LapCAD, a MSC/NASTRAN PRE/POST-PROCESSOR ON THE MACINTOSH

Gert M. Lundgren

LAPCAD Engineering
1568 Diablo Point Court
Chula Vista, California 92011, USA

ABSTRACT

LapCADII Version 4 now offers both preprocessing as well as postprocessing on the Macintosh microcomputer.

The preprocessing features make it possible to create a new model entirely from scratch, using low-level tools for generation of nodes and elements, as well as automated mesh generating macros. Models can also originate in AutoCAD and VersaCAD, and then be imported into LapCAD via its built-in DXF and TWGES translators.

Once a model has been created, it can be altered using LapCAD's built-in editing tools. These tools allow instant conversion of single elements into an alternate multi-element pattern, selectable via a click of the mouse on a candidate icon. These editing tools exist for surface elements as well as for solid elements.

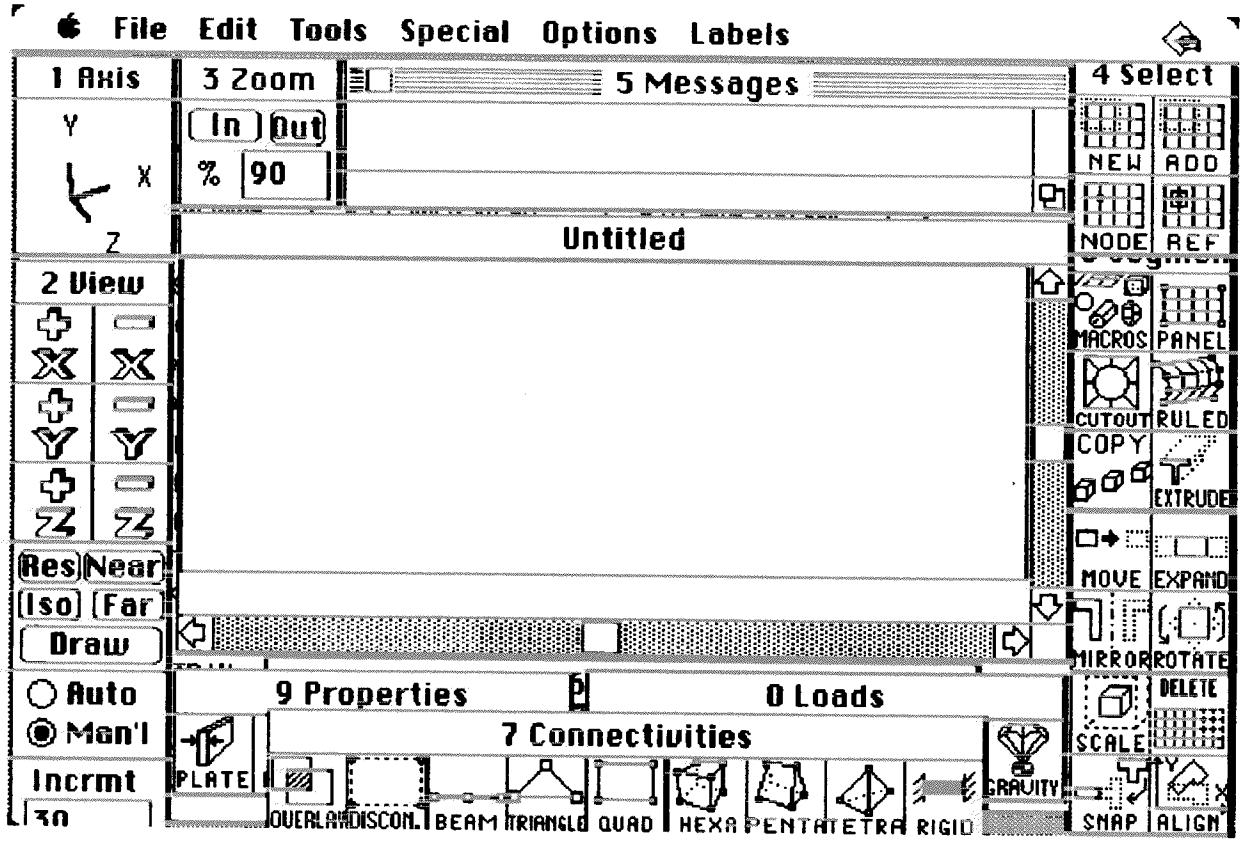
In addition to the editing tools, LapCAD also provides numerous features for rotation, stretching, moving, scaling and alignment.

The preprocessing features also include the application of boundary constraints, enforced displacements, and external forces, pressures and temperatures.

The created MSC/NASTRAN input file is complete, with an Executive Control, Case Control, and Bulk Data.

Once the model has been run, the resulting output can be retrieved with LapCAD, and a deformed shape can be displayed. Internal stresses can also be superimposed directly on the model.

INTRODUCTION

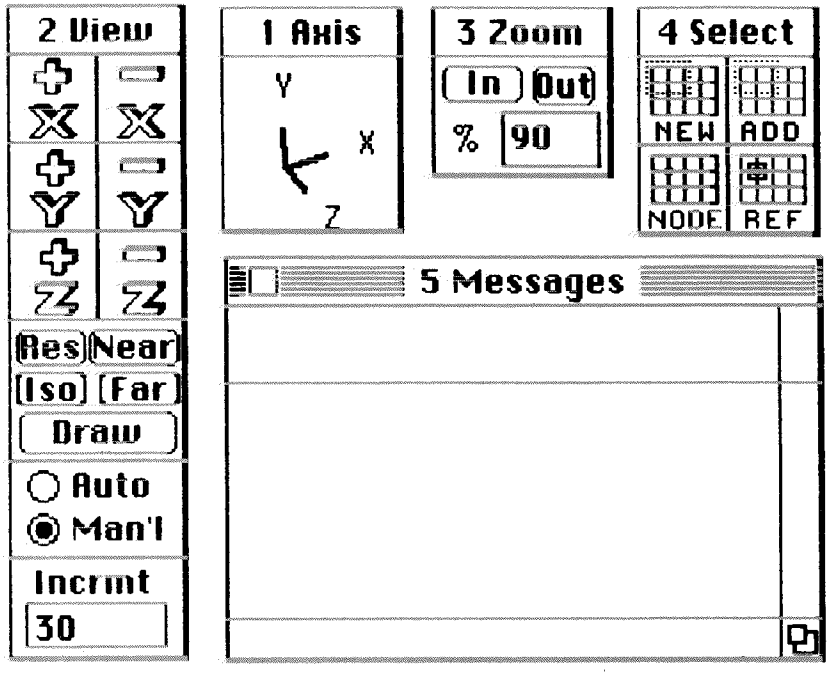


LapCAD offers the user an interactive graphics interface, where each major group of tasks has been collected in a single window. The user selects the desired task by clicking on an icon with its design being related to the task at hand.

Once the user has selected a given task or icon in one of the tool windows, a dialog box is brought up, which contains user controlled variables relating to the selected task. After the user has verified or altered these variables, he/she proceeds with the completion of the task, which may amount to only the clicking on an implementation button, or lets the user complete the task with the mouse, such as connecting a HEXA element with the mouse.

PREPROCESSING

Interface tools



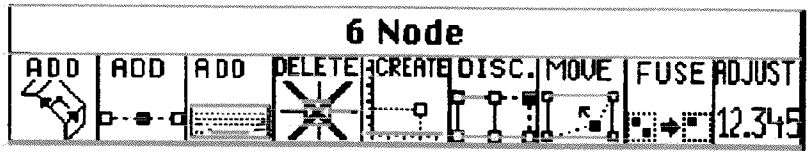
The interface tools allow the user to view the model from another angle and perspective, by clicking on an icon or button. Rotations take place around the chosen axis, as can be monitored in the 'Axis' window.

By dragging a rectangle around a targeted area of the model, and then clicking on the 'In' button in the 'Zoom' window, that area will be magnified to the borders of the modeling window.

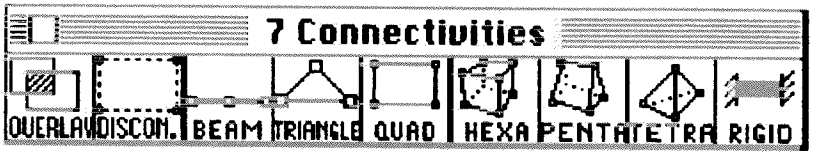
The 'Select' window allows the user to define an area of the model for manipulation with the various tools, or to designate that area as a layer.

The 'Messages' window offers directions to the user, related to the current task.

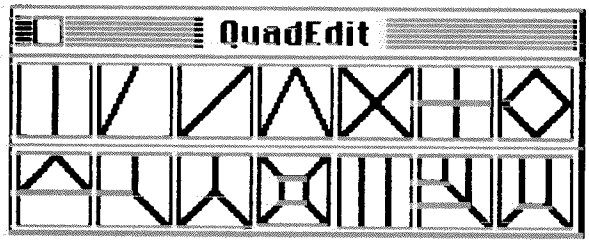
Modeling tools

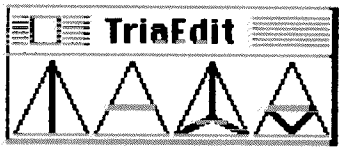


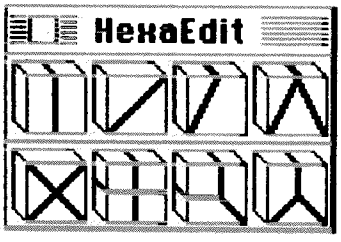
The 'Node' window provides several modes of node additions, such as a digitizing in a user defined local coordinate system, defined anywhere in space, based on three nodes. Also included are deletion of a single node, and real-time movement of the node. Individual coordinates can also be adjusted for an individual node, selected with the mouse.



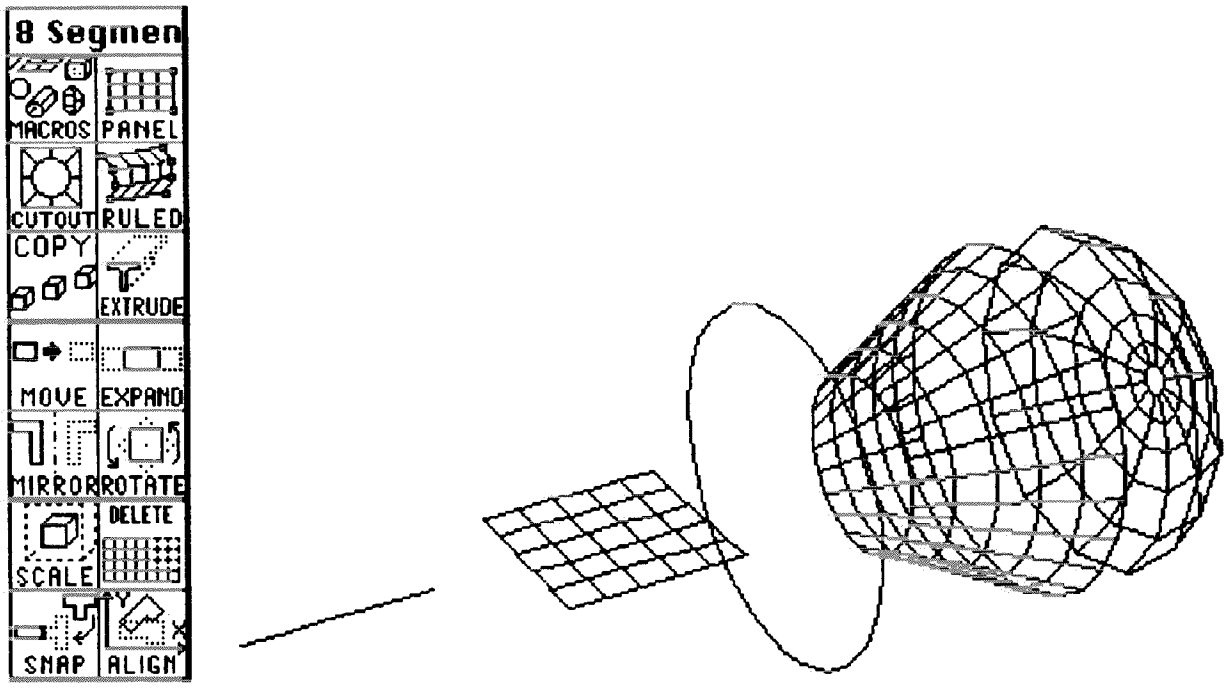
The 'Connectivities' window offers tools for connection of surface elements, as well as for solid elements.



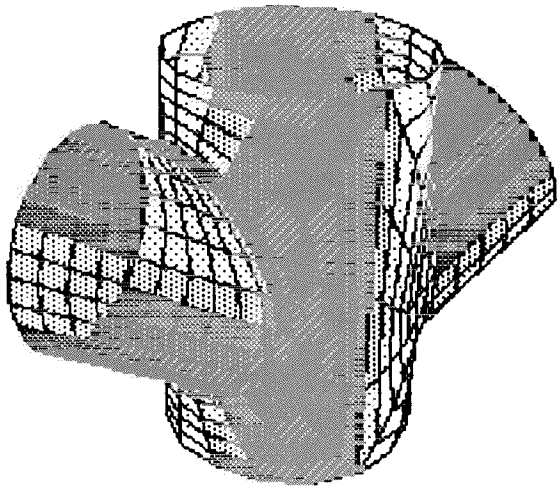




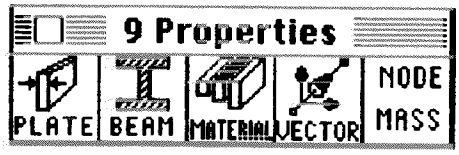
Several editing windows are available for modification of a single surface or solid element. After selecting one of the editing icons, and then clicking on a corresponding element in the model, that element is replaced with the element pattern in the chosen icon.



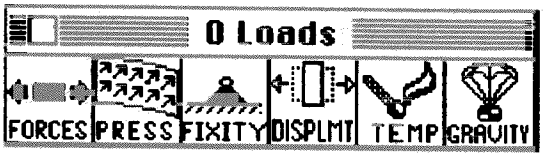
The 'Macros' icon in the 'Segment' window helps the user with simple objects such as line, panel, box, ring, cylinder and sphere. Pipe intersections can also be created with a click of the button.



All dimensions and nodal densities are controlled by the user. Each object is a complete finite element model in that each has a default setting for the physical properties.

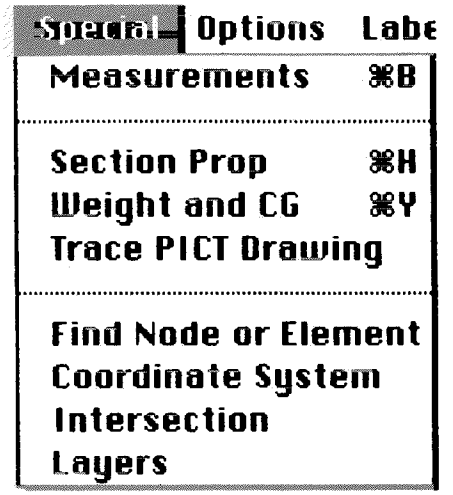


The physical properties can be adjusted under mouse control for an individual element, a group of elements (collected with the 'Select' window), or the entire model can be changed with a single click of the mouse.



The external environment includes nodal forces, surface pressures, boundary constraints, forced displacements, nodal temperatures, and gravity.

Special features

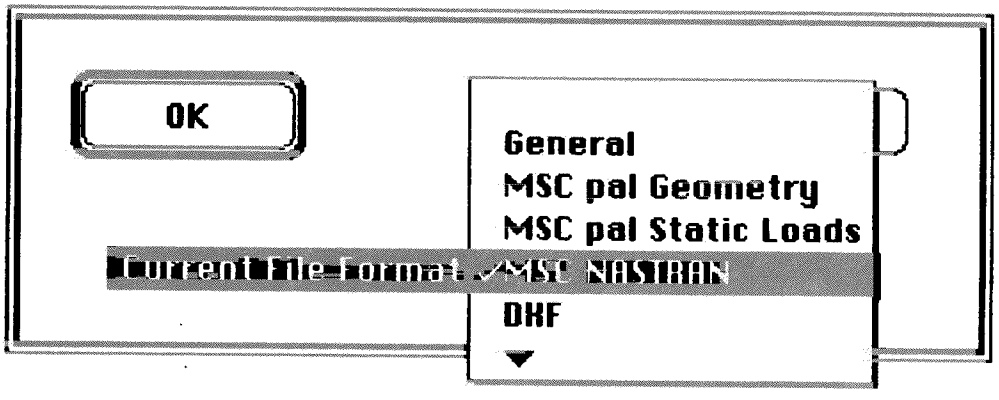


The 'Special' pull-down menu offers a variety of miscellanous features, such as 'Measurements'. This item allows the user to measure distances between any two nodes by clicking on these nodes. The feedback consists of the internal node numbers, the global x, y, and z distances, and the absolute distance.

By selecting 'Section Properties', properties around the global axis as well as the principal axis are computed, for any two-dimensional model made up of surface elements in the global x-y plane. By applying axial load and moments around the two axes, the user can determine combined stresses at any node that is clicked on.

'Trace PICT Drawing' brings up the PICT formatted file previously read. By moving the mouse and clicking on selected corners of the picture, a trace of the drawing can be translated into node points. These points can then be connected and the resulting model segment can become a stand-alone model, or be merged with a larger model. The PICT file can be created by scanning the actual drawing, using the Apple Scanner. This mode of input is similar to the way a digitizer works, and is the most convenient way of inputting basic geometry.

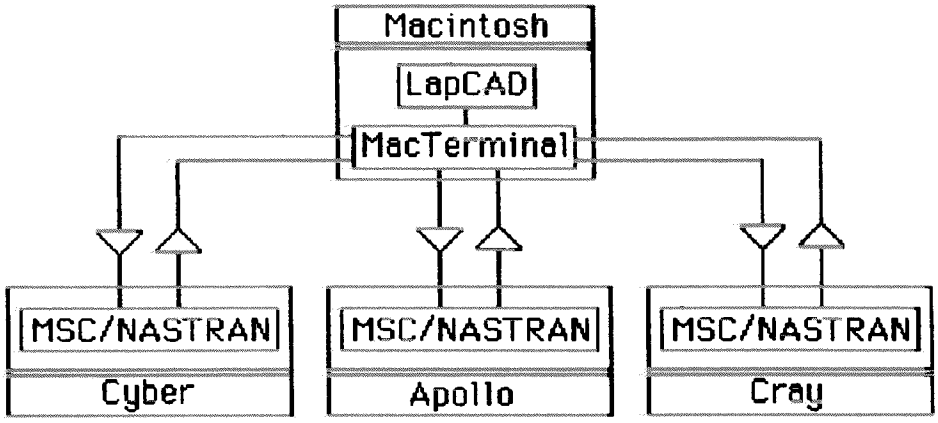
Creation of MSC/NASTRAN Input File



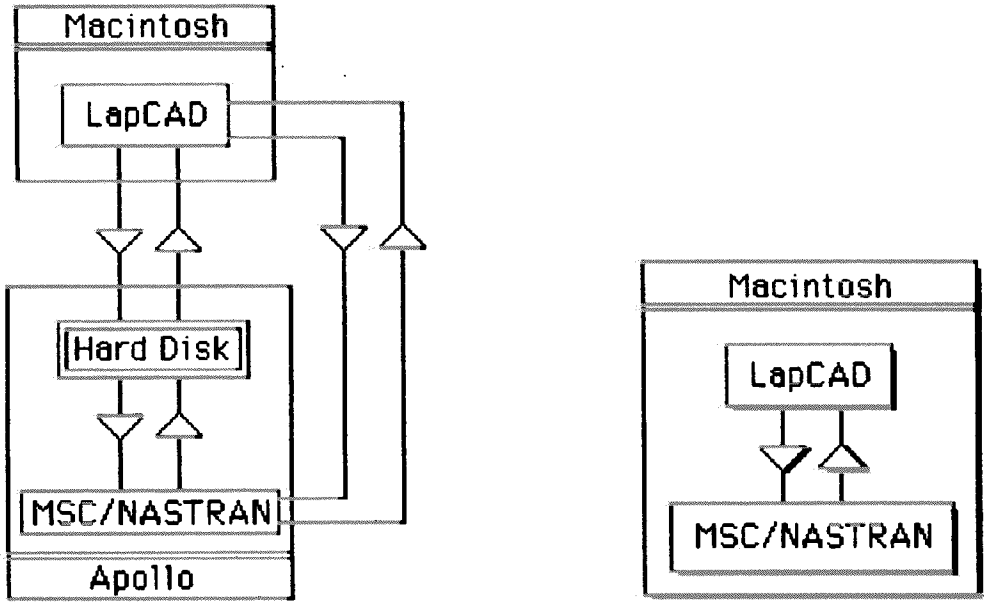
Once the model has been created, it can immediately be written out in the MSC/NASTRAN format as shown above. This input file is complete, with an Executive Control, Case Control, and Bulk Data, in other words ready to run.

SOLVING THE MODEL

Communication packages such as MacTerminal allow the user to transfer data to and from mainframes or workstations, as suggested below:



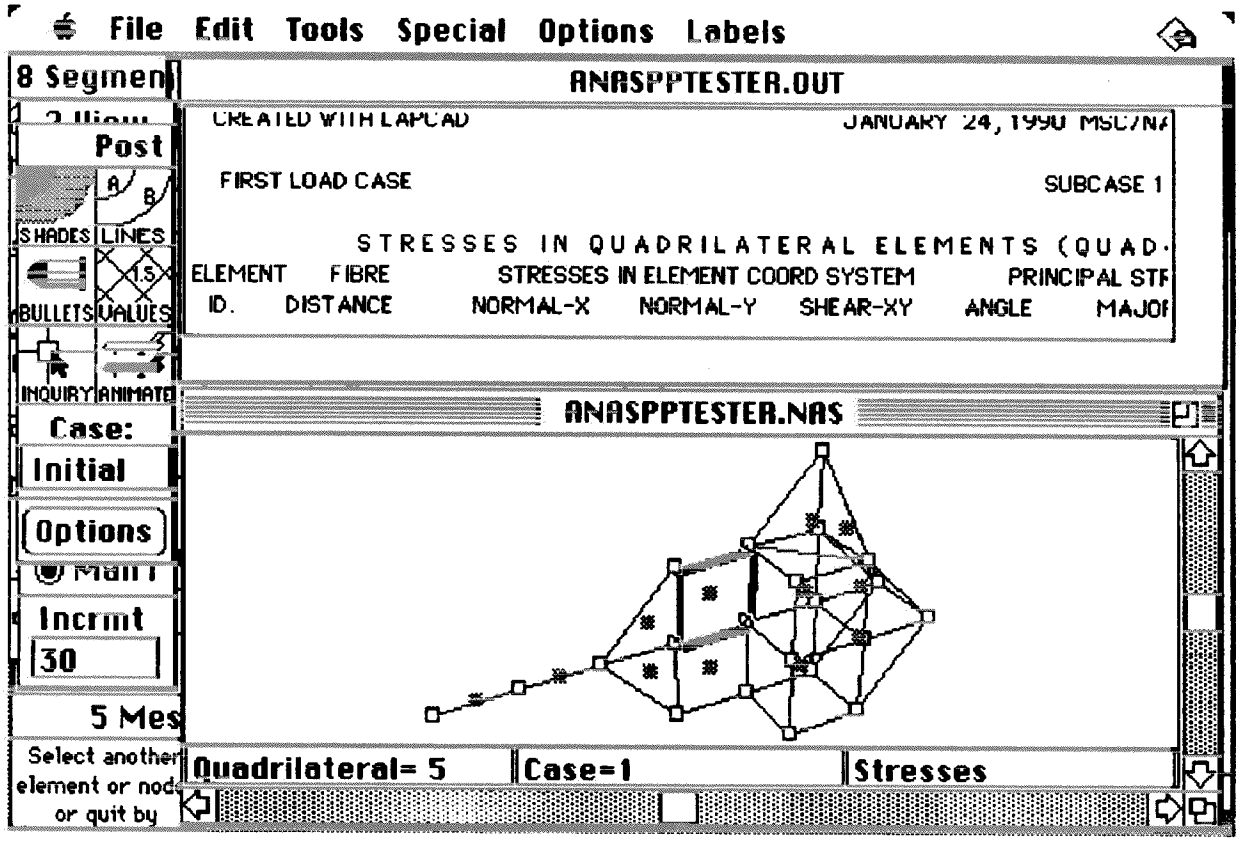
A more direct way of processing the finite element model is via communication with the hard disk that the workstation utilizes:



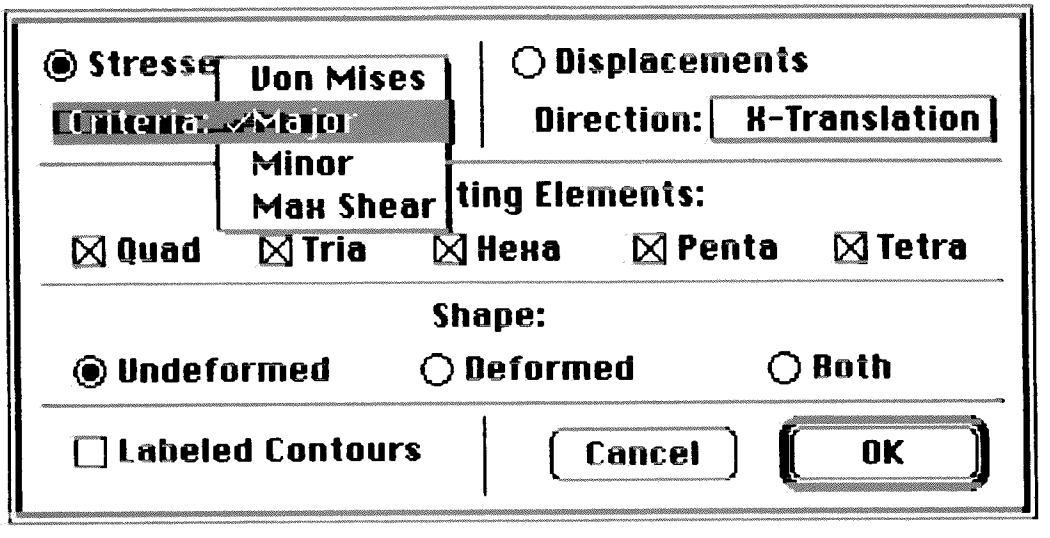
Finally, by installing MSC/NASTRAN on the next generation of workstation class Macintoshes, the most convenient user environment is obtained.

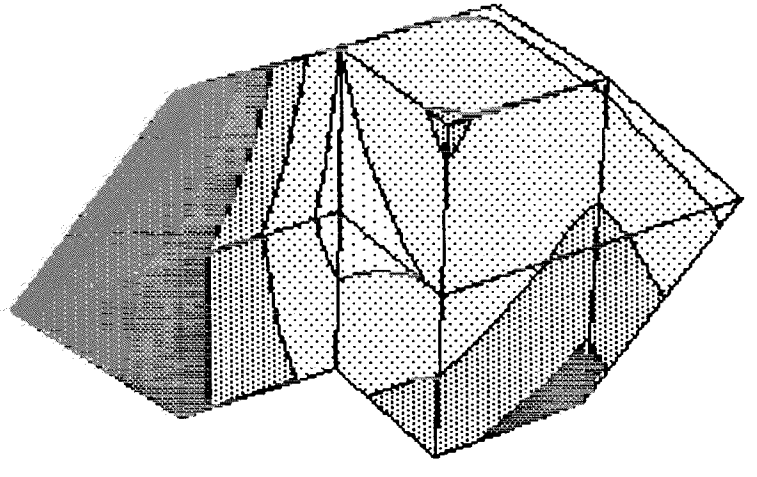
POSTPROCESSING

User Interface



LapCAD provides a point-and-click facility for review of output related to individual nodes or elements.





A means for viewing output in a global manner, such as shaded contours, is also included.

Data format

LapCAD requires no special type of output format from MSC/NASTRAN. It simply reads the ASCII type format labeled F06, which is identical to the printed output. In other words, what you see on your printed output is also what LapCAD is working with. Samples of the type of output that LapCAD utilizes is shown below:

```
* * * * * * * * * * * * * * * * * * * * * * *
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* *                                       * *
* *                                       * *
* *                                       * *
* *                                       * *
* *       M S C / N A S T R A N           * *
* *                                       * *
* *           VERSION -  66               * *
* *                                       * *
* *          JAN  4, 1989                 * *
* *                                       * *
* *         DIGITAL EQUIPMENT             * *
* *                                       * *
* *         MODEL VAX 8700                * *
* *                                       * *
* *            VMS V5.1                   * *
* *                                       * *
* *              MSC                      * *
* * * * * * * * * * * * * * * * * * * * * * *
* * * * * * * * * * * * * * * * * * * * * * *
```

D I S P L A C E M E N T V E C T O R

T1	T2	T3	R1
-1.801239E-03	-1.075161E-02	-6.947407E-03	0.0
-9.154174E-04	-9.678694E-04	-2.699363E-03	0.0
-1.767784E-03	-1.042630E-02	-6.403474E-03	0.0
-9.239643E-04	-1.107957E-03	-3.701934E-03	0.0
-8.932343E-04	-8.520672E-04	-1.697907E-03	0.0
2.152615E-04	-1.338120E-03	-4.208342E-03	5.049087E-04
-1.895910E-04	-1.099558E-03	-2.838120E-03	6.417058E-04
-3.556274E-04	-7.926864E-04	-1.021980E-03	6.349099E-04

B A R E L E M E N T S (C B A R)

SA4 SB4	AXIAL STRESS	SA-MAX SB-MAX	SA-MIN SB-MIN
0.0	-5.717012E+02	-5.717012E+02	-5.717012E+02
0.0		-5.717012E+02	-5.717012E+02
0.0	-2.967739E+03	-2.967739E+03	-2.967739E+03
0.0		-2.967739E+03	-2.967739E+03
0.0	4.330119E+03	4.330119E+03	4.330119E+03
0.0		4.330119E+03	4.330119E+03
0.0	-9.238130E+02	-9.238130E+02	-9.238130E+02
0.0		-9.238130E+02	-9.238130E+02

S T R E S S E S I N H E X A H E D R O N S O L I D

CORNER GRID-ID		------CENTER AND CORNER POINT STRESSES-------- NORMAL		SHEAR		PRINCIPAL
278	X	-2.515252E+03	XY	-2.686005E+02	A	-1.238117E+02
	Y	-4.143546E+02	YZ	3.327606E+02	B	-3.113048E+03
	Z	-8.019346E+02	ZX	1.105458E+03	C	-4.946813E+02
280	X	-6.575960E+03	XY	-2.686005E+02	A	-2.890235E+02
	Y	-4.936049E+02	YZ	3.327606E+02	B	-6.627991E+03
	Z	-9.753312E+02	ZX	-4.909119E+02	C	-1.127882E+03
281	X	-7.781810E+03	XY	-2.686005E+02	A	1.654115E+03
	Y	1.256228E+03	YZ	-5.061005E+02	B	-7.818847E+03
	Z	1.007962E+03	ZX	-4.909119E+02	C	6.471124E+02

S T R E S S E S I N P E N T A H E D R O N S O L I D

CORNER GRID-ID		------CENTER AND CORNER POINT STRESSES-------- NORMAL		SHEAR		PRINCIPAL
78	X	-2.727535E+02	XY	1.042136E+02	A	-1.123621E+02
	Y	-4.697526E+02	YZ	-2.307489E+02	B	-9.871620E+02
	Z	-7.039138E+02	ZX	3.071508E+02	C	-3.468958E+02
191	X	-2.727535E+02	XY	1.042136E+02	A	3.529230E+02
	Y	-2.436076E+02	YZ	-2.278509E+02	B	-5.676556E+02
	Z	1.477712E+02	ZX	3.076776E+02	C	-1.538574E+02
158	X	-3.637629E+02	XY	1.042136E+02	A	-1.336011E+02
	Y	-3.069313E+02	YZ	-2.291682E+02	B	-9.133392E+02
	Z	-6.036061E+02	ZX	3.050431E+02	C	-2.273601E+02

S T R E S S E S I N T E T R A H E D R O N S O L I D

CORNER GRID-ID		------CENTER AND CORNER POINT STRESSES-------- NORMAL		SHEAR		PRINCIPAL
190	X	-1.918808E+02	XY	1.767151E+02	A	8.142967E+02
	Y	-1.112055E+02	YZ	9.073611E+01	B	-1.463160E+03
	Z	-4.370300E+02	ZX	-1.116499E+03	C	-9.125261E+01
-1GRID CS 4 GP						
CENTER	X	-4.478317E+02	XY	4.271616E+02	A	8.569642E+02
	Y	-1.373991E+02	YZ	-8.286846E+02	B	-1.337104E+03
	Z	-6.418597E+02	ZX	-5.959800E+02	C	-7.469504E+02
160	X	-4.478317E+02	XY	4.271616E+02	A	8.569642E+02
	Y	-1.373991E+02	YZ	-8.286846E+02	B	-1.337104E+03
	Z	-6.418597E+02	ZX	-5.959800E+02	C	-7.469504E+02

S T R E S S E S I N Q U A D R I L A T E R A L E L E M E N T S

STRESSES IN ELEMENT COORD SYSTEM			PRINCIPAL STI	
NORMAL-X	NORMAL-Y	SHEAR-XY	ANGLE	MI
9.387595E+02	9.311400E+02	1.303411E+03	44.9163	2.23
-1.500289E+03	-7.669090E+02	-4.516112E+01	-86.4894	-7.64
2.311152E+03	4.249172E+03	-8.614570E+02	-69.1813	4.57
-2.774208E+03	-4.466788E+03	6.067964E+02	17.8204	-2.57
-2.415757E+01	-2.350458E+03	1.133147E+02	2.7821	-1.86
8.428710E+02	2.819861E+03	5.987832E+01	88.2668	2.82
7.286508E+02	1.231406E+03	3.475982E+02	62.9369	1.40
9.235792E+01	-1.086830E+03	-1.211015E+02	-5.8035	1.04
-1.042080E+02	-7.700863E+01	1.358190E+02	47.8590	4.58

S T R E S S E S I N T R I A N G U L A R E L E M E N T S

STRESSES IN ELEMENT COORD SYSTEM				
NORMAL-X	NORMAL-Y	SHEAR-XY	ANGLE	PRINCIPAL
1.839682E+03	3.674267E+02	-3.826178E+02	-13.7320	1.
1.128495E+03	1.755075E+03	-2.160395E+02	-72.7053	1.
1.623712E+03	3.953040E+02	1.087348E+03	30.2697	2.
2.965212E+03	3.193187E+02	-5.478330E+02	-11.2472	3.
6.928851E+02	-5.896935E+01	-8.286613E+02	-32.7991	1.
3.398770E+02	-3.872806E+02	6.812221E+02	30.9552	7.
-5.761821E+02	-1.118047E+03	-1.559762E+01	-1.6474	-5.
-6.749689E+02	-1.073343E+03	1.226776E+03	40.3888	3.

REFERENCES

MSC/NASTRAN User's Manual

SUMMARY AND CONCLUSIONS

The task of structural analysis via the finite element method (FEM) can be divided into three major sub tasks, preprocessing, solving, and postprocessing. Version 4 of LapCAD will perform two of these tasks, preprocessing and postprocessing. As the Macistosh platform evolves, these sub-tasks will be integrated with the solving of the model in an increasingly seamless fashion, all to the benefit of the end user, the structural analyst.