Fallout from the Shuttle Robot Arm

Painting railway hopper cars can be an expensive and time-consuming job, particularly if you have 11,500 of them, as does Canadian National (CN) Railways. That's why CN went looking for a better way to do it, and found one: the Robotic Paint Application System, now operating at the company's Transcona repair and overhaul facility in Winnipeg, Manitoba.

Developed for CN by Vadeko International Inc., Mississauga,Ontario, the robotic paint shop has two parallel paint booths, allowing simultaneous painting of two hopper cars, which are covered, tanklike carriers of such materials as coal, grain and potash. Each booth has three robots, two that move along wall-mounted rails to spray-paint the exterior, a third that is lowered through a hatch in the railcar's top to paint the interior. A fully computerized system controls the movement of the robots and the painting process.

CN, which prides itself on innovative ways to improve services and rates, was looking for a system that would speed up and lower the cost of painting hopper cars. Vadeko's answer met the approval of CN officials, who call it a "key advancement." The robotic painters can do a car, inside and outside, in four hours; the job formerly took 32 hours. This dramatic reduction in hopper car out-of-service time provides an economically important gain in equipment utilization.

And there are bonuses. The robotic system applies a more thorough coating, particularly to the car interior, that CN expects will double the useful life of its hoppers and improve cost-efficiency. Additionally, human painters no longer have to handle the difficult and somewhat hazardous job; CN paint shop employees have been retrained to operate the computer system that controls the robots and to handle such other jobs as paint selection, inspection and the logistics of moving cars through the robotic facility.

In sum, CN got for its investment in advanced technology a fourfold dividend: productivity gain, cost savings, improved working conditions, and significantly enhanced utilization of much in demand hoppers.

The system that made all this possible traces its technological ancestry to the Space Shuttle Remote Manipulator System (RMS), the robot arm used to deposit payloads in space or retrieve them from orbit. A robotic counterpart of the human arm, the RMS—or Canadarm as it is known in Canada where it was developed—has shoulder, elbow and wrist joints, plus a series of electric motors that serve as "muscles." Its "hand" is a cylindrical grappling fixture, which grasps a metal prong on the payload to be maneuvered. The Canadarm is controlled by an operator on the Shuttle Orbiter's flight deck, aided by sensors in the robot arm that send control information to a flight deck computer display. The system can handle any payload the Orbiter can carry; in coming years, it will also serve as a tool for space assembly and construction tasks.

Canadarm was developed by the National Research Council of Canada; prime contractor is Spar Aerospace Limited, Toronto, Ontario. The project was funded by the Canadian government as Canada's contribution to the Shuttle program, with the conviction that the technology would generate important Earth-use spinoffs and establish Canadian industry as a leader in robotics.

Canada's Vadeko International, manufacturer of large robotic systems, was founded by Dr. Graham D. Whitehead (left), shown with Canadian Defense Minister William McKnight (center) and Ben Torchinsky, board chairman of Agra Industries, Vadeko's parent company.

Robotic systems for railcar maintenance head technology transfers in the field of transportation

The investment has paid off; in fact, Spar formed a division specifically dedicated to development of robotic spinoffs. The first was a robot arm not unlike Canadarm that was designed to remove, inspect and replace large components of Ontario Hydro's CANDU nuclear reactors. A second major spinoff was development of remote-controlled mining equipment that increased productivity fourfold and removed miners from a hazardous operation. Spar is exploring other robotic systems for remote material handling in such operations as nuclear servicing, chemical processing, smelting and manufacturing.

Vadeko International represents an extra dividend on the Canadian investment, because Vadeko is a spinoff company, a fallout from Spar Aerospace. It is an example of a personnel-type technology transfer, wherein aerospace personnel move to other industries, bringing with them aerospace-acquired skills and know-how that have potential for non-aerospace applications.

In this case, the principal instrument of technology transfer is Dr. Graham D. Whitehead, president of Vadeko International. Dr. Whitehead was a member of the original Spar Aerospace Canadarm design team; he also worked on the initial spinoff, the CANDU project. In 1981, he left Spar to found Vadeko International. Among his associates are many of the other Vadeko engineering, project management and technical personnel who worked at Spar on Canadarm and CANDU.

Still a young company and relatively small, Vadeko has already built a solid reputation for advanced systems engineering. It has good financial backing, with 50 percent of its stock owned by the industrial conglomerate Agra Industries of Saskatoon, Saskatchewan. It is a partnership that benefits both companies; two of Agra's divisions are involved in joint ventures with Vadeko. Besides the headquarters in Mississauga, Vadeko operates three other facilities in Toronto, Winnepeg, and Ottawa, plus sales offices in Minneapolis, Minnesota and Seattle, Washington.

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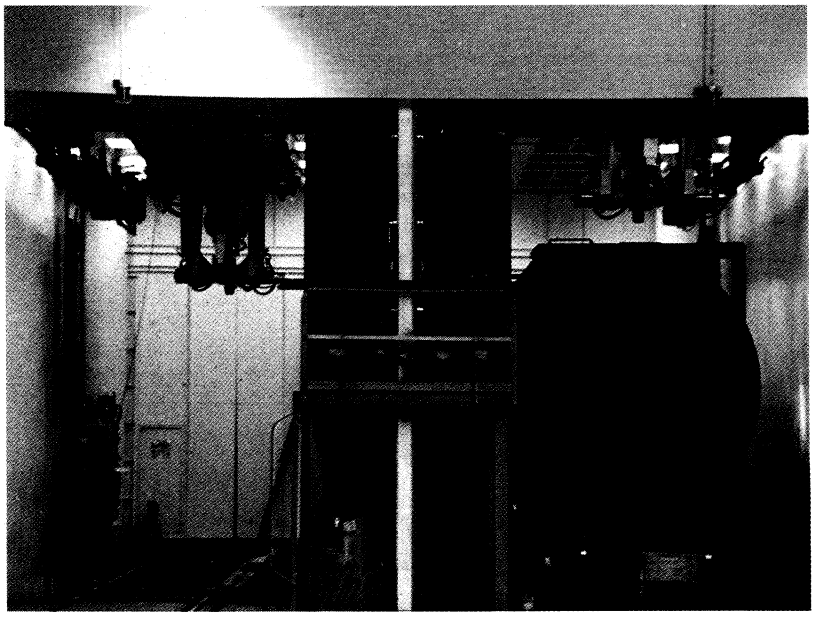

Shown above is Canadian National Railways' Robotic Paint Shop, two parallel paint booths with a hopper car ready for painting in the right hand booth. Each booth has three robot painters, two to handle the railcar's exterior and a third that drops through a roof hatch to paint the hopper. The photo at right shows the ceiling-mounted inside robot and, in red at left photo, one of the wall-mounted exterior painters. The robots can do in four hours a job that formerly took 32 hours.

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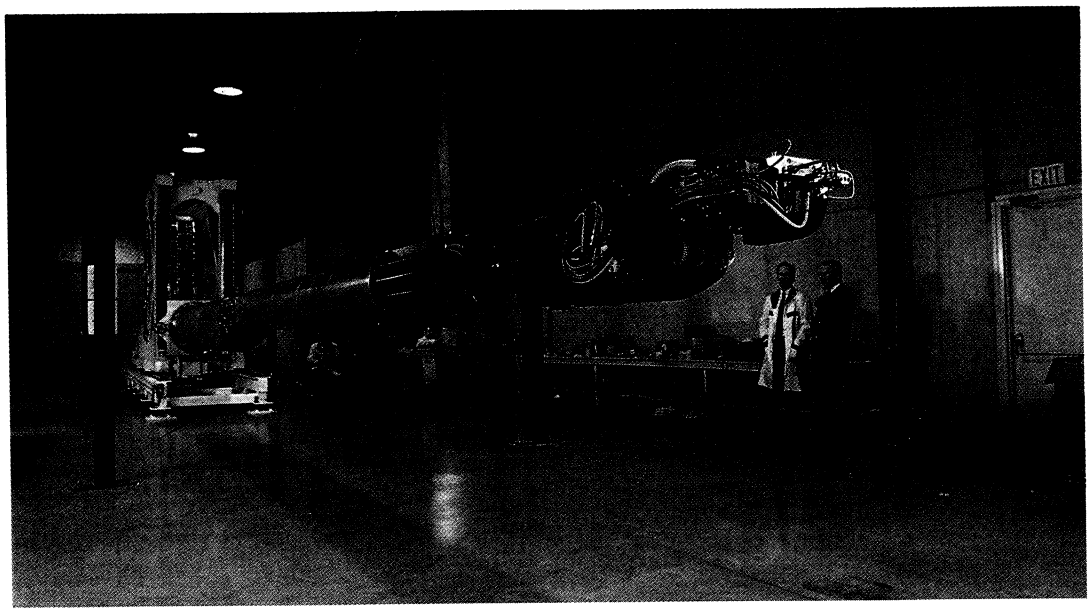


Vadeko designed and built for rocket manufacturer Hercules Aerospace this 50-foot-long Rolling Cantilever Robot, used to clean, degrease and apply coatings on large solid rocket motors.

In addition to large scale robotic systems, Vadeko International is engaged in such other areas of technology as flexible automation, nuclear maintenance, underwater vehicles, thin film deposition and wide band optical monitoring.

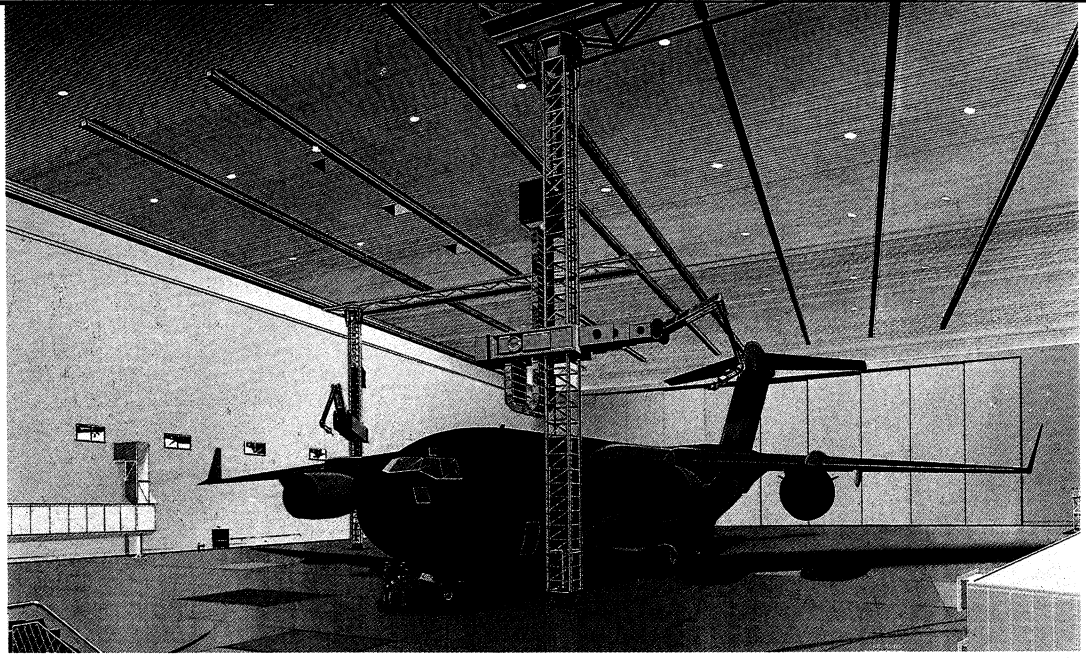
Among the company's major recent projects are two performed for U.S. space contractors. The first, under a contract from Hercules Aerospace, Salt Lake City, Utah, called for construction of the world's largest robot arm, a 50-foot long system that weighs 35,000 pounds. Hercules is using the Rolling Cantilever Robot to do automatically a painting job on large rockets that would be difficult to accomplish with human painters. The rockets are large solid fuel motors used as boosters on U.S. expendable launch vehicles. Before the motors are filled with solid propellant, it is necessary to clean and apply special coatings to the cylindrical motor casings inside and out, and to apply the coatings uniformly. This assignment called for a rather complex robot system that incorporates six major assemblies and provides five axes of motion. Despite the complexity, Vadeko designed, built and delivered the robot arm in just seven months.

Vadeko also won a contract from Thiokol, Inc., Wasatch, Utah to produce the controls and software for a similar large robotic system. Called the Bore Inspection Tool System, its job is inspection and repair of the volatile propellant surfaces of the Space Shuttle's Solid Rocket Boosters, which are manufactured by Thiokol. So the technology transfer has come full cycle: one Shuttle system—Canadarm—spawned a series of spinoffs, one of which will help improve the Shuttle.

Another Canadarm descendant of enormous potential is waiting in the wings: a robotic rail cleaning system, an offshoot of the Canadian National Robotic Paint Application System.

Over time, grease and debris build up on the undersides of railway and subway cars. Periodic cleaning is necessary to prevent fires and ease access for maintenance. That's a difficult job by conventional methods.

Vadeko has designed a Robotic Undercar Cleaning System that employs two robots mov-



One of the largest robotic systems ever built is Vadeko's Automated Preparation and Paint Application System, designed and fabricated for McDonnell Douglas Corporation to apply all exterior coatings to large aircraft. The aircraft pictured is the C-17 military airlifter still in development.

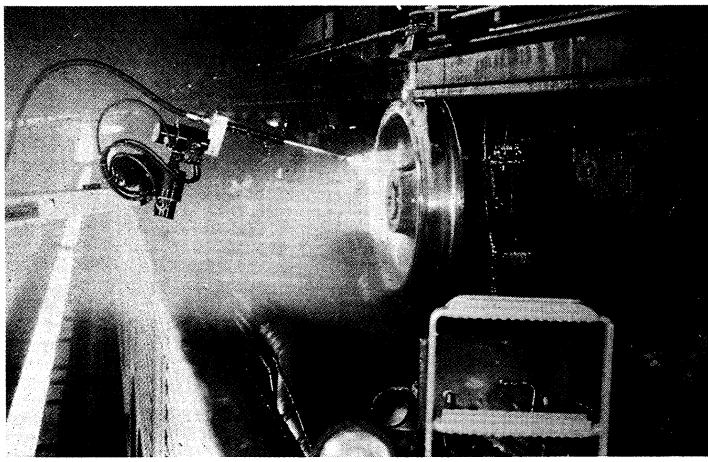
ing along a 180-foot section of track. The fully automatic facility identifies the type of railcar and directs the movement of the robots without human intervention; the robots perform delicate cleaning operations on the complex undercar equipment, using a combination of water and compressed air. The system increases the efficiency of railcar maintenance while allowing removal of humans from a hazardous and unpleasant environment.

Vadeko designed the cleaning facility for Long Island Rail Road (LIRR), a major New York Commuter line; LIRR is considering full scale implementation of the facility. Rail services in Toronto, London and New York are also interested.

Among other Vadeko robotic systems are a Press Unloading System for automatically removing aluminum castings from an injection molding press, and a fully automatic system for assuring the correct removal of vials from an inventory of more than 1,300 possible vial selections.

Vadeko also has a major project in retail level automation, a joint venture with 20/20 Recycling Centers, an Agra division. Legislative actions in California created a need for retail recycling services capable of receiving aluminum cans, glass bottles and plastic containers in exchange for a monetary incentive. A major player in this market, 20/20 recognized that automation of the scrap acquisition process could improve throughput while reducing costs. So 20/20 called on Vadeko to utilize its extensive background in flexible automation to design an intelligent, reliable and adaptable Reverse Vending Machine. The system is in development.

One other Vadeko Project merits special note: the company's work for the Bank of Canada and the National Research Council of Canada in anticounterfeiting measures. New technologies, such as laser scanning and high fidelity color copying, pose a threat to the security of multicolored Canadian money. Vadeko's approach to foiling counterfeiters draws on its thin film technology expertise to develop a "revolutionary" currency protection process – but Vadeko can't elaborate for security reasons. The Bank of Canada has permitted Vadeko to partially commercialize the technology and it could find a big market. Other nations have expressed interest in the currency protection process and the process is adaptable to many other security applications, such as drivers' licenses, identification cards, securities, passports and police documents.



For the difficult railroad job of cleaning complex undercar equipment, Vadeko has designed a twin-robot system that automatically moves along a track beside the car and sprays a combination of water and compressed air.