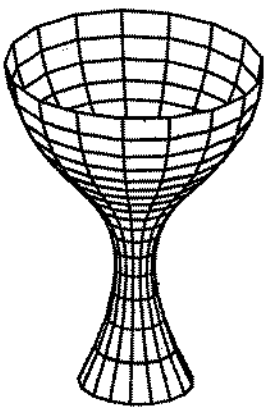
ALGORITHM DEVELOPMENT



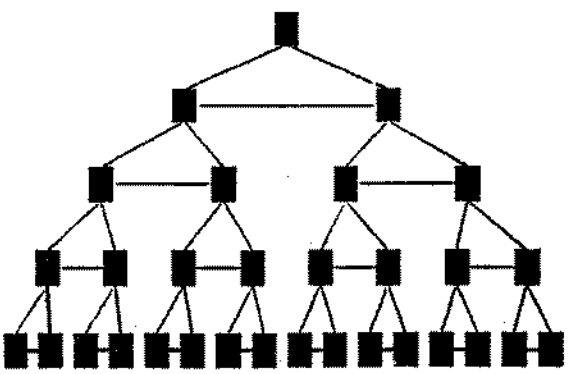
PRE-& POST PROCESSORS FOR FINITE ELEMENT ANALYSIS

NAL has developed a high-performance finite element software package for structural analysis. User-friendly interactive pre- and post-processors are being developed in a joint project between NAL and C-MMACS to provide user interface for the package to facilitate preparation of model data and visualisation of results. The following capabilities have been added during the reporting period to the pre- and post- processors.

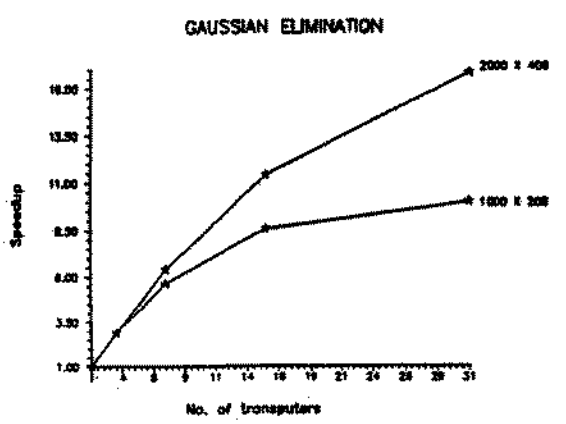
◀ *Fig. 9 An illustration of the hidden line removal program incorporated into the pre-processor for viewing 3D models in FEM.*

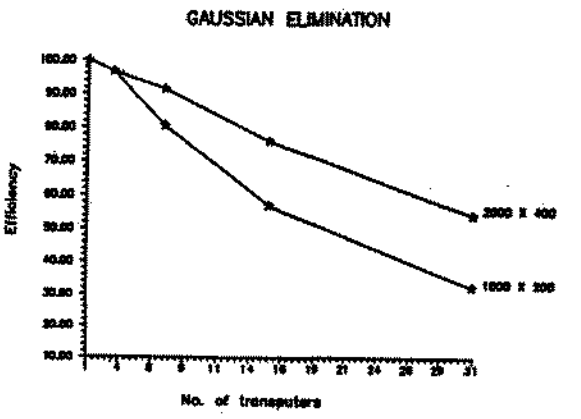
▼ *Fig. 10 A typical result for Gaussian elimination for banded matrices for triangular mesh topology.*

- A hidden line removal program has been incorporated into the pre-processor for viewing the three dimensional models. (*Fig. 9*)
- The pre-processor can now generate a quadrilateral mesh for



TRIANGULAR GRAPH





axisymmetric structures and quadrilateral surfaces bounded by cubic parametric curves.
- A program for two-dimensional contour plotting has been developed for graphical postprocessing of results. It uses bilinear interpolation.

It is planned to integrate the processors with the finite element package.

PARALLELISATION OF LINEAR SOLVERS

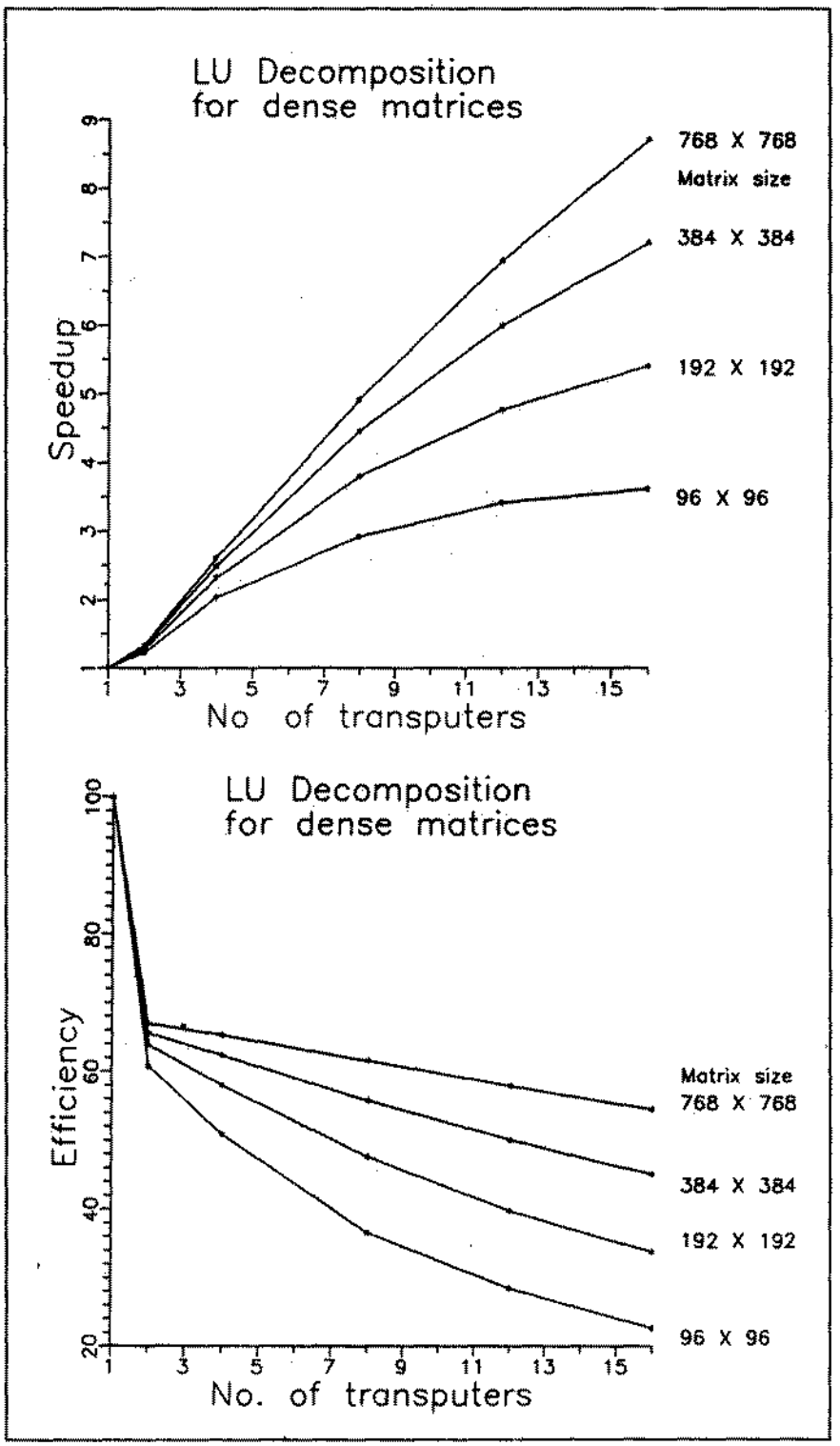
Parallelisation of linear solvers has been an area of study of C-MMACS from the viewpoint of effective use of parallel computing in solving the large system of equations typically encountered in finite element and finite difference methods. The following solvers have been parallelised and implemented on the transputer-based computer at C-MMACS and on PARAM at C-DAC, Bangalore.

- LU decomposition
- Cholesky decomposition
- Gaussian elimination

For the above three cases, variants for dense as well as banded matrices have been developed. These parallel programs can run on any arbitrary configuration of transputers (mesh, tree, pipe, ring etc.). A salient feature of the programs is that before communicating data from one processor to another, the program determines the shortest path and sends data along that route. The performance of the algorithms have been evaluated by studying the effect of the number of processors and the problem size on the speedup and efficiency for different topologies (see *Fig. 10, 11 for more details*).

STUDIES ON PANEL METHODS USING PARALLEL COMPUTERS

Panel method calculations on parallel computers need efficient parallel algorithms for the solution of the dense system $Ax = b$ of linear algebraic equations for determining the singularity strengths. The 16-transputer-based parallel computing facility at C-MMACS was used to analyse the performance of a newly developed parallel algorithm. Investigations were conducted to examine how the parallel time efficiency of the new algorithm depends on (i) the problem size, (ii) the number of transputers activated, and (iii) the topology of the transputer interconnection network. The algorithm showed good speedup with problem size. When pipeline topology was employed, a parallel efficiency of 66% was obtained for a problem size of 1152 panels with 16 transputers.



▲ *Fig. 11 Typical results for LU decomposition for banded matrices.*

The efficiency increased to 73% when pipeline inter-transputer connection was replaced by mesh connection topology. Other connections were being explored to improve the efficiency further (see /CM 6/).

AN EXPERT SYSTEM FOR MATERIAL SELECTION

Expert systems are tools for simulating domain-specific knowledge of an expert in a selected field. They differ from conventional programs in their use of AI techniques such as object-class relationships, rules for representation of knowledge, search techniques, and heuristic reasoning. The selection of materials for the components of a complex system involves expertise and detailed information about materials and it often depends on experience as well as subjective decision making. It is therefore a candidate field of an expert system. At C-MMACS such a knowledge-based system is being built. The first experimental version is being evaluated. When requirements of an application are specified in terms of physical properties like strength, hardness, weight etc., the system chooses a set of suitable material from a database. They are then evaluated by heuristic and quantitative criteria commonly used by an experienced design engineer. The program is built using the expert system shell Nexpert, which supports object-class relationships and forward/ backward chaining etc., and is found to be efficient. The present version deals with alloys. The system, when fully developed, would have the potential of coding considerable detailed information and understanding in the field of material selection for applications in development of contemporary large engineering systems.