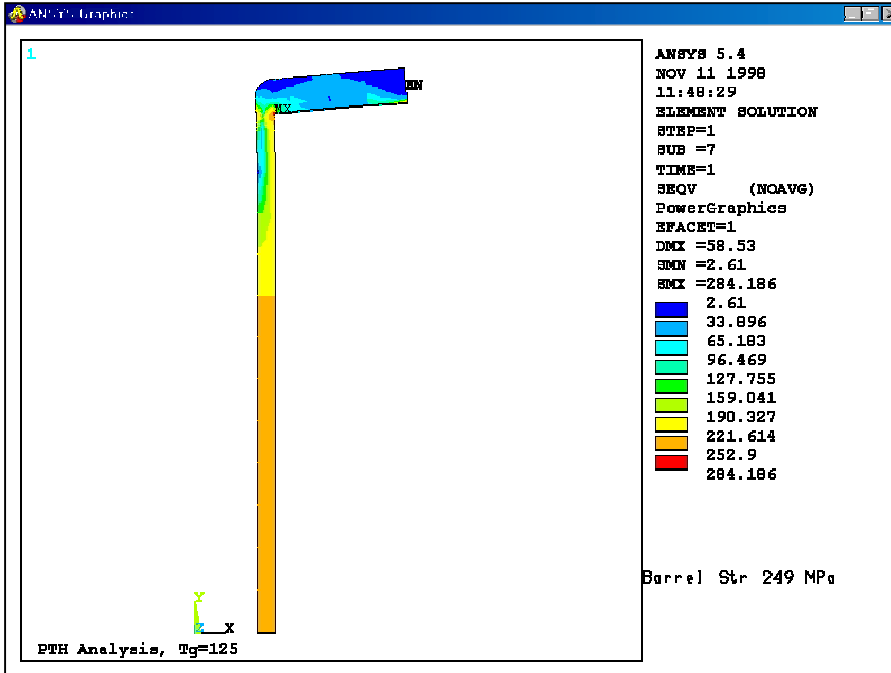
- TEN LAYER DOUBLE BLIND VIA
- EPOXY, FIVE CORE, 80 MILS THICK
- COST SENSITIVE
- RELIABILITY ISSUES AFTER THERMAL CYCLE
- FATIGUE ANALYSIS PREDICTED RELIABILITY WITH POLYIMIDE

CASE 2 LAY-UP

- LAYERS 1-5 & 6-10 ARE BLIND



Case 2 Analysis Results



Standard FR4

$$\sigma_{\text{barrel}} = 249 \text{ MPa}$$

64% Reduction

$T_g = 220 \text{ }^\circ\text{C}$ Polyimide

$$\sigma_{\text{barrel}} = 90 \text{ MPa}$$

Conclusion: Polyimide design chosen to reduce stress and increase reliability



USE OF ENGINEERING TOOLS CASE STUDY 3

- SIX LAYER, 67 MILS THICK WITH NON-SYMMETRICAL Z AXIS
- SEVERE WARP
- WARP ANALYSIS PREDICTED THERMAL DISTORTION
- MODELED CONSTRUCTION VARIABLES - REDUCED DISTORTION



"Quality in Every Process"

CASE 3 LAY- UP

ORIGINAL



024



.010



.005



.010



.005



REVISED



024



005



005



005



024



Case 3 Original

PWB Thermal Bending Model (1D Formulae)	
PWB Total Diagonal	5.445181356024792
Coef. Thermal Bending ($\alpha.b$)	0.005570211573007959
Temperature Change	175
Warpage	463.1800528757218
Warpage Ratio	85.06237397644043
Margin of Safety	-0.9999118294064767

Calculate Results

PWB Plane Strain Model (2D FEA)	
Initial Temperature	25
Final Temperature	200
Temperature Change	175.0
FEA Min Elem Div	2
FEA Aspect Ratio	4
Max Stress XX	3557.52
Min Stress XX	-9867.29
Local Warpage	2.236E-4
Warpage Ratio	0.0019409722222222224
Margin of Safety	2.8640429338103752

Create FEA Input View FEA Input

Calculate FEA Results View Graphical Results

PWB Layup

Legend: ■ Dielectric ■ Conductor

PWA / B Parameters	
Description	Warning Module PWA
PWA Part #	ABC_9010
PWB Part #	ABC_9230
PWB Pre-Lamination Thickness	0.0624
PWB Post-Lamination Thickness	0.05759999999999999
PWB Total Width	3.799999999999999
PWB Total Length	3.9
Allowable Warpage Ratio	0.0075

Case 3 Re-Design

PWB Warpage Analysis

File Help

PWB Thermal Bending Model (1D Formulae)

PWB Total Diagonal	5.445181356024792
Coef. Thermal Bending ($\alpha.b$)	3.930100179381556E-7
Temperature Change	175
Warpage	0.0285606544898684
Warpage Ratio	0.005245124564725033
Margin of Safety	0.4298993107694049

Calculate Results

PWB Plane Strain Model (2D FEA)

Initial Temperature	25
Final Temperature	200
Temperature Change	175.0
FEA Min Elem Div	2
FEA Aspect Ratio	4
Max Stress XX	3533.1
Min Stress XX	-10854.18
Local Warpage	2.823E-4
Warpage Ratio	0.00208801775147929
Margin of Safety	2.59192348565356

Create FEA Input View FEA Input

Calculate FEA Results View Graphical Results

PWB Layup

Legend: Dielectric (Green), Conductor (Yellow)

PWA / B Parameters

Description	Warning Module PWA
PWA Part #	ABC_9010
PWB Part #	ABC_9230
PWB Pre-Lamination Thickness	0.0714
PWB Post-Lamination Thickness	0.0676
PWB Total Width	3.799999999999999
PWB Total Length	3.9
Allowable Warpage Ratio	0.0075

CONCLUSIONS

- WE ARE A SMALL BUSINESS WITH LIMITED ENGRG. RESOURCES
- U - ENGINEER HAS PERMITTED US TO SOLVE SOME COMPLEX PROBLEMS
- WE NOW HAVE THE CAPABILITY TO PROVIDE A VALUABLE SERVICE TO THE CUSTOMER