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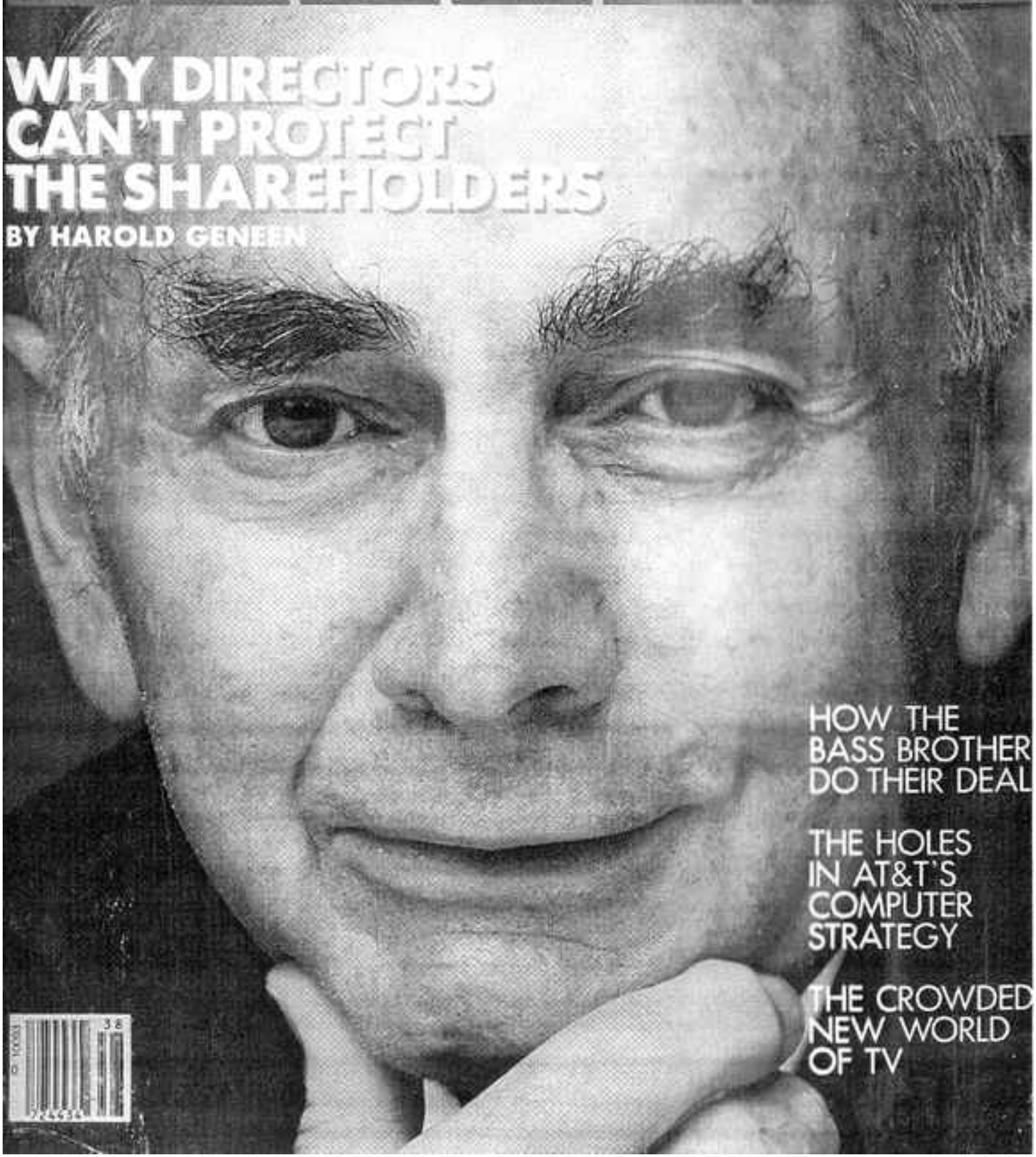
FORTUNE

WHY DIRECTORS CAN'T PROTECT THE SHAREHOLDERS

BY HAROLD GENEEN



HOW THE BASS BROTHER DO THEIR DEAL

THE HOLES IN AT&T'S COMPUTER STRATEGY

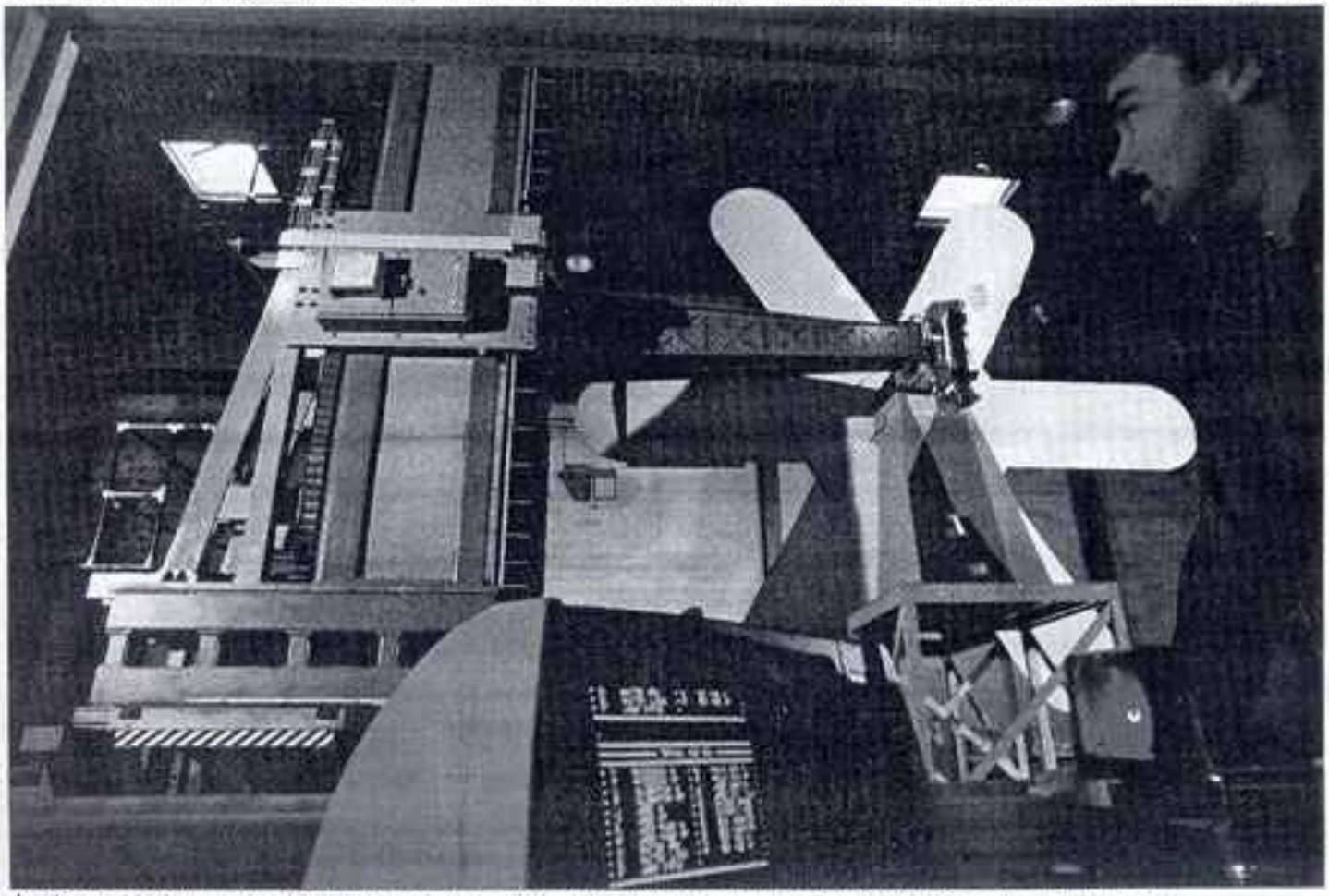
THE CROWDED NEW WORLD OF TV

MACHINES THAT SEE LOOK FOR A MARKET

Seeing-eye systems are expensive to make and difficult to sell. But now that giant General Motors has invested in four small vision companies, more and more factories are beginning to focus on what this versatile new technology can do on the production line. ■ *by John W. Dizard*

OF ALL THE HOT technologies for the factory of the future, machine vision has become the hottest. Machine vision systems use computers to analyze and interpret images—for example, images of parts going past an inspection point on an assembly line. They can replace human quality controllers, guide robots, or read type. And while they don't have the extraordinary range of capabilities human observers have, they can perform many simple tasks faster and more reliably.

The prospect of tireless, faultless, nonunion eyes on the production line understandably excites manufacturing executives. The industry's sales have doubled every year for the past four years. General Motors, the biggest user of machine vision systems, decided this summer to inject capital and technical help into four of the leading companies in the field—which has had the effect of



A robot guided *by machine vision welds and inspects ship propellers. This device, made by Robotic Vision Systems, has 3-D perception.*

PHOTOGRAPH BY JOHN MADERE

lending big-company legitimacy to a new industry. To top it off, there's no immediate prospect of tough competition from the Japanese or Europeans. Although Hitachi and Matsushita Electrical Industrial have done work on vision, they are technologically behind U.S. companies.

THAT'S THE SIZZLE. The steak is still pretty tough. Machine vision makers have had a difficult time getting their systems out of the lab and onto the shop floor. To put the U.S. industry into perspective, consider that two toy robots, Tonka's GoBot and Hasbro's Transformer, may have sales of $170 million this year—more than twice the vision industry's projected 1984 sales of $80 million. The biggest public company specializing in the field, Automatix Inc. of Billerica, Massachusetts, lost $2.8 million last quarter on sales of $4.5 million. One of the few other public companies, Robotic Vision Systems of Hauppauge, New York, lost $299,000 last quarter.

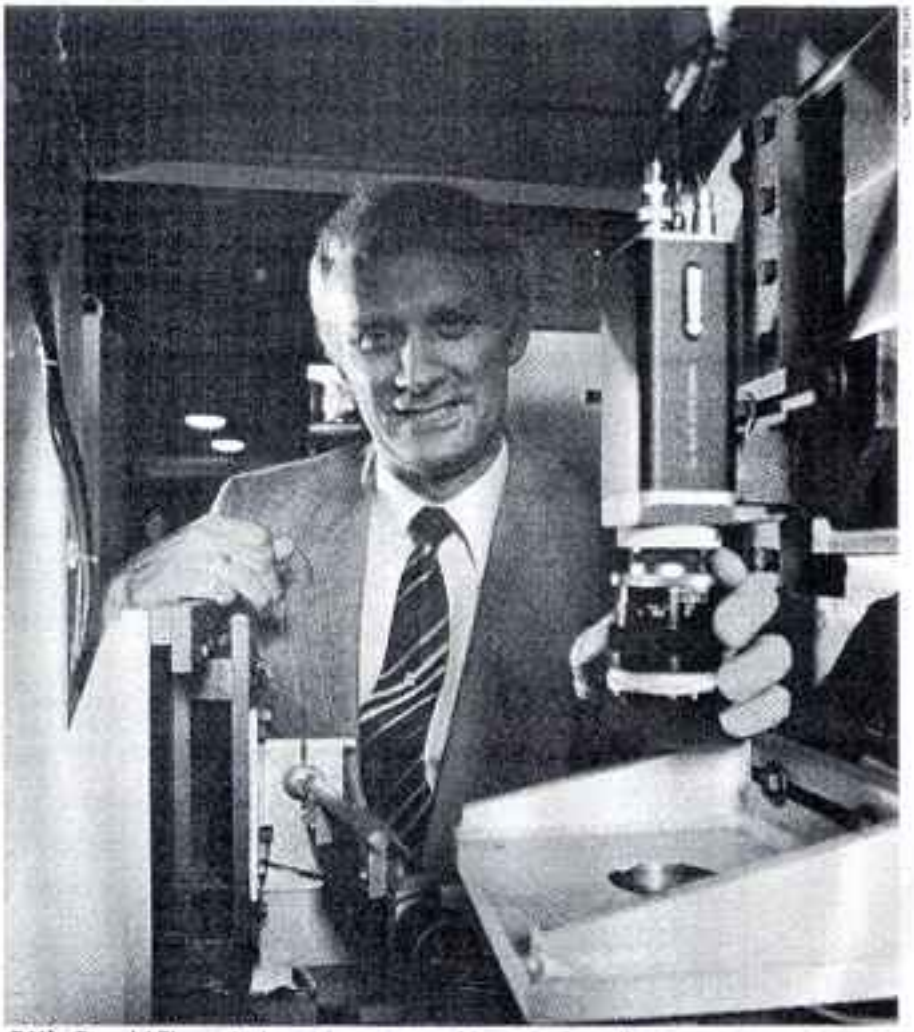
The fundamental problem in the vision industry is a big cultural gap between the factory-based users and the lab-based developers of the systems. The developers say that users have unrealistic expectations about what vision machines can do and that factory floor managers often have an adversarial attitude toward new technology. The factory managers say the vision companies overpromise and don't design equipment to perform well in tough environments.

Another problem for the vision companies is that so much of what they make is custom-tailored. To get a system onto the floor, they have to solve the specific problems faced by specific customers. But if all of a company's effort goes into custom solutions, it's not going to make the big bucks that come from selling the same solution dozens or hundreds of times. And even if the industry wanted to become a seller of custom solutions, there just aren't enough qualified engineers to do the necessary work for every application. For all these reasons, progress has been slow.

Which is too bad, because machine vision is truly a useful technology. The field was begun by artificial-intelligence researchers trying to duplicate the human perception process. Much of their money came from defense and intelligence agencies that wanted to automate the interpretation of photo-intelligence gathered by aircraft and satellites. There are a number of different approaches to artificial vision, but all start with a camera's image of a scene—such as an assembly line—that's broken up into little squares called pixels, short for picture elements. The vision system's computer compares the pixels with one another and identifies the most prominent or important features of the objects in the scene, such as edges, holes, or the outlines of letters and numbers. It then compares these features with a model stored in the computer's memory and decides if they're the right features in the right place. If, say, a metal stamping in the scene is the wrong size or lacks the right number of holes, the vision system can tell a worker or a machine to take it off the assembly line.

A machine vision system has the potential to inspect 100% of the parts it sees—far better than the 80% efficiency often attributed to human inspectors. Vision systems can also be used to guide robots to the parts they're working on, which immensely enhances a robot's flexibility and productivity. That's why GM wanted to get intimately involved in the little vision companies it invested in. Each of the four—Automatix (1983 sales: $13 million); Robotic Vision Systems ($2.9 million); View Engineering of Simi Valley, California ($15.5 million); and Diffracto Ltd. of Windsor, Ontario ($8 million)—is what passes for an established company in the field, though it seems strange to talk about established companies in a business that has existed in its present form for not much more than three years.

GM's investment coincided with the automaker's establishment of what it calls an activity within the GM Technical Center in Warren, Michigan. The activity is named Machine Intelligence Technology Implementa-



GM's Gerald Elson *checks a vision system used for engine inspection.*

RESEARCH ASSOCIATE *Michael McFadden*

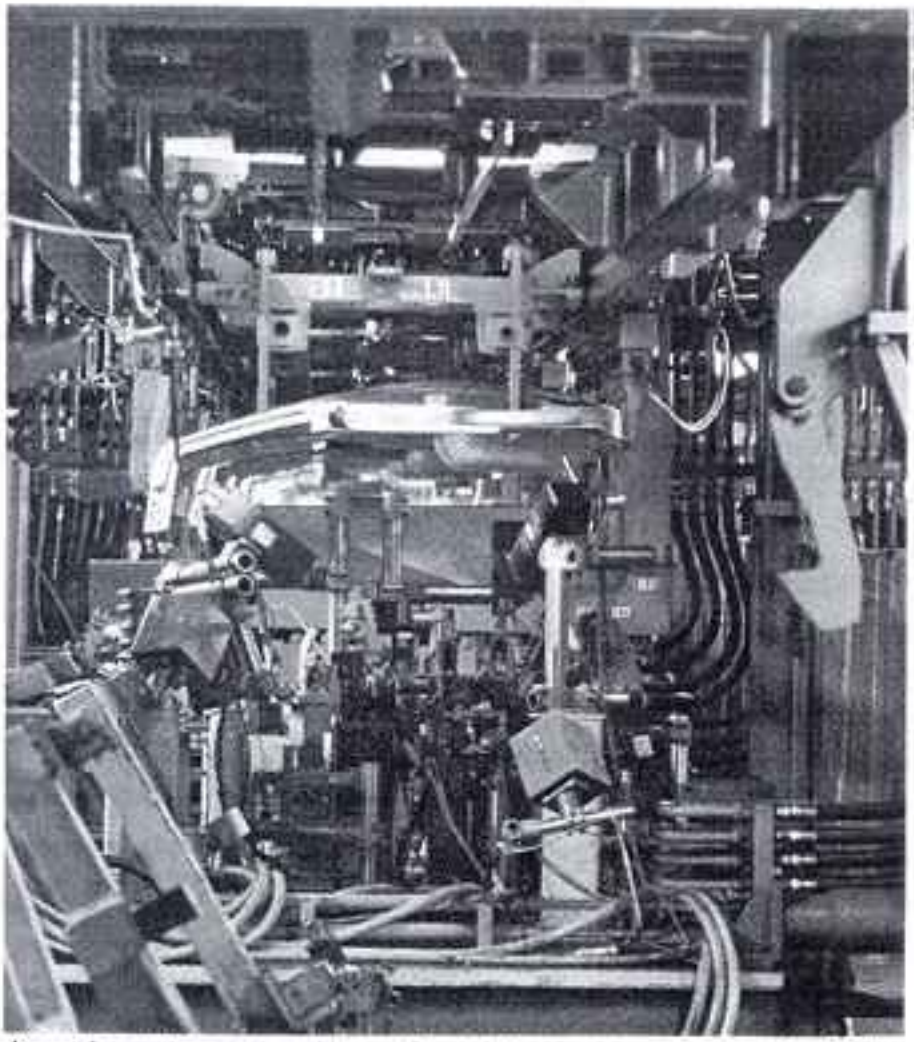
tion. "Our intent is to work with these companies so we can implement this technology rapidly," says Gerald Elson, the head of the new GM operation. "We picked these companies because they are current suppliers, they need to grow, and we don't need them hampered by some of the traditional relationships that have existed with suppliers. We went into this form of arrangement to help them help us."

Traditional relationships have often been contentious, whereas GM's will be almost cozy. The automaker will appoint a director to the board of each firm and, more significantly, provide money for research and development as well as for applications engineering. Also, some of the advanced machine vision technology developed by the GM Tech Center will be made available to the four vision firms. Any new systems developed for the auto industry in conjunction with the Tech Center will be provided to GM on an exclusive basis for the first 18 months after the devices are ready for market. After that, the vision companies can sell them to anyone.

THE TECH CENTER has had problems introducing its own technology in GM plants. As one machine vision entrepreneur says, "Tech Center people don't have a good reputation with plant managers for providing ongoing support for the systems they install. They're good at providing new technology, but when an installed system runs into trouble, the Tech Center designer always seems to be at a scientific conference 200 miles away." For that reason, says a GM executive, "we need these outside companies to sell vision technology to our own plant managers."

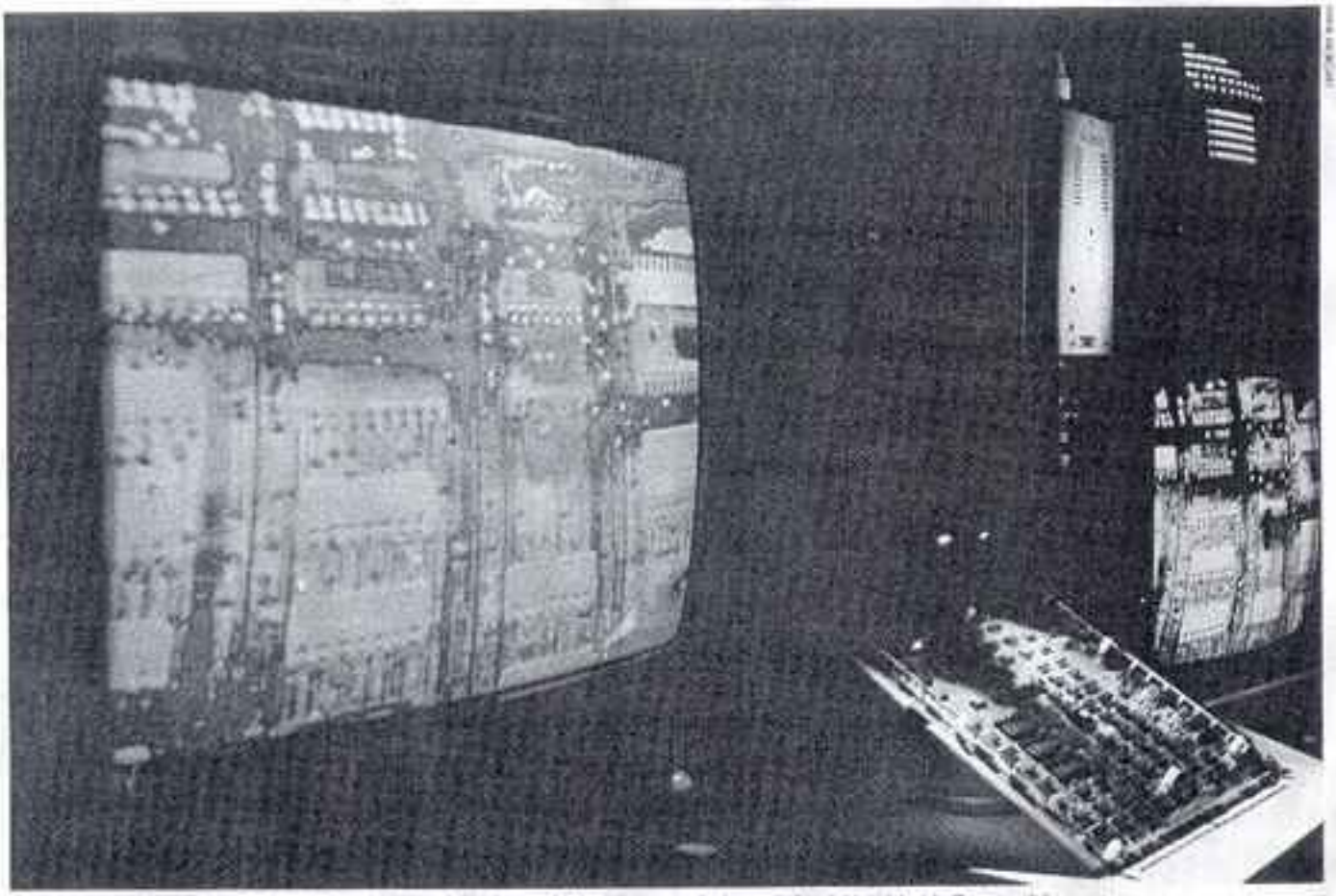
The General Motors deals weren't the first such alliances in the machine vision business. The first auto company tie-up was between Ford Motor and Synthetic Vision Systems, an Ann Arbor, Michigan, manufacturer that uses technology originally developed for the military. Also, Caterpillar Tractor made a similar investment in July in Advanced Robotics Corp., a Columbus, Ohio, company that has done substantial work on a vision system dedicated to guiding robot seam-welding machines. But the GM deals may have set off a scramble for alliances between machine vision makers and corporate investors. Almost immediately there was talk of several more such tie-ins.

The dealmaking resulted in part from the vision companies' need for money to finance rapid expansion. The tight venture capital market and the collapse of the come-dream-with-us initial public-offering market on Wall Street have made cash much harder to get. But the driving force has been the recognition by the vision industry that on its own it simply doesn't have the people or the money to get its products to market. Marketing conjures up an image of glitzy public relations people, long lunches, and even longer lines of putter. But marketing machine vision systems is a lot more gritty—and a lot more expensive—than months of vinous meals. Machine vision salesmen are often engineers themselves. They must work intimately with the applications engineers, who do the custom work necessary to make a standard machine fit the particular needs of a customer. Also, plant managers who have seen a lot of high-tech solutions that come in with a bang and go out in the dumpster frequently insist that new firms in the vision industry ship to them on consignment. That can mean tying up $60,000 to $100,000 worth of capital in very soft receivables every time a salesman runs into a tough customer.



A gauging system *similar to this one at Chrysler's Ontario mini-van plant starred in a TV ad featuring Lee Iacocca. The machine, made by Perceptron, is examining apertures on mini-vans.*

Although gross margins (sales less materials and direct labor before subtracting selling and overhead) in the vision industry are huge—50% to 70% of sales—they are eaten up by the expense of paying those marketing and applications-engineering costs. According to Stanley Lapidus, the president of Itran Corp., a small Manchester, New Hampshire, vision company: "The basic systems price is maybe $20,000 to $60,000, but the special applications software, the associated machinery on the factory floor, and the cost of the vendor's time and the customer's time is



Complex printed circuit boards, *the guts of the electronics industry, can be inspected quickly with this Cognex vision system.*

four to five times that figure." Those indirect costs aren't always tracked by the vendor or the user, but they drain capital from the vision companies and erode the economics of vision systems for the customers.

The auto industry, while still the biggest market for the vision vendors, has an unusually tough set of problems. Vision and auto company engineers must contend with dirty, hot, crowded factory floors, pulsing with sparks and electromagnetic fields that wreak havoc on vision systems developed in clean electronic labs. Says Tim Pryor, the chairman of Diffracto Ltd., one of the new GM partners: "We've had systems in plants where we couldn't get someone to wipe the window protecting the camera once a week, because it was something new and they didn't want to mess with it."

All these problems are evident in the candy store structure of the vision industry. That $80 million in total sales is divided among 80 to 100 companies. The head count depends on whether you believe the smaller and newer companies are real players. Almost nobody makes a profit on such low volumes, and those companies that do don't make much. Even General Electric, whose machine vision sales outside the company range from $5 million to $7 million, has been losing money in the business. That doesn't bode well for companies with smaller names and fewer assets. Laura Conigliaro, a security analyst with Prudential-Bache who is the unofficial guru of the vision industry, says: "A lot of companies thought time was on their side. They figured an industry shakeout wouldn't come for a while. With the GM deal, we can see that time is not necessarily on the side of marginal companies."

For all the problems involved in getting machine vision up and running, working systems exist and are out there proving their value. Thomas Vander Plas, an industrial engineer working at Oldsmobile's Lansing, Michigan, plant, says: "Right now one of the machine vision applications I'm working on is picking car hoods off a conveyor line and putting them into a shipping rack. We're using a laser lighting system and several cameras. The system looks for the hoods, and a robot picks them up and puts them in the right slot. We were working with Automatix, and we were concerned that the applications engineering would be a real bear. As it turned out, Automatix had a test model up and running in two days."

Even skeptical plant-floor managers know that the automation machine vision provides is critical to overcoming cost and quality competition from overseas. A manager of manufacturing systems for a big consumer goods company says, "We know we have to apply this technology in the next five years. Two years ago I saw some of these systems at a convention, and I thought they weren't there just yet. But you can't keep waiting for developments that might not come for a while. There are certain applications for machine vision that we can now use in our business, particularly in inspection."

The enthusiasm for applying vision has

even spread to foreign manufacturers with lower costs than the U.S. Sergio Sedas, an engineer with Fabricación de Maquinas SA, a Monterrey, Mexico, manufacturer of capital goods for the glass and plastics industry, says: "Even with low labor costs, you're never going to get the same quality with human inspection. If you want to compete internationally, you're going to have to have vision." Sedas is now shopping for his company's first system.

WHILE CUSTOMERS scan the machine vision industry for suppliers, the fledgling vision companies are trying to focus on their customers. Some, like Automatix, have a reputation for taking on tough jobs for tough customers in the auto business. Others, such as Cognex Corp., another Massachusetts vision company, concentrate on companies that understand the limitations of technology, such as IBM and Pratt & Whitney. Robert Shillman, president and chief executive of Cognex, believes executives in the metal-bending industries require too much handholding. "They've all seen *The Six Million Dollar Man* and *Knight Rider* on TV, and they truly believe a machine vision company should have systems that can do all that," says Shillman. Cognex, which is clocking up sales at a $6.5-million annual rate, had its first profitable month in July.

Cognex initially specialized in tasks such as reading serial numbers of integrated circuits and turbine blades as they wend their way through factories. Such automated parts-tracking helps manufacturers keep control of inventory. The company has gone on to use much of that software to inspect the quality of characters printed by typewriters.

Shillman argues that to be successful, a vision company must "find problems in the real world to which it can apply standardized solutions." For example, a machine vision company might have a basic software package that reads numbers and letters. A special version of that would be adapted to the needs of, say, pharmaceutical manufacturers. This software would check the integrity of pill bottle seals while reading and recording lot numbers. Then custom applications work would be required to adapt the software instructions to the particular packaging machinery, lighting levels, vibrations, and other environmental conditions in a specific customer's plant.

The electronics industry is more enthusiastic than most about applying machine vision. These companies not only are more at home with the technology but have a lot of nit-picking jobs that lend themselves to automation. In printed circuit board inspection, for example, a machine vision system can check to make sure that components mounted on a board are the correct ones for the job, are fastened securely, and are properly aligned. Laura Conigliaro of Prudential-Bache refers to what she calls a "lemming-like rush among companies to do printed circuit board inspection."

As they do with most technological gadgets, the buyers of vision machines put a premium on user-friendliness. The user in many cases is from the same metal-bending culture as the average assembly line worker but has the training of a skilled technician or engineer. Among the more user-friendly systems are those made by Itran. Says Lapidus,

INVESTOR'S SNAPSHOT

AUTOMATIX

SALES (LATEST FOUR QUARTERS)	**$14.8 MILLION**
CHANGE FROM YEAR EARLIER	UP 60%
NET LOSS	**$6.8 MILLION**
CHANGE	LOSS YEAR EARLIER
RETURN ON COMMON STOCKHOLDERS' EQUITY	**−25%**
FIVE-YEAR AVERAGE	NOT AVAIL.*
RECENT SHARE PRICE	**$13.50**
PRICE/EARNINGS MULTIPLE	**N.A.**
TOTAL RETURN TO INVESTORS (12 MONTHS TO 8/15)	**−40%**
PRINCIPAL MARKET	**OTC**

*Held public offering 3/8/83

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INVESTOR'S SNAPSHOT

ROBOTIC VISION SYSTEMS

SALES (LATEST FOUR QUARTERS)	**$4.6 MILLION**
CHANGE FROM YEAR EARLIER	UP 44%
NET LOSS	**$0.8 MILLION**
CHANGE	LOSS YEAR EARLIER
RETURN ON COMMON STOCKHOLDERS' EQUITY	**−57%**
FIVE-YEAR AVERAGE	−33%
RECENT SHARE PRICE	**$12.25**
PRICE/EARNINGS MULTIPLE	**N.A.**
TOTAL RETURN TO INVESTORS (12 MONTHS TO 8/15)	**−1%**
PRINCIPAL MARKET	**OTC**

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TECHNOLOGY

Itran's president: "The primary user of an Itran system is a manufacturing engineer, who usually has a degree in mechanical engineering. He's familiar with mechanical concepts such as jigs, fixtures, and programmable controllers for machine tools." The screens on Itran's vision machines display little electronic tools, such as calipers and positioning pins, so the engineer can program it using the mechanical language he learned years ago. Itran's system is fairly simple to explain and operate, but as one machine vision expert says, "You pay for that kind of user-friendliness by degrading other qualities such as speed. That could be overcome in time as the cost of processing the extra software drops, but it's still an issue."

Also, just as machine vision engineers are becoming friends with shop-floor engineers, high-level technical planners and central staffs are working to get the shop-floor engineers out of the loop of programming the systems. In other words, the central staff wants to be able to program the vision systems directly from computer-aided design (CAD) systems. As even user-friendly Lapidus says, "Right now you have to wait months to design a part, get the machine tool to make it, and then take the part and use it to program the vision system. When our machines can communicate directly with the CAD systems, we can do that programming on the day the part is designed."

AT GM THIS EFFORT at true computer integrated manufacturing is called Manufacturing Automation Protocol, or MAP. MAP's hardware consists of a high-capacity coaxial cable string among all the factories' computers and electronic controls. The software acts as a translator to make the data coming out of one computer understandable to another. The first demonstration of MAP will take place next year at a GM factory of the future in Saginaw, Michigan, designed to make front-wheel-drive axles. "The vision systems that we buy will have to be MAP-compatible," says GM's Elson. Right now there aren't any vision systems that are, if you will, MAP-friendly. That means vision makers must spend even more money on hardware and software development.

But gradually the vision industry is locating its market. As the technical whizzes get grease on their white coats and the plant managers learn to talk the machine vision dialect of computerese, the vision companies can almost taste the moment when those big gross margins turn into big net margins. ◘