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**TECHNOLOGY**

# INNOVATION



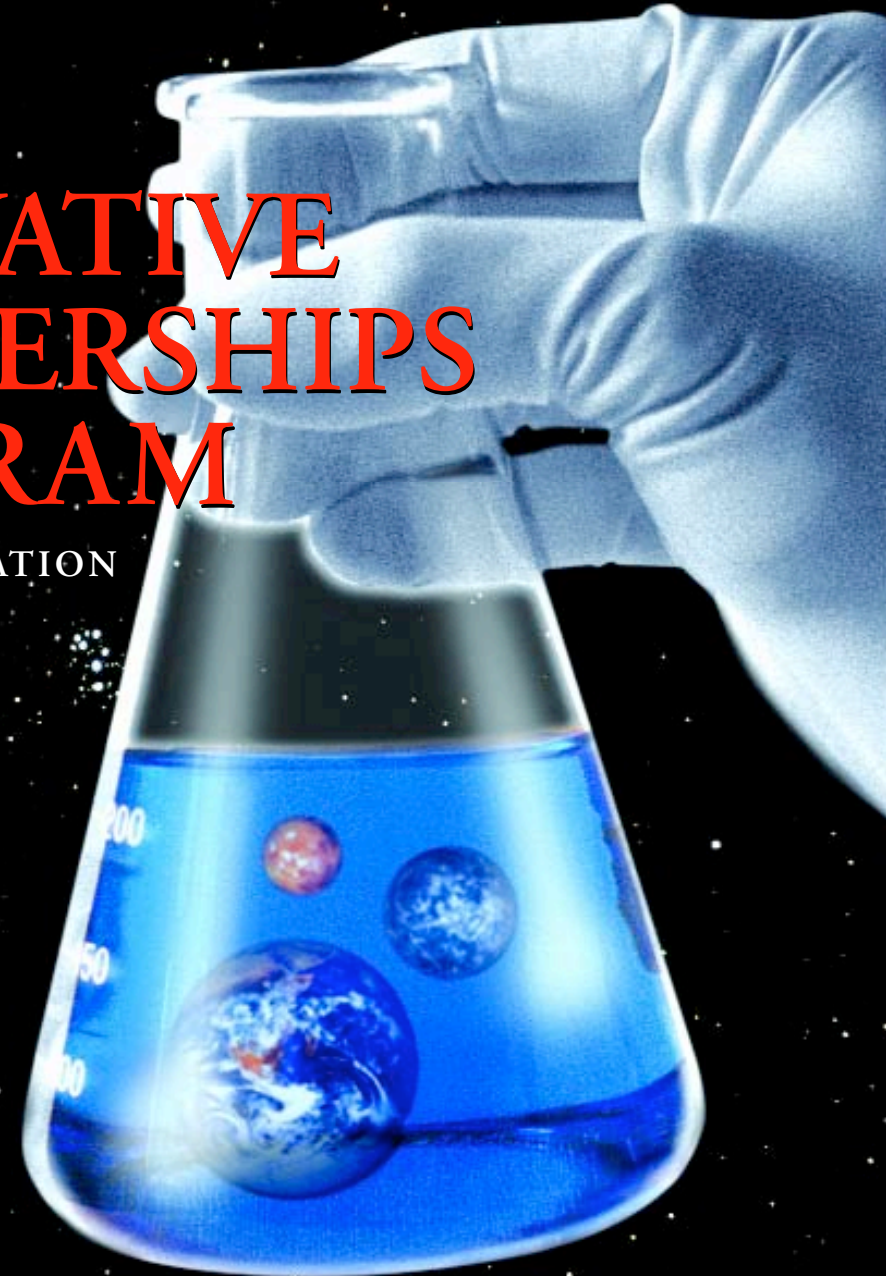
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION'S MAGAZINE FOR BUSINESS & TECHNOLOGY

FROM THE LABORATORY TO THE UNIVERSE:

THE ROLE OF THE

## INNOVATIVE PARTNERSHIPS PROGRAM

IN SPACE EXPLORATION



**PLUS**

Software Links  
Pediatricians  
With New Research

Innovative Technologies  
Earn R&D 100 Awards

# Innovative Research

## EXAMPLES OF HOW NASA IS WORKING WITH SMALL BUSINESSES

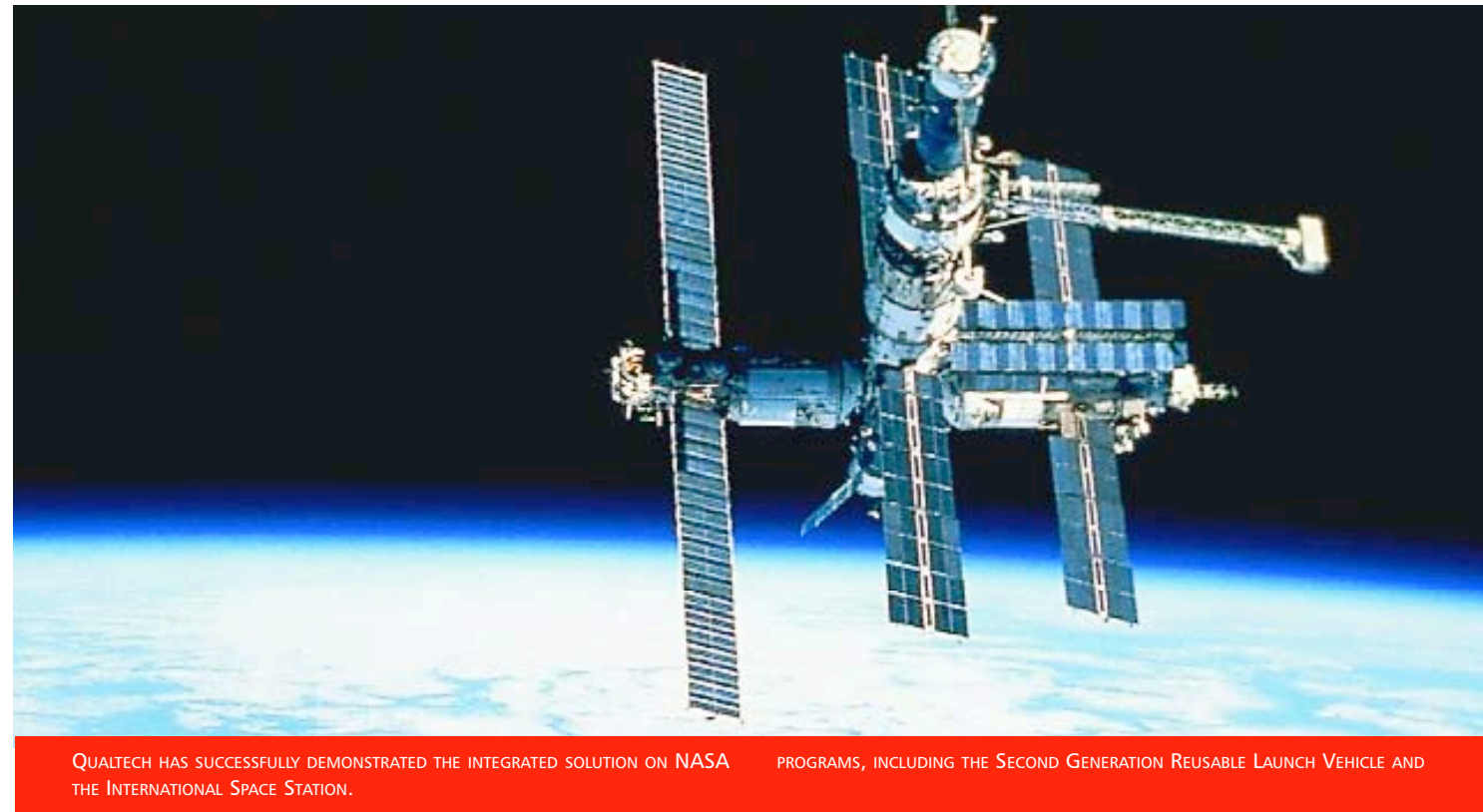
### SBIR Contracts Lead to Innovative Diagnostic Applications

In 1994, armed with the first generation of remote diagnostic and maintenance software for which it would soon become known as an industry leader, Qualtech Systems Inc. (QSI), of Wethersfield, Conn., began collaborating with scientists at the NASA Ames Research Center on the first of a series of Small Business Innovative Research (SBIR) contracts. Over the next seven years, that research would produce the innovative tools for which QSI would be awarded the 2002 NASA Space Act Award.

What Qualtech created to earn the prestigious award – for significant scientific and technical contributions to NASA’s aeronautical, commercialization and space goals – was a software toolset for designing and developing diagnostic applications such as those required in Integrated Vehicle Health Management (IVHM) systems.

“Integrated vehicle health management systems (IVHM) are an especially important aspect of advanced space missions,” says Dr. Ann Patterson-Hine, leader of the Research in Intelligent Vehicle Automation Group at NASA’s Ames Research Center, who has worked with Qualtech throughout most of the company’s 11-year relationship with NASA. “An effective IVHM tool suite, like the one Qualtech created, makes it possible for you to manage all stages of development, from design through implementation.”

Not only did Qualtech produce a package of design and diagnostic software tools that solved a range of problems for NASA over the course of the past decade, but the tools developed for NASA have formed the foundation of Qualtech’s growing commercial business, as well.



QUALTECH HAS SUCCESSFULLY DEMONSTRATED THE INTEGRATED SOLUTION ON NASA PROGRAMS, INCLUDING THE SECOND GENERATION REUSABLE LAUNCH VEHICLE AND THE INTERNATIONAL SPACE STATION.

Supporting systems engineering, systems design and testability, automated diagnostics and troubleshooting, and system autonomy, the tools QSI developed for NASA during the 1990s are:

- TEAMS® (Testability Engineering And Maintenance System), a tool used in static design/analysis phases of complex systems.
- TEAMS-RT®, a real-time diagnostic engine that provides diagnostic functionality for integrated vehicle health systems on-board a flight vehicle or embedded into a run-time architecture.
- RDS® (Remote Diagnosis Server), an application that can support multiple simultaneous diagnostic sessions from a variety of remote systems.

Working directly with NASA or in partnership with larger companies, Qualtech has successfully demonstrated the inte-

grated solution on NASA programs, including the Second Generation Reusable Launch Vehicle and the International Space Station. The technology and products are now mature, having been flight tested at NASA and on military programs – and deployed in every-day commercial field maintenance operations. Qualtech sees NASA’s new Exploration Program as an opportunity to leverage this technology and the investment that has been made in the TEAMS® tool set.

TEAMS®, the first of the tools QSI produced for NASA, allows system designers to assess performance, facilitating ease of maintenance and diagnostic performance simultaneously during the design phase. Its novel modeling approach, multi-signal flow graphs, provides a simple, efficient modeling representation which can capture a system’s structural and functional relationships. That information is essential to performing diagnostics in the later phases of system development and deployment.

The initial version of TEAMS-RT®, the real-time diagnostic tool, was developed under a contract in support of Ames’ IVHM technology development program for the X-33 vehicle program. TEAMS-RT® was enhanced under two follow-on contracts. Additional capabilities were developed to implement: real-time monitoring and diagnosis in the presence of imperfect tests and temporary failures; ranking and selection of available tests to enable quick and accurate fault isolation; real-time, on-board diagnosis using existing computing resources; and real-time, on-board monitoring and diagnosis under actual flight conditions.

The capability of monitoring software components of highly automated systems was developed under two more NASA R&D contracts. Complex functionality, added to the software, helped to reduce costs and improve reliability in aerospace systems, automobiles and in many safety critical systems. Consequently, any health monitoring solution must consider failures in both hardware and software aspects. A system for automating the monitoring, diagnosis, and troubleshooting of the Unitary Wind Tunnel control systems was developed using TEAMS-RT®.

“This research has been very exciting,” says Dr. Patterson-Hine. “Even today, trying to troubleshoot both hardware and control software simultaneously is very challenging. Not only has QSI demonstrated engineering excellence in addressing NASA’s challenges, but the company has also shown a willingness to listen, carefully, to the needs of their customers and work to really solve their unique problems.”

Further enhancements of TEAMS-RT® resulted in the Remote Diagnosis Server. A distributed diagnostic solution, the Remote Diagnosis Server features ultra-compact memory requirements that enable tele-diagnosis of legacy systems that were not originally designed for real-time, on-board diagnosis. It also offers diagnostic capability for highly connected, network enabled systems.

And that refinement, in turn, led QSI directly to the devel-

**INNOVATIVE RESEARCH**

opment of TEAMATE, an advanced diagnostic and health management solution that was deployed, last year, to commercial users, including field service engineers (FSEs) of Orbotech Ltd. Orbotech, based in Israel, is a world leader in providing yield-enhancing, production support solutions for specialized applications in the supply chain of the electronics industry, principally for printed circuit boards (PCBs) and flat panel displays (FPDs).

“After an extensive evaluation process, we selected TEAMATE from our short list because of its intuitive knowledge engineering capabilities and its diagnostic accuracy- two critical elements required for maintaining sophisticated inspection systems,” says Oz Desheh, Corporate Director for Customer Support at Orbotech.

Qualtech could not have asked for a better customer to showcase its remote diagnostic capabilities. “Considering the fact that our installed base is spread over three continents, several different languages and time zones, achieving consistent service performance across the entire field force is a challenging objective,” says Shimshon Sayag, Orbotech’s Corporate VP for Operations and Customer Support. “We expect that TEAMATE will help us achieve this objective.”

A direct descendent of the suite of TEAMS® products developed through the NASA research, TEAMATE enables Orbotech to rapidly deliver pinpoint diagnostic and maintenance solutions to FSEs worldwide.

Faced with an equipment problem, Orbotech FSEs simply enter the initial machine failure symptom(s) or error codes into TEAMATE, which then quickly guides them, step-by-step, through the troubleshooting process, suggesting additional symptoms to look for, which tests to perform, what repair action(s) to take, and, finally, what repair verification steps are needed. Unlike many diagnostic software tools that present FSEs with a range of possible solutions, TEAMATE isolates the root cause for specific faults and swiftly guides FSEs through a single, ideal corrective action.

The TEAMATE solution is based on two components. The first is a graphical modeling tool used by Orbotech engineers to compile their knowledge, experience and expertise into well-structured knowledge bases. The second is a universal diagnostic engine that accesses these knowledge bases and provides optimized troubleshooting guidance on a FSE laptop computer.

“When equipment fails, the challenge is to get it back on line as

quickly as possible. This is particularly critical in today’s manufacturing industry where downtime is incredibly expensive,” says Kevin Cavanaugh, COO of Qualtech Systems. “Given the complexity of Orbotech equipment, mean time-to-repair (MTTR) really hinges upon the skills, experience and knowledge of individual field service engineers. TEAMATE offers a truly revolutionary concept in this regard, because it enables any field service organization to elevate its field service and help desk engineers to an expert level.” ■

*For more information, please visit the SBIR/STTR Web site at <http://sbir.gsfc.nasa.gov/SBIR/SBIR.html>.*

*Please mention that you read about it in Technology Innovation.*