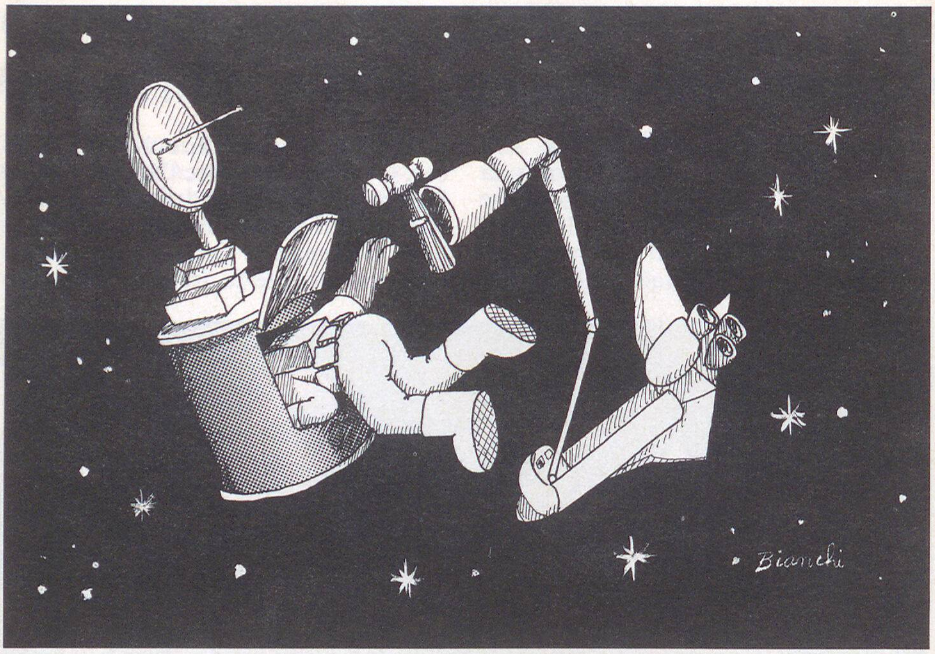


could not support even its own weight on earth, so one of Spar's Canadian suppliers built a test rig for use on a very flat floor. Here, cradled in this special rig which glides on air bearing pads, Canadarm can float over a floor as perfectly flat as modern technology can make it. The arm itself could move its shoulder, elbow, and wrist joints all at once, although only in the plane of the floor.

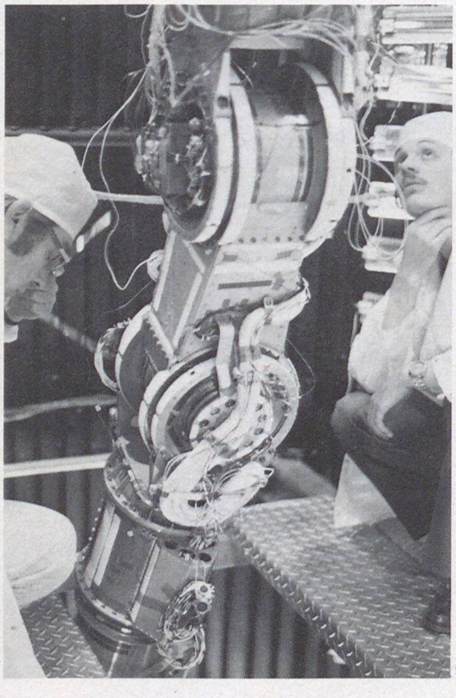
The next time you reach for a cup of coffee, notice how your hand wobbles slightly from your predetermined path, even after repeated practice. Such wobbling is not acceptable in the Shuttle's arm. The orbiter's bay may be the size of a boxcar, with a similar cargo-carrying function, but the cargo could be as delicate as a cabinet full of Dresden china. Also, the cargo-bay doors are not just covers. They also house radiators designed to get rid of the heat generated by *Columbia*'s electrical equipment. These radiators and the cargo bay are crisscrossed with lines carrying high-pressure coolants, electric power, and other services. Inadvertent contact with these vital, fragile components must *not* occur.

But how can a single astronaut, acting through two hand controllers like those which guide *Columbia* from her forward control station, possibly keep track of three huge arm segments moving six ways at once? Again the answer came from the way Canadarm mimics our own bodies. When we reach for that cup of coffee, we do not consciously command our wrist to rotate, our elbow to pitch down, our shoulder to yaw left. Our eyes set a goal, and our brain achieves that goal without troubling our active mind. Similarly, the operator of the arm uses hand controllers in the crew compartment to command Canadarm's end effector to move in a desired direction. Shipboard computers then determine what each part of the complex system should do to fulfil that demand in the safest, most effective way.

The first space arm was officially signed over to NASA in February 1981, at the Spar plant in Toronto where it had been built. Trucked gingerly to Kennedy Space Center by the same driver who had taken the King Tutankhamon exhibit across North America the previous year, Canadarm was integrated into *Columbia* in June 1981. At that time, NASA officials praised Canadarm as an exemplary subsystem: dependable, simple to install, and virtually trouble-free. There were, however, a few tense moments still to come. In August 1981, data analyses from the first mission showed that, fractions of a second after the huge solid-fuel boosters had ignited, an airborne shock wave reflected from the launch complex and "twanged" *Columbia* with a force that, at some frequencies, was many times what had been predicted. NASA immediately began to modify the launch complex, adding massive "water hammocks" underneath the SFB nozzles and increasing the flow rate of the water ducted beneath *Columbia* to dampen liftoff shock. This did, in fact, virtually eliminate the problems at launch.

Canadarm now takes its place as a vital component of NASA's Space Transportation System. With the success of the third launch, the attention of NASA will move away from the Shuttle system itself and on to the deploying of cargo in space. It is, after all, the Shuttle's *raison d'être*. □

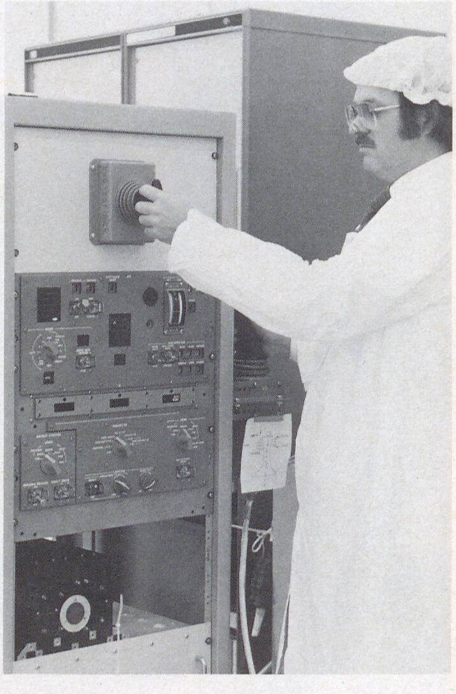
Bill Atkinson



(Spar)

Copper nerves and motorized muscles of the arm's "wrist" being prepared for flexing in a thermal vacuum chamber.

Préparation pour un essai thermique, dans une chambre à vide, des nerfs de cuivre et muscles motorisés du "poignet" du bras.



(Spar)

Hand control systems for CANADARM were developed by CAE in Montreal.

C'est CAE, de Montréal, qui a mis au point les mécanismes de commande de la main du bras spatial canadien.