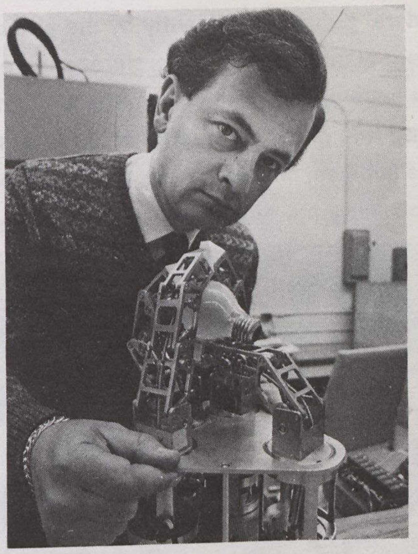
Small robotic hand a boon for industry

A five-member mechanical engineering team at the University of Toronto, led by Andrew Goldenberg and Jacek Wiercienski, has developed a four-fingered prototype of an electro-mechanical hand for small industrial robots that could expand the flexibility of manufacturing systems.

In addition to having a great deal more dexterity than conventional pincers on current industrial robots, the device and associated mechanisms weigh only about 2.3 kilograms, well within the capability of small industrial robots. "The goal of our research is directed entirely to industrial applications, and so the greatest challenge has been to design a hand within a 2.3 kilogram limit," said Dr. Goldenberg.

The prototype has clutches under the base of the hand. Each finger joint has one clutch for each axis of motion.

A single electrical motor drives four fingers, each about 20 centimetres long. One finger is fixed and acts like a thumb while the other three are multi-jointed and can each rotate 360 degrees forwards or backwards.



Jeff Wasserman, The Globe and Mail

Dr. Goldenberg demonstrates prototype hand for small industrial robots.

A command to move a joint results in the motor sending energy to the appropriate actuator and clutch by a unique, flexible transmission system: it lengthens or shortens, much like a tendon. The joints are locked when the clutch is de-energized.

The researchers are currently working to have each finger driven independently by its own motor. Also, in conjunction with computer scientists, they are attempting to develop more specialized control sensors and to link them with an artificial vision system.

"There is an entire discipline developing in electrical engineering to solve problems in the area of real-time control. What this hand must have for flexible manufacturing systems is a computerized control system sophisticated enough to correctly find a desired part or tool, then to position the hand and, finally, to apply the correct amount of force to manipulate and move the object," said Dr. Goldenberg.

Powerful chips for computers of the future

Scientists at Bell Northern Research (BNR) Ltd's new $35-million laboratory in Ottawa are using an advanced process called molecular beam epitaxy (MBE) to produce quality experimental gallium arsenide chips for very high-speed integrated circuits.

These integrated circuits are more powerful than conventional chips made from silicon. Electrical signals can travel through the chips much more rapidly, making gallium arsenide chips desirable for future computer products and communication systems.

The new process to make gallium arsenide chips "gives BNR a virtually defect-free surface on the wafer, and produces materials with excellent electrical and optical properties for our experiments", said BNR scientist Anthony SpringThorpe.

BNR is producing the chips for high speed data processing systems and for fibre optic communication systems. The company's experimental systems can transmit more than two billion pieces of information a second along a single fibre.

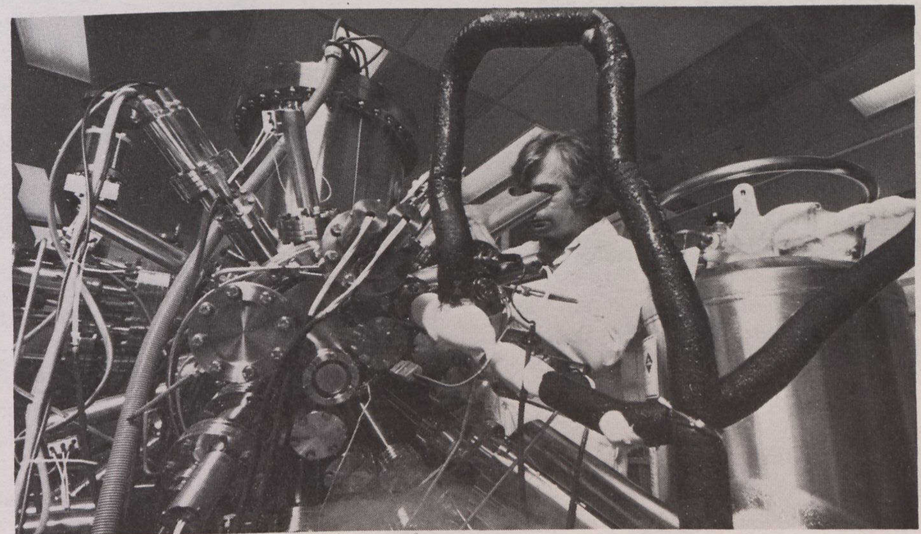
Layering wafers

Chips are made from thin wafers of silicon or gallium arsenide, built up with layers of materials that conduct current through microscopically small circuits. The performance of the circuit depends on creating layers that are uniform and atomically smooth.

To produce gallium arsenide circuits, an unprocessed gallium arsenide wafer, called a substrate, is placed inside the MBE's sealed chamber. Atomic beams of the elements gallium, aluminum, arsenic, silicon, or beryllium that are generated in separate small furnaces are then uniformly deposited on the gallium arsenide wafer in layers. Each smooth microscopic layer may be as thin as 150 billionths of a centimeter.

The depositing process is controlled by manipulating mechanical shutters in front of openings in the furnaces. The smoothness can be monitored using the MBE's internal electron microscope.

To prevent contaminants, such as water and oxygen, from interfering with the growth of the surface layer, the MBE system must be maintained at very low pressures, which are about ten trillion times less than normal atmospheric pressure. This is partially achieved by pumping liquid nitrogen from a tank through cooling coils in the MBE's chamber. As the gas exits through the system, it causes water vapour to condense.



Dr. Anthony SpringThorpe monitors the smoothness of the surface being layered onto a gallium arsenide wafer using the advanced molecular beam epitaxy system.