Electronic Transactions on Numerical Analysis.
Volume 15, pp. 106-121, 2003.

ISSN 1068-9613.

ETNA
Kent State University
etna@mcs.kent.edu

ADVANCING ANALYSIS CAPABILITIES IN ANSYS THROUGH SOLVER TECHNOLOGY*

GENE POOLE , YONG-CHENG LIU†, AND JAN MANDEL‡

Abstract. This paper describes substantial improvements in analysis capabilities in a large scale commercial finite element program made possible by the implementation of solver technology. The ANSYS program is a commercial finite element analysis program, which has been in use for thirty years. The original code, developed around a direct frontal solver has been expanded over the years to include full featured pre- and post- processing capabilities, which support a comprehensive list of analysis capabilities including linear static analysis, multiple nonlinear analyses, modal analysis and many other analysis types. The finite element models on which these analyses are used have continued to grow in size and complexity. This growth in size and complexity has been both enabled by and dependent on new solver technology along with increased computer memory and CPU resources. Beginning in 1994, ANSYS added a Jacobi preconditioned conjugate gradient solver (JCG) and subsequently an Incomplete Cholesky Preconditioned Conjugate Gradient solver (ICCG) to improve thermal analysis capabilities. In recent years the addition of the Boeing sparse matrix library for modal and static analysis, and a proprietary preconditioned conjugate gradient solver as well as additional iterative solvers, to support new CFD capabilities have greatly increased the number of solver options available in ANSYS. Most recently, in version 5.7, ANSYS has added a new domain decomposition solver for solving very large structural analysis solutions on distributed MPI-based computer systems and the newest iterative solver option, an algebraic multi-grid iterative solver (AMG).

This paper will describe implementation considerations for the addition of new solver technology to a large legacy code, compare resource requirements for the various solver choices and present some comparative results from several customer generated problems. The AMG solver benefits, both in improved robustness and parallel processing efficiency, will be described. The paper will also discuss some of the implementation challenges that have been overcome to add new solver technology to a large existing code. The role of solver technology in meeting current and future demands of large scale commercial analysis codes will be discussed.

Key words. Finite elements, elasticity, iterative solvers, algebraic multigrid

AMS subject classifications. 65N55, 65F10, 65N30, 65N22

* Received May 22, 2001. Accepted for publication October 20, 2001. Recommended by John Ruge.
† ANSYS, Inc., 275 Technology Drive, Canonsburg, PA 15317
‡Department of Mathematics, University of Colorado at Denver, Denver CO 80217-3364.