

## Error-free Software

In the 1960s, during the development phase of NASA's Apollo lunar landing program, Johnson Space Center awarded a contract to The Charles Stark Draper Laboratory, Inc., Cambridge, Massachusetts—then affiliated with Massachusetts Institute of Technology—for onboard guidance, navigation and control of the Apollo spacecraft. Two women played important roles in that highly successful effort: mathematician Margaret H. Hamilton, who directed development of Apollo onboard computer software,



and physicist Saydean Zeldin, section head for the guidance portion of that development. Their Apollo experience included extensive analysis of computer errors, which led to their later formulation of a mathematical theory for development of "higher order" software designed to catch computer mistakes early. In 1976, they formed Higher Order Software, Inc. (HOS) in Cambridge to develop and market an engineering tool that corrects computer errors at the entry level, a system termed by experts a major advance in computer technology. Hamilton (left in the above photo) and Zeldin are pictured with executives of HOS.

Hamilton and Zeldin began their error investigations after the first lunar landing in 1969. Over a period of years, they studied mistakes and how they might have

been prevented, which resulted in an organized system of error analysis and correction. They sought to define a system free of ambiguities or "interface errors," meaning software that is logically incomplete, redundant or inconsistent. After leaving Draper to form HOS, they devoted five years to a program of research and development. From the NASA analysis of error classification and correction came the mathematical theory for a way to design software so that it is logically error-free. HOS developed a software engineering tool that was first tested in a 1981 Department of Defense project; it was found to increase productivity by 600 percent and to reduce costs by 83 percent on that project. In 1983, HOS began marketing an error correction computer program called USE.IT.

USE.IT employs the computer to automate the systems development process, eliminating human logic and implementation errors; first it assists the systems designer in defining objectives, then it automatically produces an error-free program code that eliminates data entry mistakes—thereby generating considerable savings in time and money. A major advantage of the system is its language—called AXES—which resembles normal language so that a user can write functions in English and the system will convert the code to conventional computer languages. Because debugging and code generation are automatic, a person with no programming experience could write software with USE.IT.

USE.IT has found wide acceptance in a short time. HOS clients include many of the nation's largest companies, who employ it in such applications as manufacturing, banking and insurance. The software tool is mounted on Digital Equipment Corporation's VAX computers and HOS is now designing a system for mainframe computers, a broader market. Last year, the NASA-originated software came full cycle when The Singer Company's Link Division became a USE.IT client; Link designs and builds flight simulation equipment for Space Shuttle crew training.

