## An arm for a spacecraft **Design OK**

The design of a complicated manipulator arm which is being built in Canada for use in space has been approved.

Within a few years, the kind of space mission shown will have become commonplace. Satellites will be carried into orbit on board the Space Shuttle Orbiter — the first of this new generation of spacecraft is now being built by NASA, the U.S. space agency and lifted out of the cargo bay by a manipulator: a mechanical arm with the reach of two telephone poles laid end to end, articulated at shoulder, elbow and wrist joints. By controlling the computer-coordinated movements of this arm from within the Orbiter, an astronaut will be able to maneuver cargoes as big as a bus (up to 18.3 m long, 4.6 m in diameter and 29 500 kg in weight). The unprecedented ability to launch, repair, or recover satellites while in orbit will open a whole new era in the use of space.

Under the overall management of NRC, a Toronto and Montreal-based industrial team, led by Spar Aerospace Products Ltd., with Dilworth, Secord, Meagher and Associates, CAE Electronics Ltd. and Spar Technology Ltd., is now designing and constructing this formidable tool. The project is on schedule and a complete manipulator system will be delivered to NASA in July 1979, for flight later that year.

The precisely orchestrated process of designing the manipulator arm reached a milestone recently when all the principals involved in building and using it — engineers and specialists from NASA, Spar, NRC and elsewhere — gathered in Toronto and subjected tens of thousands of pages of documents, drawings and working models to intense examination. During this critical design review their collective approval was obtained for the project to proceed into its final phases: the construction and testing of hardware capable of use in space.

The examiners were broken into 10 teams, each questioning the design from the point of view of a different discipline. Was the arm as light as possible? Do tests and computer simulations confirm that it will work as required? And the most important question — for to survive in space, man is utterly dependent upon his machines — is it reliable and safe?

Eight-hundred-and-eighty-eight questions were formally raised, and though minor discrepancies were found no



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major deficiencies were discovered in the design.

Aaron Cohen of NASA, the man who manages the building of the Orbiter, says: "An incredible amount of bits and pieces are being put together by some of the best people in the world to make this spacecraft. I want to compliment the Canadians on their efforts and good progress."

Canada is contributing the first manipulator system; NASA will buy additional systems for the rest of their Orbiter fleet. The rationale for this multi-million dollar contribution is to support and develop a Canadian industry capable of designing and manufacturing such high-technology tools. Remote manipulators may be used in many environments hostile to man: not only in space — where the use of manipulator-equipped spacecraft to assemble immense solar energy collectors is being considered — but also on earth. For example, a research team jointly backed by Canada and Germany is now studying the feasibility of building unmanned underwater vehicles with manipulator arms capable of, among other tasks, welding pipelines on the ocean floor.

"An Arm in Space", a booklet available from the Public Information Branch, NRC, Ottawa K1A 0R6, describes the Space Shuttle's Remote Manipulator System in more detail.