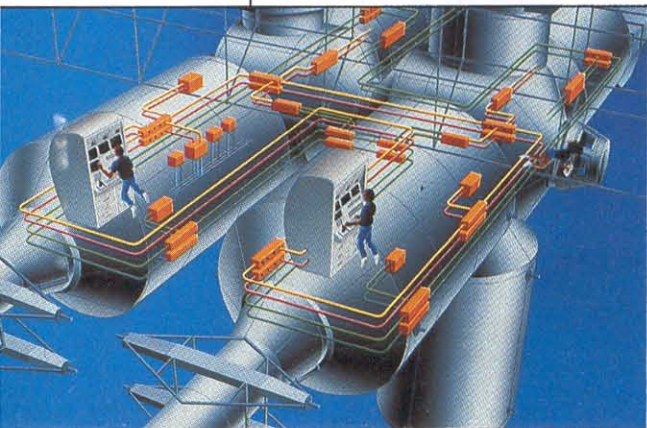


# DATA, DATA, EVERYWHERE

The trials and tribulations of designing a user-friendly space station

By John R. Williams

**W**andering through a mockup of Space Station Freedom offers visitors two views of life in space. The first is the cramped quarters, with readily available views of Earth below. The second is rows and rows of computer terminals, sensors and other hardware necessary for life in space.



IBM

Computers will play a key role in the daily operations of the space station. Because science is the primary mission, NASA is designing a computer system to manipulate millions of megabytes of data gathered from up to 30,000 sensors aboard Freedom.

Not only does the computer have to be reliable, it also has to be lightweight, easy to maintain and easy to use. NASA decided early in space station planning to use available off-the-shelf hardware and software. The Data Management System, or DMS, being developed by Houston-based IBM Federal Systems Company in cooperation with McDonnell Douglas, will monitor life onboard Freedom.

"NASA was far-sighted in pushing the use of off-the-shelf components to contractors," says John D'Ambrose, manager of Space Station Development Engineering. "We looked at the space shuttle and the maintenance costs of custom

hardware and software. We always envisioned low maintenance and low life cycle costs. So we all agreed that we would try to fuse technology—capturing pieces of hardware and software developments—and make them part of the whole."

To make the computers user-friendly, engineers considered many types of interfaces. Many of the computer tools that we take for granted on Earth just aren't feasible in the weightless environment of low-Earth orbit. "Any space-based interface is going to present a challenge to the astronauts," D'Ambrose says. "If a crew member weren't strapped in—using a harness, Velcro straps, or a foot anchor—just something simple like clicking in a keyboard would send him floating away. That wouldn't contribute to a good typing style." Even a mouse would float and be difficult to control, so engineers chose trackballs. Astronauts will use joysticks for precision control systems such as the space station's robot arm.

At first, engineers considered voice recognition interfaces, but, according to D'Ambrose, the idea was quickly dropped. "The technology just isn't there yet, although it may be soon," he says. "Right now it takes up too much space and computing power." The weightless environment also rules out touch-sensitive screens. With the possibility of objects floating around, something could accidentally activate a screen.

Other factors had to be considered in the design of the zero-g hardware. Space station computers will be linked by a fiber optic network, as opposed to copper wiring, which, according to IBM spokesperson R. Pierce Reid, is heavier, bulkier, transmits information more slowly and is more prone to radiation effects. Moreover, liquid crystal diode color screens, similar to those found on some laptop computers, were chosen over cathode ray tube video monitors since they are

smaller and consume less power.

Making the system easy for astronauts to use has been a challenge for system engineers. To integrate all the software and hardware into a single system requires over one million lines of code. A graphical user interface, similar to "Windows" software, will allow astronauts simple access to spacecraft systems, but behind the scenes a total of seven subsystems are at work. Six of the systems, including networking, file exchange, user interface and data storage and retrieval, run aboard the space station itself. The seventh system is the root of the multi-layered system and runs from the ground because of its size. The Master Object Data Base Manager (MODBM) acts as a hub where all avionics data feeds in and out for use by ground supporters.

To ready the hardware for spaceflight, computer systems must be tested more rigorously than their Earthbound relatives. IBM shakes and bakes their systems, but computer chips and components must also be designed to withstand radiation. Earth's atmosphere blocks out a host of high-energy particles that can deposit charge in a computer circuit, causing it to "flip." A single change in a binary code, the basic language of computers, could seriously alter a message sent to the computer. So, engineers design the chips in such a way that they can more easily handle this kind of stress, D'Ambrose says.

Scientists on Earth can also expect to benefit from the system. "Commercial software makes links to the ground easier," Reid says. "You could design your experiments and monitor them from your home or office...It's going to be an incredible boon." ■

*Contributing editor John R. Williams wrote about a low-cost lunar mission plan employing the space shuttle in our May/June issue.*