

## Engineering, Operations and Mission Support for NASA

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### CLIENT

The National Aeronautics and Space Administration (NASA), an agency of the U.S. government, pioneers the future in space exploration, scientific discovery and aeronautics research.

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### CUSTOMER NEED

Since the inception of its manned space flight program, NASA has placed tremendous emphasis on the training of its astronauts and ground support personnel. Years of training are required before any astronaut or ground support person is ready to participate in his or her first space mission. The development of these very extensive training programs, and the preparation and maintenance of the facilities in which the training programs occur, is a major objective for NASA.

Two of the largest training facilities are located near the Johnson Space Center (JSC) in Houston, Texas:

- The **Neutral Buoyancy Laboratory** (NBL) is where most of the training for Extra-Vehicular Activities (EVA)—those taking place *outside* the spacecraft—is conducted. In addition, testing and evaluation of EVA hardware and mission timelines are supported here.
- The **Space Vehicle Mockup Facility** (SVMF) is where much of the training for Intra-Vehicular Activities (IVA)—those occurring *inside* the spacecraft—takes place. In addition, testing and evaluation of space vehicle hardware and procedures are supported here.

NASA needed a contractor to manage each facility, as well as engineer, build and maintain the necessary equipment (trainers and mock-ups), and provide ongoing operations and mission support for the training programs housed within its walls. In addition, NASA requested assistance in the creation and development of the actual training regimen and the rehearsal exercises that its instructors would utilize with all of the astronaut candidates and flight controllers.

As web technologies have matured and become more capable, NASA also expressed interest in exploring ways in which these technologies could be utilized in its flight control training programs. NASA wanted a contractor to conduct a thorough and broad Training Needs Analysis of its overall training program and to consider how web technologies could be effectively employed to support many of the program's aspects.

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### HOW WE HELPED

Under the current NBL/SVMF Operations Contract (NSOC), Raytheon manages both the NBL and SVMF facilities for NASA, and provides the required engineering support for all of the equipment and mock-ups at each facility. At the NBL, Raytheon manages a 202' X 102' X 40' pool in which NASA instructors can model, simulate and test all of the details involved in an EVA mission. The NBL contains full-size mock-ups of both the Shuttle and the International Space Station (ISS) that are used in the various exercises and simulations, including those requiring critical lifting and rigging activities. At the SVMF, Raytheon also assembled high-fidelity, full-size training mock-ups of the Shuttle and ISS for modeling, simulating and testing all types of intra-vehicular activities, including critical emergency escape and rescue training.

Under a previous Training Systems Contract, Raytheon engineers developed a complete Space Station Mission Training Environment and communications architecture in which NASA can simulate Shuttle and ISS activities across the entire planet and integrate with control centers and trainers everywhere. When

developing the Space Station Training Facility (SSTF), Raytheon software engineers created more than 2.7 million lines of code, and integrated more than 5 million lines of code from external sources, including more than 1 million lines of Russian code for the ISS. Raytheon also built 47 complete flight computer emulators and maintained a minimum of 25 instructor/operator positions in the training facility at all times.

At both the NBL and SVMF, Raytheon continues to deliver ongoing 24/7 operations support services, including managing all aspects of the facilities, providing logistics and maintenance capabilities, and ensuring that all of the modeling, simulation, training and test activities are conducted successfully. As the astronaut training program requirements have evolved over time, Raytheon has also provided extensive design and systems engineering support for the development and modification of new vehicular mock-ups and other equipment that can facilitate the latest training activities.

As a trusted partner of NASA, Raytheon is currently providing detailed training needs analyses and ongoing support for the creation and testing of new training capabilities to enhance flight controller students' and instructors' abilities to operate the latest scientific equipment, experimental devices and operational procedures for current and future missions. In addition, Raytheon is demonstrating to NASA how the latest web-based, computer-based training technologies could be used as part of a blended learning solution to improve student throughput and to help ensure certification success.

Raytheon engineers have also developed a state-of-the-art, web-based Exercise Control System, based on a Services Oriented Architecture, that manages the start-up, shut-down, configuration, commands and other functions to control the many simulation elements that are often widely distributed. This system is being used across the corporation to tie together and control simulation exercises, and it is being considered for future NASA training concepts.

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#### **CUSTOMER RESULTS**

As a result of this partnership, NASA has realized its goal of achieving the capability to model, simulate and test every element of each mission, across the entire program life cycle. Raytheon-delivered simulation capabilities have contributed to NASA's Mission success, and recent contributions through the ongoing Space Station flight controller training program have the potential to increase efficiencies and reduce costs for the program. Over the years, every NASA astronaut, flight controller, instructor and ground station operator has participated in at least one mission training activity supported by Raytheon.

By leveraging deep engineering expertise in multiple disciplines, Raytheon's NASA engineering team was able to design, develop and deploy the groundbreaking International Space Station Flight Computer Simulation program. This enabled NASA to utilize a variety of innovative methods to simulate the entire ISS mission, while staying within stringent budgetary constraints.

Raytheon's commitment to mission success, teamwork and safety in operations mirrors NASA's and has resulted in awards and recognition for excellence. Raytheon employees have received numerous Group Achievement Awards from NASA throughout the Shuttle and Station programs. For almost every Shuttle launch, at least one Raytheon employee has won the prestigious Space Flight Assurance Award for his or her contribution to that mission. The NBL and SVMF facilities have two of the highest safety records throughout all of NASA. This focus on safety has resulted in receipt of the VPP Star of Excellence Award from OSHA for the last three years. Raytheon also received the 2007 Johnson Space Center Contractor Safety Forums Super Nova Award for Safety Excellence, the highest award presented for safety excellence.

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