The National Aeronautics and Space Administration (NASA) has begun a program that will result in a permanently manned, fully operational United States space station by the mid-1990s. The space station is intended to support scientific and commercial endeavors in space, stimulate new technologies, enhance space-based operational capabilities, and, in general, maintain America’s leadership in space during the last decade of this century and into the next century... The station can be used as a base by orbital maneuvering vehicles and orbital transfer vehicles (OMV and OTV). The OMV is a remotely controlled vehicle that can be controlled from several hundred miles away by a crew member on the shuttle or station. The OTV would extend man’s presence far beyond the range of the OMV by being able to travel tens of thousands of miles from the station to geosynchronous orbit and then to the moon, transporting large platforms, or a crew of two to four astronauts, or an OMV.

Automation of the space station is required for more effective use of the crew and to make the station more autonomous. In a recent study [1], SRI International examined automation concepts postulated by four NASA contractors (TRW, Martin Marietta, GE, and Hughes) [2]-[5] to determine the required research and development in artificial intelligence (AI) to attain these concepts. The goals of the SRI study were to (1) provide guidance with respect to the state of the art in AI-based technologies, (2) review the results of the four NASA “concept design” contractors to determine the AI capabilities required by the designs, (3) delineate a series of demonstrations that would indicate the existence of these capabilities, and (4) develop an R&D plan leading to such demonstrations.

DEMONSTRATIONS

The following demonstrations would verify that expert-system capabilities are available for maintenance and repair, controlling manufacturing processes, and subsystem monitoring and control. These demonstrations...
can start with ground operations and demonstrations; they would next proceed to actual spaceflight implementation—first on the shuttle, then on the space station itself.


» Information retrieval from a database that describes the structure and functionality of major systems in formal or semiformal language.

» Information retrieval from a database describing maintenance and operating procedures of major systems in formal or semiformal language, including information as to the purpose of the procedures and their component steps.

» A system capable of fault isolation of a single subsystem, using standard maintenance procedures.

» Same as the preceding, but using distributed expert-system architecture with the aim of improving real-time performance and evolutionary potential.

» A system capable of fault isolation of multiple interacting subsystems, using standard maintenance procedures.

» Same as the preceding, but operating under real-time constraints and allowing for data errors.

» A system for control of a single manufacturing process or a single experiment.

» A spaceborne processor particularly suited to mechanization of expert systems.


» An advanced expert system that can run many major subsystems, maintain and control experiments and manufacturing processes, schedule tasks, and interact with intelligent robots.

» An advanced expert system that can cope with an unanticipated major system failure (like the one that occurred during Apollo 13).

» An expert system that can improve its own maintenance skills—i.e., “learn” from experience.

CONCLUSIONS

In examining space station applications, it is evident that a high return on research investment, in terms of safety and effective utilization of ground and spacecraft crew, is to be found in automation of the operation, maintenance, and control of space station subsystems and manufacturing processes. The crucial characteristic of these applications is that the domain is dynamic—i.e., it involves reasoning about the effects of sequences of actions and tests that can change the state of the world over time. Moreover, because various subsystems will be operating simultaneously, it is important that the representation be sufficiently rich to enable reasoning about concurrency and subsystem interaction and that efficient procedures for automatic scheduling and synchronization be developed.

REFERENCES


[Contributor’s note: Construction of the International Space Station began in Earth orbit in 1998.]

Upper and Lower

In silence and in ways covered from the eyes of other men, he struggled, grew, learned, in the years just after he came home from Congress and Washington. The boy who had lain awake nights and wrestled to unravel the big words “in-de-pend-ence” and “pre-des-ti-na-tion” had become a grown man who wrestled to unravel the ways of putting simple words together so that many could understand the ideas and feelings he wanted them to understand. He said, “I am never easy when I am handling a thought, till I have bounded it north, bounded it south, bounded it east, and bounded it west.”