is currently working on a state-of-the-art computer graphics simulator to be used in the design and testing of the MSS and eventually for training astronauts in its use.

Spin-offs

Although the focus of the MSS program is on robotics for space, the project is also encouraging earth-based spin-offs. Spar has already begun development of industrial manipulators for use in dangerous environments — inside nuclear reactors and mines, under water and on high-power transmission lines. And according to the Canadian Institute for Advanced Research, the space station project "has the potential to be a major — perhaps the major driving force in a number of key technologies for the next quarter century. It . . . will have a particularly strong impact on the field of advanced automation and robotics. The technologies developed for the space station can and will be applied on earth." If Canada develops expertise in new competitive industries, "there would be a very handsome return on the government's investment," the institute added.

In a related development, the National Research Council (NRC) of Canada together with Canadian industry has built the space vision system (SVS). A computerized machine vision system, it will provide astronauts operating the Canadarm with graphic and numerical data on the positions and motions of the arm and the payload it's trying to grab. Canadian astronaut Steve MacLean will test the SVS prototype on the shuttle, and this technology will also be incorporated into the MSS.

Canadians on Board

The MSS project is appealing because it is small enough to manage technically and financially in a modest space program. At the same time, it is an essential and highly visible element of the space station, and one that will further the Canadian reputation for technological excellence.

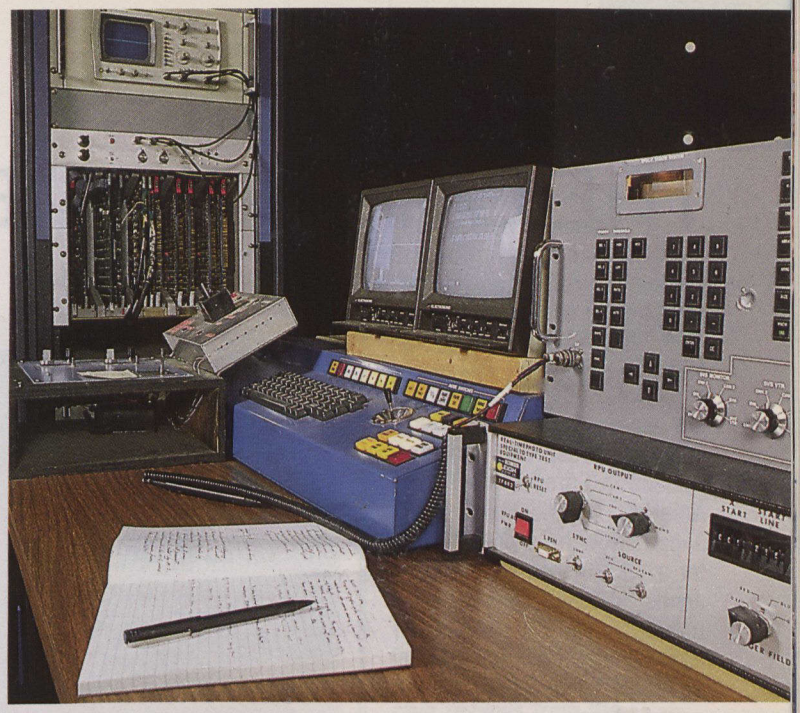
But there's more than prestige involved. The MSS is also Canada's ticket on board the station. Like most countries, Canada can't afford to build its own research labs and space processing factories. Its scientists and astronauts depend on access to facilities built by the other partners.

By providing the MSS, Canada has gained a 3 per cent share in space station facilities and resources. Roy VanKoughnett, head of research operations for the NRC's Space Division, estimates Canada will place someone on board the station for about six months out of every two years. (It's expected that crew tours of duty on the station will be either 90 or 180 days.)

A Canadian astronaut may either go on the shuttle flight that delivers the first elements of the MSS to orbit or accompany some of the later elements after the station has been built. In the latter case, a Canadian might become the first to serve a full tour of duty on the station. "We expect to get one or the other," VanKoughnett said. "Canadian crew will participate in on-orbit verification of the MSS."

Currently, VanKoughnett and the U.S. National Aeronautics and Space Administration (NASA) are discussing a proposal to send two Canadian astronauts to the Johnson Space Center in Houston for training in the techniques of extravehicular activity (EVA), or "spacewalks" outside the spacecraft. In the future, astronauts will use the MSS to repair, service and maintain the outside of the station. EVA training will therefore aid in the design of the MSS. "It's an effort to increase our knowledge and experience and provide a better input into the space station program," said astronaut Marc Garneau.

VanKoughnett added that "eventually we want Canadians doing EVA and taking operational responsibility for the MSS." He said this training will be essential for Canadian astronauts if they are to participate fully in space station activities.



Sophisticated computers control the Canadian-built space vision system.

Preparing for 2001

The future uses of the space station seem unlimited. Some forecasts predict the establishment of a multibillion-dollar space materials processing industry after the turn of the century. Zero gravity enhances the production of ultra-pure drugs, crystals, glasses and ceramics, and new alloys and semiconductor materials. And because these products combine high value with low volume and weight, they will likely be economical to produce in space. To assist Canada's entry into this promising industry of the future, the Canadian government has established a $100-million "user development program" which encourages the design of scientific and commercial projects for the space station.

Preparing for the space station requires access to zero gravity, however, and this has become difficult since the *Challenger* shuttle accident. As an interim measure, the NRC has been renting NASA's zero gravity training plane, the KC-135, which provides researchers with half-minute segments of zero gravity while it flies a roller coaster pattern of climbs and dives. But only so much can be accomplished on the KC-135, and access to the shuttle over the next decade is essential if Canada expects to effectively exploit its share of space station facilities.

Despite such hurdles, as the world approaches the twenty-first century, the once only imagined dreams of the future are rapidly becoming the realities of today.