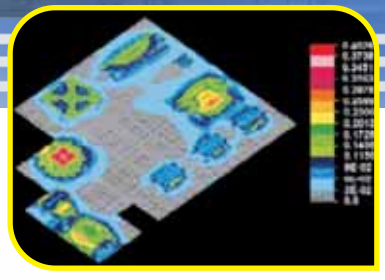
NISA™

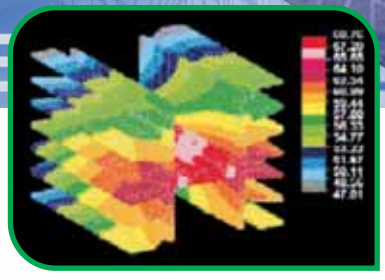
NISA - FEAP

PCB Analysis

Heat Transfer &
Thermal Stress

3D Fluid Analysis





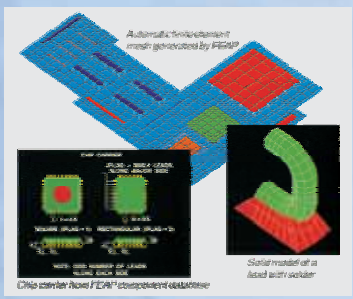
FEAP is the largest and most sophisticated finite element program for the stress, random vibration, fatigue life, 3D convective fluid flow and thermal analysis of printed circuit boards (PCBs) and electronic systems. FEAP totally integrates the NISA II/DISPLAY III/IV family of programs to simultaneously perform any or all of these analyses for any PCB configuration. This task is made easy by the fully automated mesh generation and the pre- and post-processing capabilities that are part of the program. Furthermore, a unique feature of FEAP allows the study of forced cooling effects on PCBs and inside multiple board electronic systems through a complete 3D convective fluid flow analysis.

NISA - FEAP

Sub-Modeling
Component Liberaty In

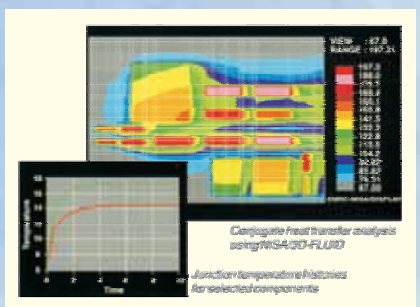
FEAP is a program for performing a complete and detailed structural, fatigue, thermal and fluid flow analysis on Printed Circuit Boards (PCBs) and the mounted components including

- Steady state heat transfer
- Transient heat transfer
- 3D Fluid flow, Forced or Free convection
- Random vibration
- Frequency response
- Transient dynamics (shock testing)
- Fatigue life computation



SALIENT FEATURES

- Extremely user friendly graphics pre-processor
- Fully automated finite element mesh generator
- Built-in interfaces to P-CAD, MENTOR GRAPHICS, PCB-ENGINEER, etc.
- Large user-expandable built-in library of commercially used component types
- Complete Integration with NISA family of programs
- Convenient FORM based inputs, efficient file management and task control through an interactive shell



COMPONENT LIBRARY IN FEAP

FEAP has an extensive built-in library of components which are commonly used in the electronic industry. Dual inline packages (DIPs), Flatpacks, Hybrid Packages, Pin arrays, Resistors, Capacitors, Leadless Chip Carriers, BGA etc., are present in the database. Geometric details, material properties and heat generation of these components are available in the FEAP database. These values can be changed with ease by the user. Several common configurations for each component type are predefined. The basic defaults contained in the FEAP database can be expanded to sixteen different configurations for each IC type. In addition, the user has the flexibility to define special configurations under each category of ICs. This provides great versatility to the FEAP preprocessor, which can access a database tailored to the needs of the user.

INTERACTIVE GRAPHICS PREPROCESSOR

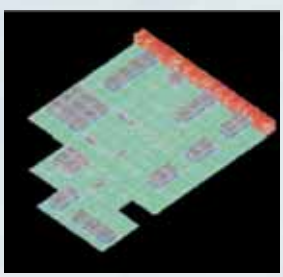
FEAP has a sophisticated user friendly graphics preprocessor for defining the PCB geometry, component layout and boundary conditions. FEAP allows PCBs to be modeled as single layered isotropic or multilayered composite boards. Components can be added, deleted, and relocated with ease. FEAP automatically checks for overlapping and overshooting of the components. The ICs mounted on the PCB can have either the traditional poke through attachment or the more recent surface mounted technology. Cutouts, stiffeners, heat sources and point masses can also be specified on the PCB.

The FEAP preprocessor has access to the FEAP component database. Various types of electronic components (ICs, resistors, etc.) in varied configurations can be picked and placed with ease. FEAP also has interfaces with several CAD packages used in PCB layout design (e.g., Mentor Graphics, Cadence Allegro, etc.). This helps to further integrate FEAP with the electronic system design process.

The Component Database in the FEAP Preprocessor

FINITE ELEMENT MESH GENERATION

FEAP automatically generates an optimized finite element mesh once the PCB layout is defined. Appropriate element types are chosen from the NISA II element library to model the PCB and its components efficiently. A well graded mesh is created by maintaining standard aspect ratios between adjacent elements. The user has flexibility in deciding upon the mesh density. Special care is taken to ensure a finer mesh in critical areas. The mesh can be viewed graphically. Options such as rotating, windowing, etc., are available to the user. FEAP generates a file containing the finite element model along with appropriate boundary conditions, which can be used directly for performing analysis.



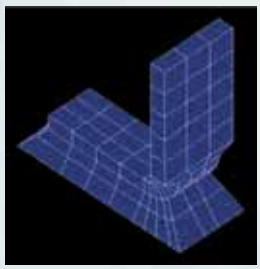
Finite Element Mesh for Structural Analysis

SUB-MODELING

FEAP uses the unique sub-modeling approach as a tool to improve the accuracy of results in a desired area. Using theresults of the first FEAP analysis, a finer mesh is automatically created within the chosen area which is used for further analysis. This approach saves considerable time and computational effort in comparison to analyzing a detailed mesh of the entire structure.

Heat Transfer & Thermal Stress
3D Fluid Analysis

As an extension to this analysis, a detailed finite element model of the end pins and solder joints of the end pins and solder joints of the component is generated using solid elements. Detailed stresses are obtained in the leads, which are used to predict the fatigue life of the component.



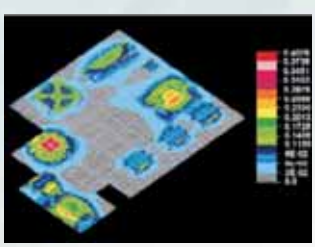
Solid Model of the End Pin

POST ANALYSIS FEATURES

- Temperature distribution over entire PCB
- Case and junction temperature plots, including component histories
- Automatic calculation of convective film coefficients from 3D fluid flow results
- Automated mesh refinement around components of interest using proprietary sub-modeling approach for greater accuracy
- Detailed solid models of end pins (surface mounted and through-hole) with solder for accurate stress predictions
- Fatigue life estimation for mounted components
- Prediction of component reliabilities

Heat Transfer and Thermal Stress Analysis

Most problems in the electronics industry today are a result of the heat generated by components mounted on a PCB. Using NISA/HEAT, FEAP can analyze PCBs mounted with heat generating components and predict the temperature profiles on the board and components. Following a heat transfer analysis, FEAP can automatically perform a thermal stress analysis of the system. FEAP can then apply sub-modeling techniques to refine the mesh around specified components for more detailed results.



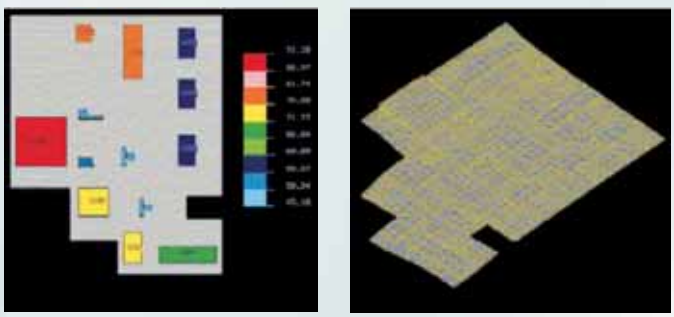
Isothermal Contours in the PCB

MODELING CAPABILITIES:

- Multilayered PCB with components
- Specified temperatures at PCB edges
- Heat generation by the components
- Mounting of components on thermal pads
- Point heat sources

ANALYSIS HIGHLIGHTS

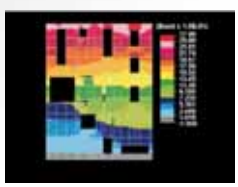
- Steady State and Transient conduction heat transfer through PCB and components
- Convection and Radiation heat transfer from the PCB & component surfaces
- Temperature distribution over the PCB and components
- Junction and case temperatures for all components
- Thermal stresses and warping in the PCB



Deformations Due to the Thermal Load

3D FLUID ANALYSIS

FEAP is integrated with NISA/3D-FLUID to simulate heat dissipation due to forced convection. Forced cooling using a fan or a blower is commonly used in electronic assemblies to maintain temperatures below critical levels. The efficiency of forced convection in dissipating heat depends on the initial temperature, velocity, type of fluid used as well as component location with respect to each other and to the source of the cooling fluid.



Pressure Distribution in the Fluid

FEAP creates a finite element model of the PCB, components and fluid channel. A complete 3D fluid flow analysis is performed. The predictions of this analysis give the engineer a powerful tool to improve the design of cooling techniques in electronic assemblies.

Modeling Capabilities:

- PCB with components & surrounding fluid
- Inlet and outlet fluid velocities and temperature boundary conditions

ANALYSIS HIGHLIGHTS

- Conduction, Convection, and Radiation heat transfer
- Conjugate fluid-heat transfer
- Temperature distribution in the fluid, on the PCB and components
- Convective heat transfer coefficient calculation
- Velocity vectors in the fluid
- Pressure distribution in the fluid

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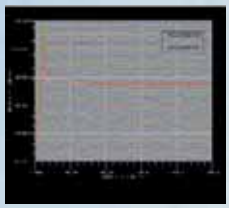
Miscellaneous Features Modeling Capabilities

DYNAMIC ANALYSIS

High cyclic stresses in the end pins of components are a common reason for the structural failure of PCBs. This is especially significant in environments where dynamic loads are predominant, like automobiles and avionics. Hence an accurate estimate of stresses is crucial to predict the life of components. FEAP, along with NISA/DYNAMICS, provides a tool to obtain the dynamic response of PCBs. Refined meshes can then be created around ICs using the sub-modeling technique. The stresses predicted by these analyses are then used to calculate the fatigue life.



Vertical Acceleration PSD at Select PCB Locations from Random Vibration Analysis

MODELING CAPABILITIES

- Composite PCB with components
- Edge and point boundary conditions
- Lumped masses and stiffeners

ANALYSIS HIGHLIGHTS

- Eigenvalue analysis
- Frequency response
- Random vibration
- Transient response
- Mode shapes and natural frequencies
- Time history of displacements, velocities, and accelerations
- Power spectral density of displacements, velocities and accelerations

MISCELLANEOUS FEATURES

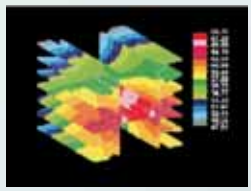
The NISA analysis modules can be used to perform analysis of electronic components and systems which are not directly supported by FEAP. The general purpose pre- and post-processor DISPLAY III/IV (of the NISA family of programs) can be used to model such problems. Customized devices such as different configurations of heat sinks, multi chip modules, and new ICs can be handled in this manner. FEAP can be used as a starting point in many such detailed analyses

THE PROBLEM

- Analysis of a finned heat sink with power transistors in an enclosure
- Forced cooling by a fan

ANALYSIS HIGHLIGHTS

- 3D mesh of brick elements generated using DISPLAY III/IV
- Conjugate fluid-heat transfer analysis using NISA-3D-FLUID
  Conduction, Convection & Radiation
- Temperature contours in the heat sink and surrounding fluid
- Velocity vectors in the fluid



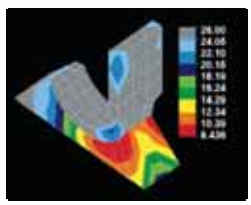
Temperature Contours in the Heat Sink

FATIGUE ANALYSIS OF END PINS

Fatigue failure of component leads due to high thermal and dynamic cyclic loads is a common cause for the failure of PCBs. Based on dynamic and thermal stress analysis, FEAP can predict the fatigue life of component end pins and solder joints. Once thermal stress and dynamic analyses have been performed on the PCB, FEAP generates solid models of the end pins in critically stressed areas. Stress analysis of these models gives detailed and accurate stress distribution in the end pins and solder joints. This stress distribution is further used to perform a fatigue analysis of end pins using NISA-ENDURE. Several pin-joint configurations are available in the FEAP library (e.g., poke-through, surface mounted J) along with several material types for the joints.

MODELING CAPABILITIES

- Refined meshes around critical components
- Solid models of end pins and solder joints
- Several pin-joint configurations
- Material library for pins and solder



Fatigue Log Life Contours

ANALYSIS HIGHLIGHTS

- Detailed stress distributions around critical components
- Stresses and fatigue life predictions in end pins and joint

About us

Cranes Software International Limited is a leading provider of Computer Aided Engineering (CAE) services to the Automotive, Aerospace, Energy & Power, Civil, Electronics and Sporting Goods industries. Over 70 dedicated scientists, technology architects and software engineers providing NISA based solutions have helped major engineering companies reduce analysis turnaround time, improve user productivity, and ensure faster return on investments. The Company has its presence in 33 countries across the world and has a user base of more than 350,000.

With a mission statement to provide its customers the best in scientific technology and to enable its customers to define new limits, Cranes is setting new standards in the scientific and engineering field. *For more information, please visit www.nisasoftware.com Email: nisa@cranessoftware.com*

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