Click here for Full Issue of EIR Volume 12, Number 40, October 11, 1985

Frontiers of industry: lasers married to robots

William Engdahl reports on the technological breakthroughs at the European Machine Tool Exhibition in Hanover.

The quadrennial European Machine Tool Exhibition, which ended on Sept. 25 in Hanover, West Germany, provided an extraordinary opportunity to view the latest and most advanced developments in not only the European machine-tool industry, but, in many cases, the world's. This 6th world exhibition for metal-working and industrial automation lasted nine days, and brought together almost 2,000 exhibitors from 36 countries, including the United States, Japan, South Korea, Italy, France, West Germany, East Germany, Czechoslovakia, and the U.S.S.R. These countries account for approximately 90% of world machine-tool manufacturers.

The most striking aspect of the exhibition was the proliferation of automation combined with the concentrated energy of laser technologies. [See *EIR,* "Robotics: Germany leads the world, by William Engdahl" Vol. 12 No. 38 for a discussion of the rapidly expanding industrial automated assembly production in Germany.] "If I were to project the most important development over the next one to two decades in world industry, it would be laser applications," the Managing Director of Daewoo Heavy Industries, Dr. Youngkook Kang, a U.S.-educated electrical engineer, told *EIR*'s reporter.

"I am responsible for development of advanced industrial technologies for our firm, and it is beyond question that we will now see the tremendous potential of laser applications throughout industry." Daewoo was at Hanover to exhibit, with considerable and justified pride, the first laser-coupled robot of Korean manufacture. He emphasized that Daewoo expects to export its Quasar-600M Laser Cutting System to Western European and North American markets.

The most impressive development visible at the Hanover exhibition was that of the advanced West German machine-tool manufacturer, Trumpf Maschinenfabrik, Headquartered in Ditzingen, near the industrial belt of Stuttgart, West Germany. Trumpf for the first time demonstrated the marriage of its industrial robot with its own, newly developed laser. This is believed to be the only company in the world which presently makes both lasers and robots "in-house."

The new tool, a five-axis laser cutting center with automatic focusing, uses either a 1,000 watt or 1,500 watt Trumpf CO_2 laser. According to Dr. Frank Ackermann, physicist with the Trumpf Laser Group, the company, following several years' experience with lasers from other major manufacturers, decided to combine its own expertise in the design and operation of machining centers with its knowledge of the particular requirements of lasers. "We had not been satisfied with the stability of any of the lasers we had previously used with our machine robots. All had one or another problem, even the best. The most common problem was in stability of the laser. It takes very long times to start up and stabilize the lasers. We decided to apply our experience and develop our own laser to these specifications."

Trumpf worked for several years in a joint industrial research project with the German Institute for Air and Space Research (DFVLR) in Stuttgart to develop the unique design of its laser. As a result of that experience, Ackermann relates, Trumpf decided to design its own laser, incorporating an entirely new concept of laser discharge, utilizing radio frequencies (Rf).

Conventional lasers in use today incorporate what is called DC-discharge within the laser. This necessitates use of ballast resistors to stabilize the discharge, which means significant loss of power. "From our work with DFVLR, we decided that use of Rf discharge was a superior technique," Ackermann emphasized. Today, Trumpf is the only industrial laser manufacturer in the world producing this Rf discharge design, though other major manufacturers, especially in West Germany, are known to be developing it.

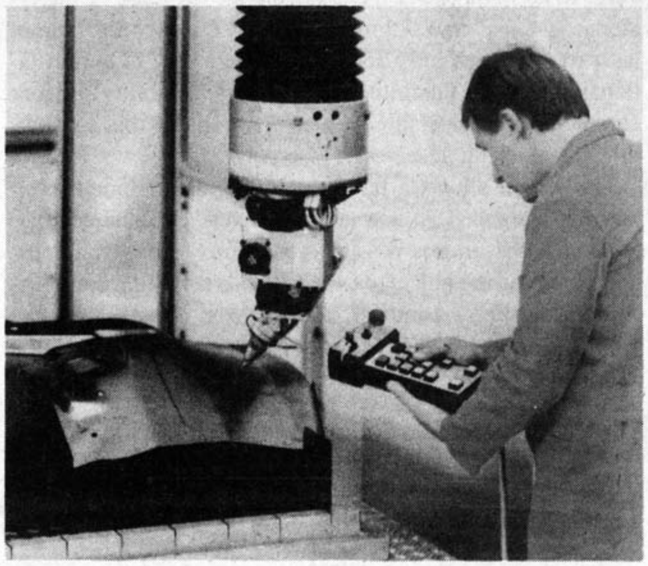
Because of the physical characteristics of the Rf discharge, the Trumpf laser is able to produce an average of more than 50% more laser output power for given input, than with conventional DC discharge models available. The advantages of this higher efficiency are obvious, especially in the area of metal cutting, where Trumpf expects its principal applications. Typical ratios for the Trumpf Rf laser are on the order of 16% of input power, compared with 10% for more conventional DC-discharge models.

Perhaps the most useful feature of this design is its inherent stability. The overall length and size of the Trumpf design is considerably less than other CO_2 lasers. Utilizing the so-called Fast Axial Flow design first developed by the Hamburg-based Rofin-Sinar, Trumpf has developed the internal geometry of the resonator, utilizing what Ackermann calls the "folded mirror design," such that the short length of the resonator enhances laser stability, compared with longer DC-discharge models. The choice of materials, drawing on Trumpf's experience in manufacture of machine-tools, further assured very stiff mechanical stability in the short, thick resonator.

In addition to greater quality of lasing, the inherent stability of the Trumpf design is superior in that it requires no "warm up" adjustment period prior to operation. Every other industrially available CO_2 laser in the 1 to 1.5 Kilowatt class must warm up for 30 to 60 minutes until all parts are in thermal equilibrium. If the laser must be shut down, as is common in heavy i
such adjustment is considerable, and is one reason many companies are hesitant to employ lasers to replace conventional metal cutting, despite its other advantages.

The Trumpf laser requires only two minutes for the routine nitrogen evacuation procedure before operation. At present power levels, it is able to cut steel at a speed of approximately 1 meter/minute depending of course on the material being cut. Using
highest power density per surface area of any energy source now in use, this means that the Trumpf laser can deliver some 50% more power density than comparable 1.5 kilowatt industrial CO_2 lasers.

Taking this advantage, Trumpf has coupled its laser with its five-axis machining center. The robot which holds the laser cutting tool travels along five degrees of freedom or



This programmable cutting machine, manufactured by Trumpf in West Germany, can be programmed to deal with highly complex contours, or can even "teach itself" to do so.

'No alternatives to continual innovation'

Excerpts from Opening Remarks by West German Minister for Research and Technology, Dr. Heinz Riesenhuber, at the Hanover Exhibition:

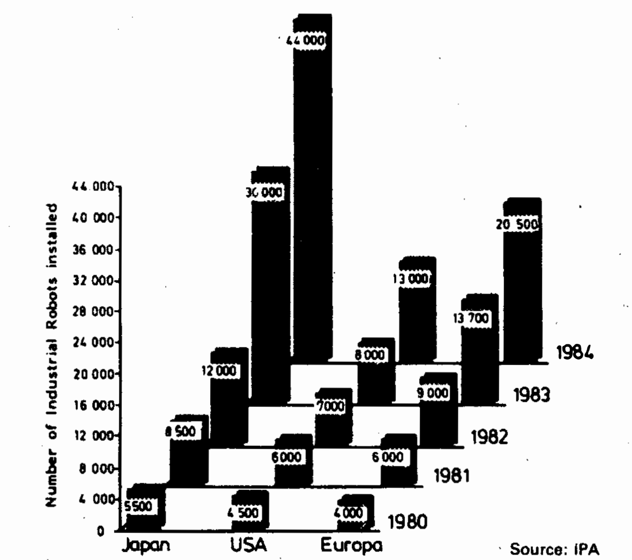
The foundation upon which our industrialized society is based is that of continual innovation: There are no alternatives to technical advancement. The factories of the future must be equipped with increasingly sophisticated systems which we today call "high-technology." Processing centers, flexible manufacturing, CAD/CAM, and industrial robots will, in the year 2000, be just as much taken for granted in manipulation and assembly as lathes and milling machines were 15 years ago. It is the task of industrial and financial policy to carry out the necessary structural adaption.

The West German and European machine-tool industry has no need to shy away from any comparisons regarding the state of technological development. The machine-tool industry, as the pathfinder in the field of development in technical manufacturing, is able to look back on a long tradition. Both the transformation of new developments into useful products, as well as improvements in the quality of technical goods, have, just as much as increases in productivity, always been achieved by improvements in manufacturing technology. . . .

axes. In addition to 3.2 meters along the "X-axis," 2 meters along "Y-axis," and .75 meters along "Z-axis," the Trumpf laser robot moves fully 360° in rotation and 120° in translational axis. This flexibility gives enormous ability to work complex geometrical three-dimensional shapes that are common in vehicle or space-craft assembly.

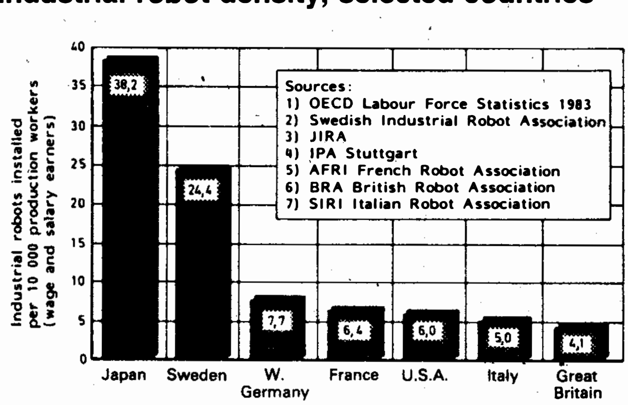
In fact, it allows a far more economical alternative, if properly integrated, to normal manufacturing techniques and, in some cases, makes possible operations otherwise impossible. Data on the object to be machined, including complexities of non-linear contours, can be taken directly from the CAD (Computer Added Design) system integrated with the Trumatic L-5000. Alternatively, data can be determined through a special software program on the machine itself, in which the number of points is drastically reduced by a method known as "spline interpolation." This vastly speeds the time required for machining new geometrical parts, an extremely important feature in diverse, small-batch manufacture increasingly common in today's industry.

International distribution of industrial robots



Source: IPA

Industrial robot density, selected countries



Source: IPA

France, Italy moving fast

While the Trumpf development represents some of the most concentrated development in unified laser and robotics technology in the world, it is by no means the only firm working to combine lasers and robotics, a marriage which will obviously become standard in industrial manufacture in the next years. The French firm, Limoges Precision, in the center of France, has developed a more conventional application of a 3-axis robot coupled with a 1,000 watt CO_2 laser, combined with Computer Numeric Control (CNC). It is capable of machining flat pieces up to a dimension of 3.5 meters by 2.6 meters. It is being employed by the French automaker, Renault, among others.

The largest and most diverse French laser manufacturer, which presented a variety of laser cutting and welding machining centers at the Hanover gathering, is the Compagnie Industrielle des Lasers, or "Cilas Alcatel." Located near Paris in Marcoussis, Cilas Alcatel grew out of the broad French experience in the nuclear industry, beginning 1966. The company has pioneered use of high-power ultra-bright lasers for assembly of "laser chains" for controlled thermonuclear fusion as well as isotope separation. Beginning in 1981, the company, a subsidiary of the large CGE company, determined to concentrate on development of industrial lasers for cutting, welding, and heat treatment of materials.

Today, the company produces industrial CO_2 lasers, incorporating the Rofin-Sinar Fast Axial Flow design, ranging from 1,000 watts to 4,000 watts. At present, they are in the process of perfecting a "super pulsed" version of its 4,000 Watt CI-4000 model, which will allow far greater energy concentration than conventional continuous designs. The principle is not unlike the aspect of lasers which allows them to destroy intercontinental ballistic missiles with relatively small power input.

Today, Cilas Alcatel produces 50% of French industrial lasers and 80% of French lasers used by the defense industry. The company has not exploited the export market with its industrial lasers, but aggressive plans are in process, following the consolidation of all CGE laser operations into Cilas Alcatel this past spring. It has established a subsidiary in the U.S.A., where 50% of the present industrial laser market exists, to gain a major position in that market. To date, users include Aerospatiale Corporation, Renault, and Aldes.

Advanced boring and milling machines

By all accounts, Italy is making most impressive advances in the machine-tool industry. The Prima Progetti

Company of Moncalieri, in the advanced industrial region of northern Italy near Turin, presented its 5-axis robot coupled with a laser, the ZAC Robot. Though slightly less versatile than the robotics of the Trumpf, the Prima Progetti design can utilize a digitized definition of the cutting path, which permits programming of the robot "off line, meaning that all machine time is used exclusively for cutting operations."

The machine also has a CAD system incorporated, which allows digitizing of complex surfaces, meaning that definition of complex cutting paths can be done extremely quickly. Prima produces industrial robots which are used by Italy's and Europe's high-precision aerospace, nuclear, and automobile industry: Alfa Romeo, BMW, Saint Gobain engineering of France, Volvo, and numerous others.

Another spin-off of experience in nuclear power engineering, Italy's Pama Industry group, has developed what is reported to be the world's most advanced design milling and boring machine-tool. The Pama "Speedram" machine-tool, a huge 48,000 Kilogram unit, is able to machine extremely large pieces as required in nuclear steam supply vessels. Using a unique "hydrostatic lubrication" technique, Pama has produced what is regarded as the finest horizontal machining center in the world in terms of accuracy and size of production.

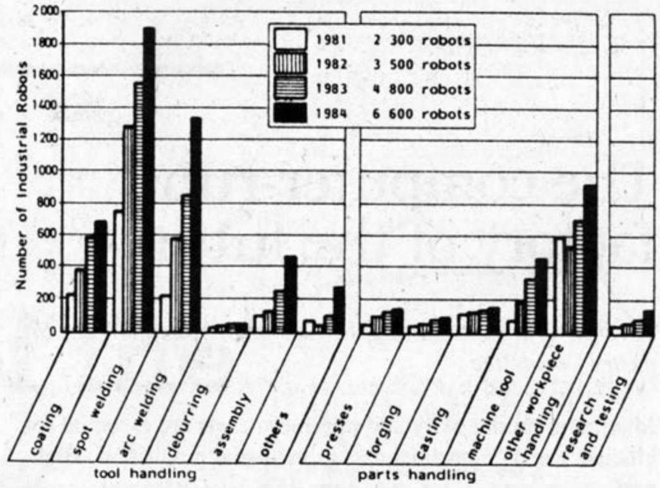
The unique precision of the Pama machine is contained in its hydrostatic bearing system. This allows movement on three axes with continuous hydrostatic pressure to maintain highest precision of large parts which must be milled or bored. The company's earlier nuclear plant experience, according to a representative, gave it the basis to appreciate the need for extremely precise tolerances on very large parts, otherwise impossible in conventional machines. Computer control and feedback systems allow constant monitoring of complex machining tasks with the large Pama system.

With the special exception of West Germany, which is the world's largest exporter of machine-tools, the Italian machine and metal-working tool companies occupied the largest exhibit space at Hanover. With just under 20,000 square meters of space, Italy was well ahead of Switzerland, with 14,000 square meter. Japan and France were approximately equal with 9,000 and 8,000 square meters, respectively.

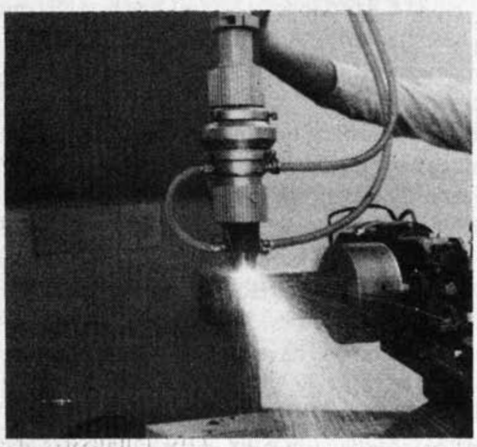
American machine-tool companies were poorly represented, with less than 2,000 square meters.

West Germany, with 79,000 square meters exceeded the total of all other 36 countries combined. While this is no direct index of national size or quality in any strict sense, Hanover's 6th European Machine-Tool Exhibition with World Participation is considered by the industry as the most significant trade event of its kind, held only once every four years. The relative national contributions are indicative of relative intensities of effort.

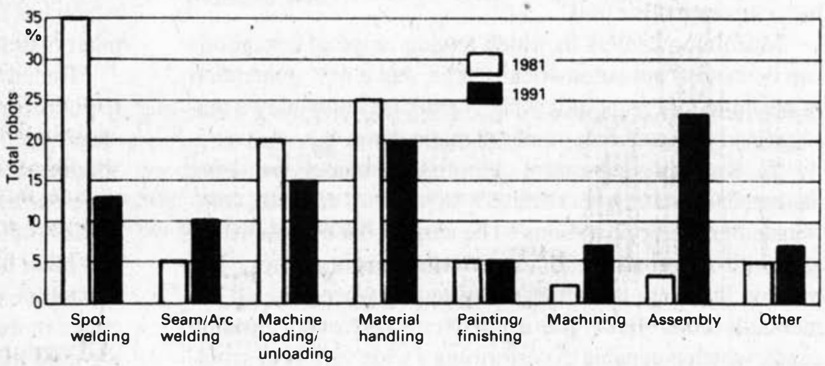
Change of fields of application for industrial robots, Germany



Source: IPA



Robot applications areas in U.S., 1981 and projected 1991



Source: Robot News International

The computer-run factory of the future

Excerpts of a statement by the European Machine-Tool Industry Committee.

Maximum productivity and minimum costs are essential for efficiency and competitiveness in industrial production. High-performance machines and automation play an important role in improving productivity. . . . The term "flexible automation" is used to describe automation and optimization of individual machines and machining functions with the aid of numerical control, integration of handling, measuring and monitoring systems into automatic production processes, as well as highly complex, computer-controlled flexible production systems. The ultimate aim is to create the fully-automated factory, in which all production and monitoring functions are computer-controlled via a comprehensive information network.

Numerical control was first applied to lathes, drilling machines, and milling machines. The control systems which are now available on the market have led to major changes in machining design. The new generation of machines is capable of performing a much wider range of functions. . . .

To an increasing extent, conventional lathes are developing into all-around machining centers capable of carrying out complex turning, drilling, and milling operations from start to finish. The various tools for turning, drilling, and milling are removed automatically from their respective magazines and inserted into special tool mounts, each of which has a separate drive unit. . . .

Machining centers in which a wide range of operations can be carried out automatically represent a new generation in machine-tool technology. Such machines now play a major role in the manufacture of prismatic parts. . . .

To an increasing extent, grinding machines are being equipped with computer control systems, thus enabling complicated grinding operations to be carried out automatically and with the constant input of measurement values. The trueing, dressing, and change of grinding wheels are all numerically controlled. The result is an all-around grinding center which is capable of performing a wide variety of grinding operations.

Numerical control has also been introduced for gear-cutting machines. In other words, the traditional mechanical coupling of tool movements and workpiece movements via change gears has now been replaced by an electronic coupling. This permits retooling and geometry changes to be carried out quickly. Gear cutting machines are also following the trend toward flexible machining centers with automatic changes of tools, workpieces and withholding devices. . .

Quality control

The trend toward machines involving only minimal human supervision demands the continuous monitoring of the tools and the workpieces, as well as the automatic correction of the machining parameters. Workpiece monitoring takes place either in the machine itself (in-process measurement), or subsequently in special measuring machines which feed the measurement back into the machine control system (post-process measurement). In-process measurement is a prerequisite for high-precision machining operations. It has been a common feature of grinding machines for several years and is now to be found in lathes and machining centers.

Sensors are also used to monitor the various functions of machine tools. Any changes trigger pre-programmed compensations in the control system or shut off the machine altogether. . . .

In spite of the progress made in individual areas, the complete realization of computer-integrated manufacture is still some way off in the future. Computer-Aided Design (CAD) is now commonplace in practically all major firms and is constantly being refined and developed. . . . The next step is the direct integration of the geometry data produced during the design stage in the control programs for the machine tools on the production line. The control programs are produced by linking up the geometry data with the relevant technology data stored on a data bank. This procedure has already proved successful for simple workpieces.

The so-called IGES interface—designed to link up CAD systems produced by different manufacturers—has already achieved widespread acceptance. Major progress has also been made in the establishment of local data networks, especially in the field of CAD. General Motors has broken new ground with its Manufacturing Automation Protocol (MAP), which has been developed in conjunction with various computer manufacturers. . . .

The advent of new surface treatment techniques has led to improvements in traditional cutting materials such as high-speed steel, carbide alloys, and aluminum. At the same time, new materials have been developed and perfected. developments were necessary in order to meet the stringent demands placed by the new materials used in the aerospace and other high-technology sectors. Silicon nitride and polycrystalline cubic boron nitride have also opened up new avenues in machining technology. At present these materials are used mainly in lathing applications. However, it is only a matter of time before they are used in metal-cutting processes (drilling, milling, grinding).

EIR

Quarterly Economic Report

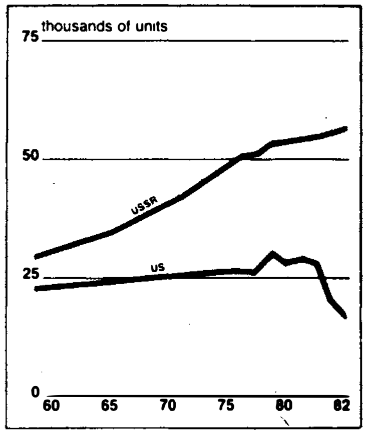
The Looming Bankruptcy of the United States

June 15, 1985

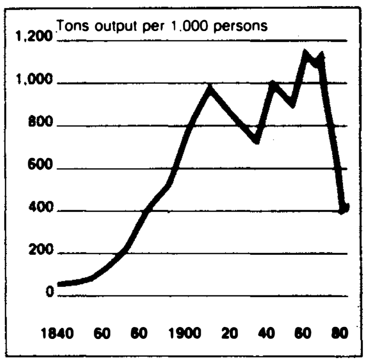
Are the U.S. government's "free enterprise" policies bringing on the "final collapse of capitalism"?

How the Russians must be laughing. With an overvalued dollar, the United States is collapsing internal production capabilities at a rate which must soon reach the point of no return, while ruining the economies of its allies. An estimated $1.3 trillion is being looted annually out of U.S. productive capabilities.

U.S. and Soviet production of power-driven metal-forming machine tools not portable by hand, 1960-82



U.S. iron output per member of the labor force



Did you know that . . .

- **Out of the U.S. banking system's some $3 trillion in loan assets, at least $2 trillion is worthless?** The S&L panic is only the beginning.

- **Since the 1950s, America's living standard has been cut by 50%.** The American population has a deficit of 20% to 70% in basic goods needed for its survival.

- **AIDS is on its way to becoming the Black Death of the 20th century.** If IMF global austerity policies are permitted to continue, the present eruption of this and other pandemic diseases in Africa will subject the United States and other formerly industrialized nations to a biological holocaust worse than nuclear war.

Since the fall of 1979 LaRouche's forecasts have established a record unparalleled in accuracy by any other economic forecasting service in the nation. Data Resources International and Chase Econometrics proved unable, in the fall of 1979, to correctly forecast the consequences of the credit policy then being initiated from the Federal Reserve by Paul Volcker. LaRouche did. Those agencies, and their co-thinkers, have been repeatedly exposed as incompetent bunglers, while the LaRouche record has been maintained.

Full year subscription: **$1,000**
Single issue (second quarter 1985): **$250**

Order from:
EIR News Service P.O. Box 17390, Washington, D.C. 20041-0390