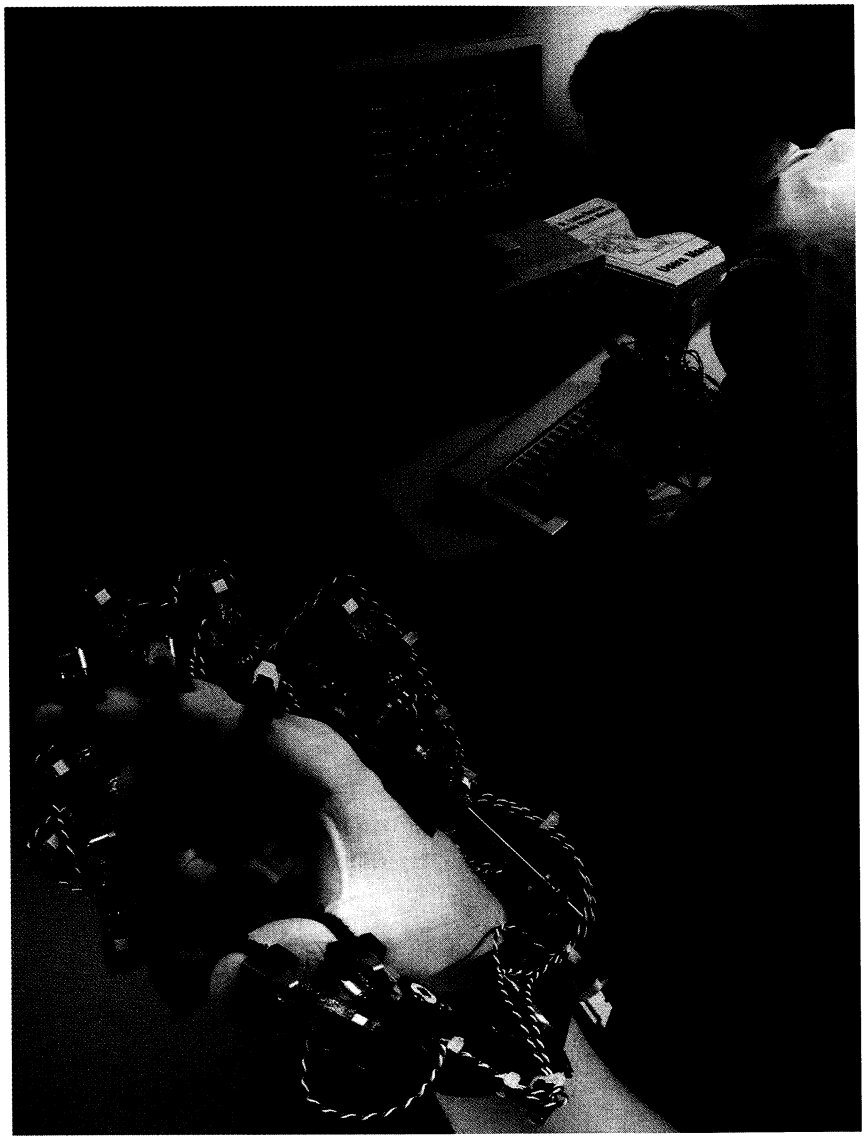
## Small Business Innovations

A highly productive source of aerospace spinoff applications is the Small Business Innovation Research (SBIR) program, established by the Congress in 1982. In its first decade, it proved eminently successful in accomplishing both of its principal objectives: increasing small business participation in high technology research and development activities, and stimulating conversion of government funded R&D into commercial applications.

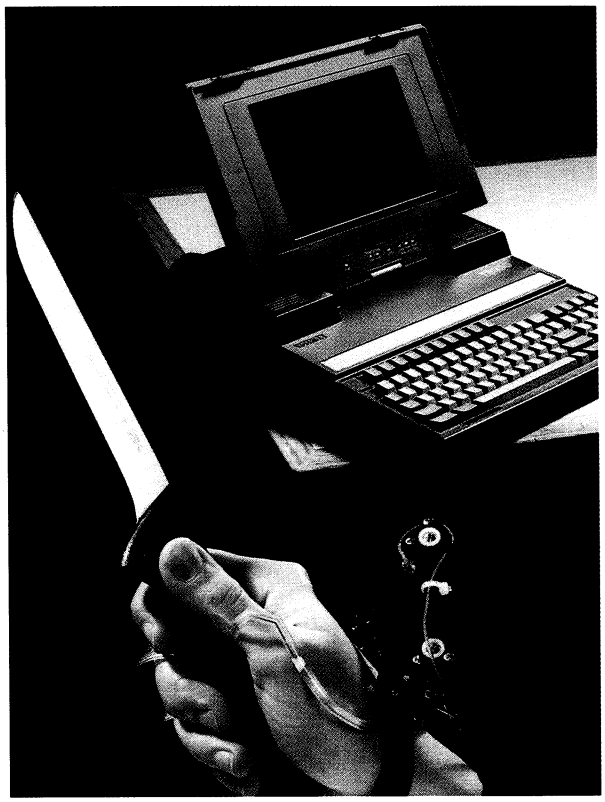


NASA and 10 other technology generating government agencies each set aside a percentage of their R&D budgets for SBIR projects, and each agency administers its own program independently under Small Business Administration guidelines.

In NASA's SBIR program, the agency has worked with more than 800 small businesses, who have developed hundreds of new systems and components that advanced NASA's capability for aerospace research and operations. NASA evaluates proposals from small firms from the standpoint of potential usefulness to NASA and the potential for commercial spinoff. The best concepts are awarded six-month contracts under which the company determines the technical feasibility of the innovation it has proposed. The results of Phase I research may lead to follow-on Phase II contracts that can run as long as two years. In Phase III, the small business participant may apply the results of Phase I/II research to development of a product or process for the commercial market, using private capital to do so.

Shown **at left** is an example of a successful NASA SBIR program, the Dexterous Hand Master™(DHM). The DHM is produced by EXOS, Inc., Lexington, Massachusetts, a company formed to manufacture and market products using robotic sensing technologies originally developed under NASA contract by Arthur D. Little's Center for Product Development, Cambridge, Massachusetts.

A 1989 winner of an R&D 100 Award, the DHM is an exoskeleton device for measuring the joints of the human hand with extreme precision. It was developed for NASA's use in controlling robots. In 1990, Exos introduced a commercial version, DHM Series II.



The DHM II is worn on the hand, connected to a computer that records hand motions and transmits that data as control signals to robots and other computers. It is used in such applications as enabling robotic hands to emulate human hand actions through remote operation; controlling and manipulating computer generated images in virtual reality environments; and controlling musical performances by shaping acoustical parameters in real time, on stage, in concert with musicians.

The spinoff DHM inspired two additional spinoffs. In 1990, EXOS introduced to the commercial market the GripMaster™, intended for use in tool design, design of other hand-held objects or design of factory workstations. The GripMaster combines the joint angle sensing technology of the DHM with pressure sensing technology to give measurement of grip strength and wrist position. The primary benefit is reduction of CTD (cumulative trauma disorders) caused by repetitive motions in the work place, a major occupational health risk.

In 1991, EXOS introduced a third product, the Clinical Hand Master System™ (**left**), a product designed for use by hand surgeons, orthopaedic surgeons, physical therapists and occupational therapists.

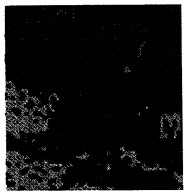
Another example is QASE® RT, a systems engineering tool for quantitatively evaluating a computer system design — hardware, software and data. Developed by Advanced System Technologies, Inc. (AST), Englewood, Colorado, the commercial QASE RT resulted from two different SBIR projects, one sponsored by the U.S. Navy, the other by Jet Propulsion Laboratory.

The purpose of QASE RT is to enable system analysts and software engineers to evaluate the performance and reliability implications of design alternatives. QASE RT evaluates system timing, capacity and availability. The user describes his system architecture and workload using direct manipulation graphics. QASE RT translates the system description into analytic and discrete event simulation models and executes them.

Analytics rapidly evaluate the feasibility of a wide range of system configuration alternatives. Simulation provides detailed performance evaluation. The results of the evaluations are service and response times, offered load and device utilizations, and functional availability.

AST, a computer performance engineering firm founded in 1984 as a research and development company, has been engaged in 16 SBIR contracts for various agencies. QASE RT, introduced in 1991, was the company's first commercial product line. (Continued)

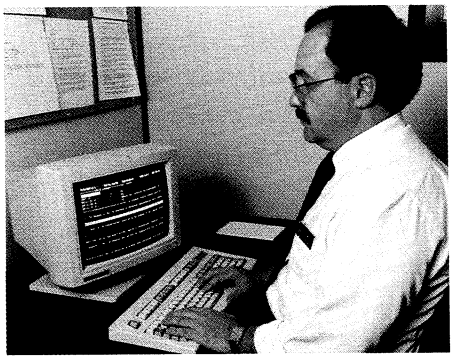
## Small Business Innovations (Continued)

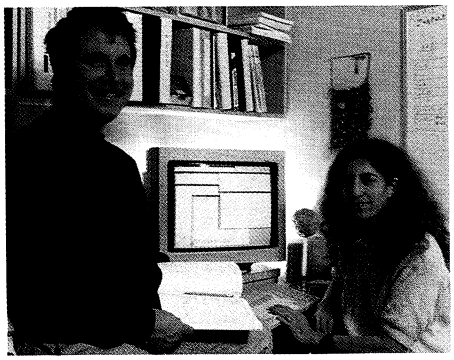


Since 1983, when NASA initiated its SBIR program, the agency has sponsored some 1,500 Phase I projects and more than 40 percent of them have progressed through Phase II. Roughly a third of the latter have generated spinoff commercial applications.

Among additional examples of spinoff developments that emerged from the NASA SBIR program is Document Director™, a software system of innovative powerful tools for automating the requirements process in large programs.

Document Director was developed for NASA by Bruce G. Jackson & Associates, Inc. (BGJ&A), Houston, Texas, a consulting firm serving NASA and NASA contractors in requirements development, analysis, management and control. In 1986, BGJ&A started development of an automated tool that combined word processing and database management technologies. The resulting successful development became Document Director, a family of software packages intended to improve the quality of requirements/specifications and provide effective control throughout the life cycle of the program. Its key advantage is the integration of word processor and database manager, which offers the flexibility and convenience of text processing capability together with the linking capability of database management.





Since problems associated with requirements induce program cost overruns and schedule delays, Document Director also offers potential for improved control of costs and schedules. Document Director says BGJ&A, "provides a means to collect and manage all information associated with requirements development and to access the information in the manner that best supports the user."

Document Director was used by NASA in its program to design the Assured Crew Return Vehicle intended to return astronauts from the Space Station in an emergency; significant time savings were realized during the planning process. The first version of Document Director was released in 1988 and since then there have been three major upgrades. The software system is used by several government and industry organizations in addition to NASA. **At left**, Randolph W. Folck, quality assurance engineer at Southwest Research Institute (SwRI), San Antonio, Texas is pictured working with Document Director; SwRI uses the system regularly in managing research projects for the electric power industry and other clients.

Another outgrowth of the NASA SBIR program is a software package to facilitate development of interfaces between resident and host data base management systems. The software package was developed for Goddard Space Flight Center by Ken Wanderman & Associates, Inc., (KWAI), Staten Island, New York; Ken Wanderman and associate Dr. Marsha Moroh, vice president and head of software research development, are pictured at **bottom left**. This was one of several SBIR projects associated with a Goddard-developed system known as DAVID (*Distributed Access View Integrated Database*).

DAVID was developed as a solution to a problem associated with the diversity of NASA information systems. There are many database formats; there are a variety of com-


mercial and in-house database management systems supporting a number of databases; and there are large quantities of data stored in sequential files, data that can only be accessed by specially written programs. This situation led to difficulties for scientists trying to access information stored in a different format from their own. DAVID was developed to act, in part, as a central database management system.

The contribution of KWAI involved development of software tools that facilitate uniform access to databases, either commercial database management systems or arbitrary file formats. The KWAI software is divided into two parts: a number of interfaces, or bridges, between DAVID and commercial database management systems; and artificial intelligence programs that interact with a human data engineer to solicit information and automatically generate DAVID interfaces to their data. The software has been installed at a number of data centers, including the National Space Science Data Center.

Software innovations developed under Ames Research Center's SBIR program include two helicopter codes developed by Continuum Dynamics, Inc. (CDI), Princeton, New Jersey.

One is EHPIC (*Evaluation of Hover Performance Using Influence Coefficients*), a program used in helicopter design to predict the engine power required for a helicopter to hover. Such prediction is important, but difficult. The primary complication is calculating the effect of the wake of disturbed air trailed by a rotor blade on its neighboring blade (**left**). The EHPIC free wake model produces converged, freely distorted wake geometries that generate very accurate analysis of wake-induced downwash; this, in turn, allows good predictions of rotor thrust and power requirements. CDI has licensed the EHPIC code to three of the four major U.S. rotorcraft manufacturers.

A second CDI product is RotorCRAFT, a program for analysis of aerodynamic loading of helicopter blades in forward flight, a major concern in helicopter design. In particular, an accurate model of unsteady aerodynamic loading is required to understand and alleviate the sources of vibration in helicopters. Using some of the wake modeling tools developed for EHPIC, CDI developed the RotorCRAFT code, which has demonstrated good correlation of measured rotor airloads, an important part of vibration prediction. The code has been licensed to Sikorsky Aircraft Division of United Technologies. •

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