ond. Suffice to say, the algorithms in LINPACK are very stable. The computational results are accurate to within the precision of the machine itself.

LINPACK, like EISPACK, goes to great lengths to minimize computer resources required to solve a specific problem. Routines for the various tasks are provided in versions corresponding to the most common ways that the user's problem might be formulated. In technical terms, LINPACK contains subroutines corresponding to the form of the input coefficient matrix: symmetric, triangular, banded, positive, and so forth. Users can take advantage of the increased efficiency provided by these different routines and not just use the form provided for general matrices.

More than 1,400 copies of EISPACK and 500 copies of LINPACK have been distributed to computer centers worldwide. Because a major computer center may have hundreds or thousands of users of these packages, the distribution numbers tell only a small part of the story. Indeed, it is rare to find a program that requires eigensystem or linear system calculations that does not use some variant of EISPACK or LINPACK, or a scientific computer user who does not know of them.

But probably the greatest long-term scientific and commercial benefit of both projects is the way in which they have influenced how we think about sub-programs for basic computations. The scientific debates in the 1960's about whether or not reliable canned programs could be produced have been settled: we now build and use them exclusively, greatly increasing the reliability and efficiency of scientific computing.

AUTOMATED REASONING PROGRAMS:
Enabling a Computer to Think Deductively

Computers have become an integral part of modern life. In the home and in the workplace; in hospitals, supermarkets, and schools; computers provide man with valuable assistance in performing many complicated and mundane tasks involving numerical calculations and the processing of information.

Until fairly recently, however, computers have not been able to *reason* or to think *deductively* about a problem situation. *Reasoning* is an activity that requires one to approach a set of facts regarding a problem in a certain way and to draw conclusions that logically follow from those facts until a solution to the problem is found. Human beings reason continually as part of everyday life, often without realizing it. Imagine how valuable it would be to humans if computers—with their speed, accuracy, and ability to handle large quantities of complex information—could be used to assist in solving problems by reasoning.

One could envision a computer program that could schedule a day's activities at home and at work so as to avoid conflicts, analyze the consequences of proposed decisions, prioritize tasks to be completed, and help find misfiled or misplaced information.

Although such applications sound futuristic, research supported by the Department of Energy's Office of Basic Energy Sciences is yielding results that represent progress toward making such a scenario possible. Researchers at the Argonne National Laboratory near Chicago, Illinois, have developed the theory, methodology, and computer programs that have made it possible to harness, for the first time, the power of computers to perform difficult and important tasks that require deductive reasoning. Using these computer programs—known as automated reasoning programs—researchers have obtained proofs for difficult mathematical problems that have eluded experts for years, designed electronic circuits for computers, and verified that other computer programs will achieve their stated purposes. These valuable research tools are now in the hands of mathematicians, computer scientists, and logicians in more than 100 universities, research institutes, and industries throughout the world.

Virtually all fields of science and engineering can benefit by applying automated reasoning to the design of better systems and the control of those systems. Eventually, all applications that involve computer programming will benefit as well. Particularly, as computer programs are used to perform more and more complex and critical procedures, it becomes increasingly important to develop formal methods for determining the reliability of those programs. Automated reasoning offers a means of doing so.

Automated reasoning is a branch of computer science that studies how the computer can be used to assist in that part of problem solving requiring reasoning. Reasoning in this sense refers to the process of drawing conclusions rigorously and logically, as opposed to probabilistic or common-sense