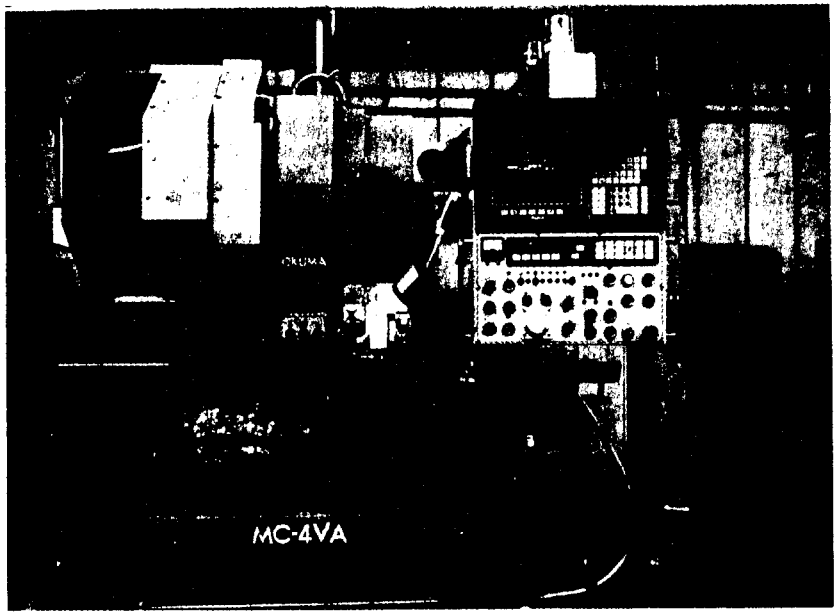
Factory of the future

Now just a dream, Technion experts are working to make it a reality, Simson L. Garfinkel reports.



Computer-controlled milling machine, developed at Technion: no need for humans. (Photo: Garfinkel)

"WE ARE designing the factory of the year 2000," explains Dr. Ehud Lenz, dean of the Faculty of Mechanical Engineering at the Technion. "We feel that we must prepare ourselves for the future so that we can answer the questions when they are raised."

In Lenz's vision, the factory of the future will consist of computerized manufacturing stations and carts to carry the parts from place to place. Robot arms will be used to transfer parts to and from the carts and computer vision will be used to perform inspections and maintain quality control.

The entire factory, according to Lenz, will be controlled from a central computer. Engineers will use this central "host" to design new parts and assembly procedures, and the host will issue commands to microcomputers which will carry out the procedures without further human involvement. The system is called Computer Integratred Manufacturing (CIM), and it will change the way everything is manufactured.

The factory of the future is just a dream. Engineers and researchers at the Technion and other places around the world are working to make it a reality within 10 or 15 years. Although many of the individual parts of the factory of the future exist now, they are for the most part crude and not very well integrated. Lenz and his colleagues are working on modernizing today's equipment and developing new technologies and techniques for the future.

One key to the factory of the future is the cart, called an Automatic Guided Vehicle (AGV), which transports parts between stations. AGVs today travel about the factory floor on a track which is specially designed, expensive to install and difficult to reposition.

AGVs being developed at the Technion will be able to follow a painted line or a bright yellow tape fastened to the floor. When the path that the vehicles follow needs to be changed, the line can be reprinted or the tape can be moved.

Alternatively, the future vehicles will be able to follow electrical signals generated by a cable underneath the floor or simply have the floorplan of the factory programmed into them by the host, Lenz said.

Today, when an AGV runs into an obstacle on the floor, such as a dropped part or a disabled AGV, the vehicle stops and waits until a human removes the obstruction. The Technion's new AGVs will be able to negotiate a path around the obstacle, if possible, or take the parts they are carrying to a holding area. They will also be able to notify the host of the obstruction, which in turn will notify the other vehicles.

Moshe Shoham, a doctoral candidate at the Technion, has developed a robot arm which can pick parts off the AGVs and place them on machines to be worked. The computer uses a laser-based vision system to locate the position of the part atop the AGV and guide the robot arm, just as we use our eyes to guide our hands when we pick up objects.

The vision system also allows the arm to pick up very heavy objects which cause the arm to flex. Because the computer can look at the arm to see the extent of the deformation, it can correct for the flexing of the arm, and help the arm successfuly place the part in the machinery.

For years people have been using microcomputers to control grinders, milling machines and drill presses. But most equipment available today requires a human operator to enter the programme for the machine. The researchers at the Technion are using IBM Personal Computers to interface commercially available Computer Numerically Controlled (CNC) machines to the central host.

The interface allows the factory's central computer to automatically modify or change the part which the CNC is manufacturing by transmitting a new set of instructions without the need for human intervention.

Other research is aimed at automatic inspection of machine-made parts. One system involves comparing a machined part to a hologram of the "master." If the newly machined part matches the hologram, the part passes inspection. Another system uses laser beams to scan the surface of the part, looking for manufacturing defects. These systems can also be used to inspect manufacturing tools, such as drill bits and punches, for wear and damage.

WITH TODAY's technology a mechanical engineer at the Technion can sit down at a Computer Aided Design (CAD) work station and design a part, such as a cam or a lever-arm, on a screen. The engineer can instruct the computer to simulate the manufacturing process and preview what the final part will look like.

Once the engineer is satisfied, he can command the host to automatically manufacture the part. Fifty minutes after the engineer sits down at the work station, according to Lenz, the finished part is ready. "We hope that in a relatively short time we will be able to do much more complicated things," he said.

Unlike mass production, CIM is designed for small manufacturing orders. Lenz defends this decision, noting that 75 per cent of the current manufacturing in the U.S. is for orders which make less than 50 pieces. When today's high costs of specialty manufacturing are removed, he continued, mass production looses its appeal and advantage.

Unattended manufacturing is another name given to the factory of the future. People involved in this field of research do not like to use the phrase publicly, as it implies that many jobs now performed by people will be surrendered to computers in the future.

Although new jobs will be created for computer programmers and engineers, it will not begin to make up for those lost. Indeed, this cutting of production-related labour costs is a strong incentive for management to install CIM systems.

Lenz said that labour accounts for the real costs of manufacturing. Manpower is expensive, and skilled workers are difficult to find. Machinery is incredibly expensive and must be run 24 hours a day in order to recover investment costs, but few skilled workers want to work second or third shifts.

Lenz claims that CIM will drastically cut manufacturing costs and increase productivity by automating the manufacturing process. The only problem then, continues Lenz, will be retraining employees and finding new jobs for the displaced workers.

THE TECHNOLOGY being developed at the Technion has applications to many fields beyond the factory. Uses in one area, health care, are being explored by Johann Borenstein, who is building a "nursing robot."

The nursing robot is not designed to replace human nurses. Instead, it is designed to allow bedridden and disabled persons to perform various tasks without asking other people for help, by giving orders to the robot.

For example, if a bedridden patient is thirsty, he can tell the robot to bring him a glass of water. The robot will be able to respond to verbal orders, and may even be able to insert video cassettes into VCRs and prepare simple meals.

Borenstein, now completing his Ph.D. in mechanical engineering at the Technion, believes that patients will prefer the computerized servant to human ones. "Figure yourself as a quadraplegic, having to be helped with everything. Wouldn't you feel more intimidated asking for help from a human?" he said. "The robot is not to replace a nurse, but to replace boring tasks."

Currently, the robot can detect and navigate its way around objects in a room by the use of a sonar ranging system, and it can pick up objects weighing up to 2 kilograms with its mechanical arm. The final robot should cost less than $10,000.

The real problem for Israel, Lenz concluded, will be the cost of initial installation of CIM in factories. CIM, as its name implies, is a complete, integrated system. "You can't just replace one machine. You have to start from the bottom" and rebuild the entire factory, he said. The cost of even a small CIM factory could easily exceed $30 million and one computerized milling machine can cost $250,000 to $1m. or even more, he added.

"It takes a lot of money to invest" in CIM, continued Lenz. "There is no way that a small Israeli company can invest this without the backing of the government. In a very short time, we will see completed factories in the States. The same in Europe. Israel is very slow in coming because government and indutry show no interest [in installing the technology]. "Countries like Israel have no choice but to enter this area of CIM," Lenz believes, for without it Israeli manufacturing cannot compete, and will collapse.

Drug-delivery techniques

DRUGS have traditionally been given orally, unless their chemical components would be destroyed by enzymes in the stomach and small intestine and therefore have to be injected straight into the bloodstream. But a whole doctor's bag of new drug-delivery techniques are on the medical horizon that will not only be less painful but also more effective.

Scientists have already developed a plastic-coating for some vaccinations, as well as insulin and a number of anti-cancer drugs, that prevent enzymes from getting to them. The Surgeons would first remove as much of the growth as possible and then implant the sheet near the tumour site. The drug then slowly spreads to act directly on any remaining malignant cells. Thus chemotherapy, which affects the whole body, could be no longer necessary.

Researchers believe that this technique will be especially useful in fighting brain tumours, since drugs used in chemotherapy cannot easily get into the brain.

Another technique is the microcapsule approach. Tiny spheres carrying disease-fighting drugs are inflow of four drugs to destroy hard-to-treat cancers. Manufactured by Intelligent Medicine Inc. of Denver, Colorado, the portable pump delivers up to four medicines at variable rates for up to 30 days at a time, particles containing female hormones through their skin.

Based on this discovery, the Alza Corporation in Palo Alto, California, has developed skin patches that deliver drugs gra[illegible]ly. An adhesive

runs on solar power. Just walk outdoors on a nice day with the $200 machine and it will keep producing music stereophonically.

A TRACTOR that borrows its automatic steering system from the landrover that travelled on the lunar surface has been developed in Israel.

Granot Technologies, a kibbutz cooperative near Haifa, has built a six-metre-wide, high-riding tractor that maneuvres easily and does not compact the topsoil. Named Merhav, the tractor has four widely spaced wheels that roll along permanent lanes. A five-metre-wide centre

four tables in a small room, with five students at each. Eight of the students had very bad colds, a result of inhaling up to 1,000 particles of type-16 rhinovirus two days earlier. The eight sat down for 12-hour poker games with 12 healthy students. Half of the healthy students were fitted with either large plastic collars or arm braces so they couldn't touch their hands to their faces, ensuring that any virus infecting their noses or mouths had to travel through the air. The rest of the students, the control group, had no restraints. A few days later, as m[illegible] estrained as unrestrained stu[illegible] got sick, clearly in