COMPETITIVE ASSESSMENT OF THE U.S. METALWORKING MACHINE TOOL INDUSTRY

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International Trade Commission
on Investigation No. 332-149
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Tariff Act of 1930

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PREFACE

On December 1, 1982, on its own motion and in accordance with section 332(b) of the Tariff Act of 1930 (19 U.S.C. 1332 (b)), the United States International Trade Commission instituted investigation No. 332-149, a competitive assessment of the U.S. metalworking machine tool industry. This study examines the factors affecting the present and future international competitive position of U.S. metalworking machine tool producers. It assesses the impact of the growing competition from imports on the U.S. metalworking machine tool industry, explores the related development of further competition in the industry's overseas markets, and examines the steps that have been and may be taken to counteract these developments. Notice of the investigation was given by posting copies of the notice of investigation at the Office of the Secretary, U.S. International Trade Commission, Washington, D.C., and by publishing the notice in the Federal Register (47 F.R. 55343, Dec. 8, 1982) (app. A).

In the course of this investigation, the Commission collected data from questionnaires sent to 200 producers, 100 importers, and 100 purchasers of metalworking machine tools. Responses were received from 140 producers, 52 importers, and 57 purchasers. A public hearing in this matter was held on June 28, 1983, in the Commission's hearing room in Washington, D.C., and testimony was received from U.S. metalworking machine tool producers, foreign metalworking machine tool producers, and importers of metalworking machine tools (app. B). Additionally, information was obtained from published sources, from questionnaire responses prepared by overseas posts of the U.S. Department of State, from interviews with corporate executives representing producers, importers, and purchasers of metalworking machine tools, from the Commission's files, and from other sources.

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EXECUTIVE SUMMARY

The U.S. machine tool industry is concerned about the decline in its competitive position in domestic and foreign markets in recent years. During 1977-82, the worldwide machine tool market was characterized by two distinct trends. First, during 1977 to early 1981, the United States (and most all major machine-tool-producing countries) experienced a tremendous growth in the production and use of machine tools following the increased emphasis on automation in most major manufacturing industries.

Then, as the impact of the recession hit the world machine tool industry during late 1981 and 1982, U.S. and foreign machine tool production, exports, and consumption dropped substantially. Although the changes in the world machine tool industry affected all major machine tool countries, the impact on the U.S. machine tool industry appeared to be generally more severe than that on other countries, especially in areas of production, exports, employment, and capacity utilization.

The major findings of this study are summarized below.

1. Structure of the domestic and foreign industry

- o <u>The U.S. machine tool industry is currently the world's second largest behind Japan</u>.

Until 1981, the United States and West Germany were the world's leading producers of machine tools; the United States surpassed West Germany in 1979 to rank first in world machine tool production during 1979-81. The surge in Japan's production of machine tools propelled it past the Soviet Union in 1979, past West Germany in 1981, and then past the United States in 1982 into its current position as the leading machine-tool-producing country, accounting for 17.1 percent of total world production. The increases in Japan's machine tool production during 1977-82 were, in part, a result of more than 20 years of Government intervention in the machine tool industry. During the growth years 1977-81, U.S. machine tool production, by value, increased 109 percent, and that of Japan increased 200 percent.

- o <u>The U.S. machine tool industry is generally composed of smaller and more specialized producers than that of all other major foreign competitors except Japan</u>.

The average number of employees per machine tool firm in the United States was 77 in 1982, the lowest among major machine-tool-producing countries, with the exception of Spain and Japan. In the United States, the top 10 firms together account for approximately 40 percent of total employment. Data on Japan's metal-cutting machine tool employment for 1980 indicate that 1,972 machine tool producers together employed approximately 37,000 workers in 1982, or an average of 17 employees per firm. The majority of Japanese machine tool producers employ less than 10 persons. Italy's machine tool industry employs

an estimated 84 workers per firm; Spain's industry, 61 workers; Switzerland's industry, 94 workers; and France's industry, 115 workers. The United Kingdom and West Germany have the largest concentration of workers per firm, with 215 and 225 workers, respectively. Data are not available for the U.S.S.R.

o Capacity utilization in the U.S. machine tool industry has dropped significantly from its peak in 1979.

Capacity utilization in the U.S. metalworking machine tool industry, according to respondents to the Commission's survey, increased from 69 percent in 1977 to 76 percent in 1979, and plummeted to 36 percent by the end of 1982. At the same time, respondents indicated that capacity to produce metalworking machine tools increased 15 percent from 1977 to 1982, primarily through the expansion of facilities and purchases of new equipment.

o Mergers and acquisitions were not significant in number in terms of total number of firms in the industry during 1977-82, but are expected to increase in the near future.

There were at least 64 mergers, acquisitions, and purchases of corporate assets in the U.S. metalworking machine tool industry during 1977-82 and 4 have occurred during January-May 1983. These mergers and acquisitions have involved principally larger companies acquiring smaller companies. There has been a trend toward foreign acquisition of U.S. machine tool companies by manufacturers based in the United Kingdom, West Germany, and Japan. Antitrust investigations involving mergers and acquisitions have been minimal.

In public hearings at the Commission regarding the U.S. metalworking machine tool industry's competitive status, industry representatives stated that the failure rate for firms in the industry would increase in the next 6 months, with a number of defunct firms being acquired by larger companies.

o Expenditures for research and development on machine tools are often partly supported by Government funds in the United States and other major producer countries.

The majority of Governments of the top nine countries which currently export machine tools into the U.S. market have established or sponsored programs dedicated to machine tool development as opposed to supporting basic research in the area of manufacturing. Those countries having dedicated machine tool research facilities include Japan, Taiwan, and Switzerland, with the West German and Italian Governments sponsoring machine tool research at universities, often with industry participation. The United Kingdom sponsors programs in the area of information systems, which include Flexible Manufacturing

Systems (FMS), Computer-aided design (CAD) and Computer-aided Manufacture (CAM), and robotics. 1/

The U.S. Government generally funds generic research and development (R&D) programs in many technologies not directly related to the machine tool industry, such as materials processing, computer applications, and electronics. Such R&D, however, can be applied to the manufacture of machine tools or in the product itself. U.S. Government-funded manufacturing research frequently is concerned with issues in machining or machine tools. However, the National Bureau of Standards and the U.S. Air Force fund programs which specifically benefit the machine tool industry and have direct application in nondefense production. The U.S. Department of Defense spends approximately $150 million to $200 million annually (projections for future years are about $300 million annually) for its Manufacturing Technology program, which indirectly benefits the U.S. machine tool industry. 2/

o Major foreign machine tool producers are more likely to acquire capital outside the firm than are U.S. producers and, therefore, have greater access to capital.

Historically, the U.S. machine tool industry has had difficulty in generating capital. Commission staff research of available documents and interviews with industry officials indicate that the small size of most U.S. producers and the cyclical nature of the industry have made it difficult for machine tool producers to secure external financing, and that few U.S. financial institutions are willing to invest in such a small, cyclical industry. This situation is reflected in the debt-to-equity ratios of U.S. firms, which are typically less than 50 percent. Major foreign machine tool producers, on average, have more financial leverage. For example, Japanese firms typically have debt-to-equity ratios of 150 percent to over 550 percent, an indication that the Japanese machine tool companies have easier access to capital than their U.S. counterparts. Generally, the major European producers have debt-to-equity ratios that vary between 30 and 120 percent.

o The production and assembly of foreign-designed metalworking machine tools are increasingly occurring in the United States.

U.S. manufacturers are increasingly producing or assembling foreign-designed machine tools under license from foreign

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1/ FMS consist of one or more computer-controlled machine tools, other machinery (such as testing and inspecting machines), automated material-handling systems, and a central computer which controls the other three elements. CAD/CAM are systems in which computers are used to eliminate repetitive, time-consuming tasks (such as mathematical calculations of a tool path through a workpiece), and improve the accuracy and speed with which design and machining operations may be accomplished.

2/ R. Donnelly, MTAG-81, Proceedings, Thirteenth Annual Tri-Service Manufacturing Technology Coordination Conference, San Diego, Calif., Nov. 30-Dec. 3, 1981, p. 19.

manufacturers, and at the same time, foreign manufacturers are establishing production or assembly facilities in the United States. Foreign manufacturers are either establishing new facilities or are acquiring U.S. manufacturers. Most notably, this is occurring among manufacturers from West Germany, Switzerland, and Japan. European firms have indicated that production or assembly in the United States is a reaction to increased Japanese competition in the U.S. market. The Japanese producers have stated, however, that production in the U.S. market is a way to minimize the increasingly protectionist mood in the U.S. machine tool industry. In addition, U.S. manufacturers are increasingly producing foreign-designed machine tools in order to maintain or expand their market share by augmenting their product line, mostly with standard, multiuse machine tools.

2. The current U.S. market

o The United States is the largest machine-tool-consuming country; however, Japan experienced the most significant consumption growth during 1977-82.

During 1977-82, the United States was the largest consumer of machine tools in the world; U.S. consumption peaked in 1981 at almost $5.6 billion, representing a gain of 233 percent over the amount consumed in 1977, and then fell to $4.4 billion in 1982. During 1977-81, Japanese consumption increased more than 200 percent to $3.3 billion in 1981 from $1.1 billion in 1977, the most significant increase of the 10 largest consuming countries.

o Imports of machine tools constitute a growing share of the U.S. market.

U.S. imports of machine tools increased from $401 million in 1977 to $1.49 billion in 1981, or by 259 percent, before declining to $1.3 billion in 1982. During 1977-81, U.S. imports as a share of apparent consumption grew from 16.7 percent to 26.6 percent, and increased to 29.5 percent in 1982.

o The import share of domestic consumption of machines tools increased significantly more in the United States than in any other major machine-tool-consuming country.

In the United States, imports as a share of domestic consumption increased to just under 30 percent in 1982 from 17 percent in 1977--a gain of nearly 13 percentage points. Import penetration was higher in France (61 percent in 1982) and the United Kingdom (61 percent in 1982), however, the percentage increase in import penetration in the United States during 1977-82 exceeded that of all other major machine-tool-consuming countries during that period. Japan's import penetration, the lowest among major machine-tool-consuming countries, was only 8 percent in 1982.

- o The Japanese share of total U.S. imports increased significantly during 1977-82, partially at the expense of West German and United Kingdom suppliers.

In 1977, Japan accounted for $105 million, or 26 percent of total U.S. imports; West Germany accounted for $91 million, or 23 percent of the total; and the United Kingdom accounted for $446 million, or 11 percent of the total. By 1982, the value of Japanese imports reached $535 million, or 41 percent of total U.S. imports, whereas imports from West Germany, valued at $204 million, accounted for only 16 percent, and those from the United Kingdom dropped to 9 percent of the total.

- o The distributor network in the United States plays an important role in the sales of off-the-shelf machine tools.

Approximately two-thirds of the value of U.S. machine tool sales is accounted for by independent distributors. The remainder is marketed through company-owned distributors, or sold direct. For both U.S.-made and imported machine tools, highly specialized machines are sold primarily to the end user directly, whereas off-the-shelf (standard) machines are sold principally through independent distributors.

3. Factors of competition in the United States

- o U.S.-made, standard-type machine tools are perceived by U.S. purchasers to be of a lesser quality than those of foreign manufacturers; however, the quality of the specialty U.S. machine tools are rated superior.

Product quality entails not only the technology embodied in the product, but also performance features such as engineering design, productivity yield, durability, maintenance costs, and energy efficiency. The Commission's survey of domestic machine tool purchasers revealed that certain foreign-made machine tools are generally perceived to be better designed than U.S.-made machine tools, have higher productivity, and require less maintenance. This appears to be especially applicable to standardized machines such as lathes and machining centers. However, U.S.-made machines for specialized applications for such industries as aerospace, fabricated-metal products, and transportation, are viewed by purchasers as superior to their foreign competitors'. A 1982 survey of U.S. purchasers by a private research group revealed that both specialized and standard U.S.-made machine tools maintained only a slight edge in engineering features, compared with foreign-made machine tools.

- o The average prices of U.S.-made numerically controlled lathes and machining centers were well above the average prices for imported like products, according to respondents to the Commission's survey.

According to responses of the producers and importers in Commission questionnaires, importers have a significant advantage in price over

U.S. producers of NC lathes and machining centers. U.S. domestic shipment prices of NC lathes in 1982 were, on average, $92,714 more than import shipment prices. U.S. domestic shipment prices of machining centers in 1982 were, on average, $89,000 above import shipment prices.

o U.S. machine tool manufacturers generally require longer lead times for delivery than do major foreign competitors.

The length of the lead time from purchase order date to delivery appears to be an important factor in a successful machine tool sale, especially for manufacturers of standardized machines. Machine tool purchasers in the U.S. market indicate that foreign producers have gained market share in part because of their ability to provide more timely delivery.

o U.S. machine tool producers generally provide better after-sales service on specialty machine tools than do their major foreign competitors, but U.S. producers are ranked lower in after-sales service for standard machines.

After-sales service not only affects the reputation of the distributor (if the product is sold through such a network), but ultimately the manufacturer as well. This is especially true if the manufacturer sells directly to the customer. The quality of after-sales service is reflected in providing spare parts in a timely manner, implementing warranties and product servicing, communicating product changes to the customer, and customer training.

According to the Commission's survey of machine tool purchasers, in the U.S. marketplace, after-sales service for foreign-made standard machine tools, such as NC lathes and machining centers, appears to be superior to that for comparable U.S.-made machine tools. After-sales service for U.S.-made specialty machine tools, however, received a higher rating from U.S. purchasers than the comparable foreign-made products.

o Inventories of foreign-built machine tools in the United States have grown substantially in recent years.

The Commission's survey of U.S. importers of metalworking machine tools indicated that as of December 1982, there were at least 5,246 foreign-made machine tools in inventory in the United States, and this figure could have been as high as 12,000 units.

According to a survey by the Japan Machine Tool Builders' Association in 1982, of the 3,878 numerically controlled (NC) lathes and 2,180 machining centers shipped to the United States in 1981, 2,500 and

1,000, respectively, were considered to be in inventory. By the end of 1982, estimates of unsold Japanese machine tools in the United States ranged between 5,000 and 10,000 units, worth up to $500 million. In late 1981 and throughout 1982, when demand for machine tools was severely depressed, large inventories of foreign-made machine tools led to price-cutting competition, with manufacturers' discounts of 15 percent being commonplace.

- o U.S. manufacturers are competitive in the United States and world markets with respect to highly specialized machine tools and somewhat less competitive in the standard-type machine tools.

The U.S. industry is regarded in world markets as the leader in high-technology machine tools that are designed for highly specialized operations. Such operations include aircraft component machining, military equipment machining, special health care equipment machining, and long assembly line operations such as those found in the automobile industry. In the standard-type machine tools, such as lathes and machining centers typically ordered by independent job shops, the U.S. equipment is perceived to be of lesser quality than that of major foreign producers, especially Japanese producers.

4. Factors of competition in foreign markets

- o The value of U.S. exports of machine tools dropped in recent years as the U.S. share of the world market declined.

In 1977, U.S. exports of metalworking machine tools were valued at $452 million, which represented 3.4 percent of world consumption of machine tools ($13.1 billion). This share of world consumption remained relatively unchanged through 1980. In 1981, U.S. exports were about $1 billion and represented 4.3 percent of world consumption, and the U.S. ranked as the third largest exporter of machine tools. The U.S. share decreased to 3.1 percent in 1982, when U.S. exports were $623 million and the U.S. fell to the sixth largest exporting country.

- o U.S. machine tool manufacturers export considerably less of their total production than do those in most other major producing countries.

During 1977-82, the United States exported between 16 and 19 percent of domestic production, making its export-to-production ratio the second lowest among major machine-tool-exporting countries. Traditionally, U.S. market demand was sufficient to absorb most of U.S. production. Foreign producers could not rely on their rather limited domestic market to the extent that U.S. producers could. West Germany consistently exported between 63 and 69 percent of its total production during 1977-82. Japan's export-to-production ratio ranged between 33 and 43 percent during the same period. Switzerland exported as much as 89 percent of production, the United Kingdom exported as much as 67 percent, and Italy exported as much as 60 percent of domestic production.

- Most major producing machine tool countries enjoy a competitive advantage over the United States because of labor and input costs and exchange rates.

Most of the inputs used in the production of machine tools in any country are purchased from domestic sources. Approximately 60 percent of the inputs in the machine tool industry are labor, and much of the remaining 40 percent consists of steel that is typically purchased domestically. Therefore, the evidence suggests that most foreign producers of machine tools have enjoyed an increase in competitiveness vis-a-vis that of the United States since 1976 because of the differences in relative inflation rates, labor costs, and changes in exchange rates.

- Japan's machine tool productivity has risen to twice that of the United States and all other major producing countries.

Machine tool productivity among major machine-tool-producing countries increased significantly during 1977-80 (or 1981, depending on the particular country). Japan's productivity gains during this period were the most pronounced among major producing countries, growing to $114,000 worth of production per employee in 1981 from $36,000 per employee in 1977, reflecting, in part, moves by Japanese producers to concentrate on mass production of standard-type machining centers and lathes as opposed to production of specialty machines. U.S. productivity in machine tools steadily increased, from $29,000 per employee in 1977 to $53,000 per employee in 1981, representing less than one-half the productivity of Japan. In 1982, U.S. productivity ranked third among major machine-tool-producing countries behind Japan and Switzerland.

5. Future markets in the United States and foreign countries.

- Future developments in the U.S. and foreign machine tool industries will focus on flexible manufacturing systems and computer-aided design and manufacturing.

In both the United States and foreign countries, the technological areas of increasing importance in the machine tool industry will be FMS and CAD/CAM. When FMS is combined with CAD/CAM, an engineer will be able to design parts and initiate production of that particular part almost immediately. The industries which consume machine tools, particularly the automobile and aerospace industries, have recently increased their purchase of numerically controlled machine tools as opposed to conventional types. Total numerically controlled machine tools in use in the United States increased from about 1 percent of all machine tools in use in 1976 to 2.2 percent in 1982, with consumption of NC machine tools equal to approximately 36 percent of total machine tool consumption in the United States in 1982. Currently, the United

States lags behind both Japan and Europe in the installation and application of FMS units; the United States does maintain the lead in CAD, but lags in the application of CAM. Other areas with important future applications to machine tools will be lasers, microelectronics, and computer data-base techniques for controlling manufacturing systems.

DESCRIPTION AND USES

Machine tools are responsible, directly or indirectly, for almost every manufactured product. They either produce the machines which produce the products or they produce the products directly. Machine tools are the only machines capable of producing other machines, including other machine tools. Thus, machine tools are responsible for almost any rise in productivity and are the standard by which a nation's industrial development and wealth are measured. Metalworking machine tools constitute the bulk of production and consumption of machine tools in the United States, as opposed to woodworking and other types of machine tools.

Metalworking machine tools are machines used for shaping or surface-working metals, including metallic carbides, "whether by cutting away or otherwise removing the material or by changing its shape or form without removing any of it." The term does not include rolling mills and hand-directed or hand-controlled tools. 1/ Metalworking machine tools are generally classified as one of two types--metal-removing or metal-cutting, and metal-forming. 2/ Metal-removing machine tools are those that "shape or surface-work metal by removing metal either in the form of chips, dust, swarf, or similar forms or by spark-erosion, ultrasonic, electrolytic, or other chipless methods." Metal-forming machine tools are "metal-working machine tools other than metal-removing (metal-cutting) machine tools." 3/

Machine tools are power-driven devices designed to cut or form metal (workpieces) to a specified size and shape within allowable tolerances and finishes. The cutting or forming of a metal part is accomplished by the precisely controlled relative movement between the workpiece and a tool. The workpiece and the tool are generally both mounted on and rigidly supported by the machine tool, although in large applications, the workpiece may be mounted externally to the machine, requiring precise movement of the machine.

Five basic types of relative motion are provided by machine tools. The five types of relative motion are accomplished when: (1) a workpiece is rotated and the cutting tool is simultaneously fed into the workpiece and traversed along its length (this is the basic cut performed on a lathe); (2) there is reciprocation 4/ between a workpiece and the tool (on a planing machine, the workpiece reciprocates and the tool is fed and traversed, and on a shaping machine, the workpiece is traversed and the tool is fed and reciprocated); (3) the workpiece is held stationary while the cutting tool is rotated and fed (as in drilling); (4) the workpiece is traversed and fed while

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1/ As defined in the Tariff Schedules of the United States Annotated (app. C).

2/ App. D illustrates the types of machine tools in each of the two major groups.

3/ As defined in the Tariff Schedules of the United States Annotated (app. C).

4/ Reciprocation refers to the alternate back and forth motion of the workpiece or tool; feeding is the term applied to motion that tends to deepen the cut; traversing is the type of motion that exposes new areas of the workpiece to the tool, broadening the cut.

the cutting tool rotates (milling and grinding operations); and (5) the workpiece is positioned between opposing tools which move together to strike, squeeze, or shear the workpiece (as in punching, bending, stamping, forging, and similar operations).

Metal-removing machine tools include machines for boring, drilling, gear cutting and finishing, grinding (special-purpose, surface, and tool and cutter grinding), polishing, lapping, honing, milling, planing, shaping, slotting, broaching, sawing, filing, turning, threading, and for multiple functions (machining centers). Metal-forming machine tools include machines for punching, pressing, shearing, bending, forging, forming, and other special tasks. In addition to the above-named machine tools, special-purpose and one-of-a-kind machine tools are produced to meet the special needs of individual customers.

Hundreds of different operations can be performed by machine tools; however, areas of application can overlap, and most operations can be performed by at least three types of machine tools. Under a given set of circumstances though, only one machine tool will do the best job. Therefore, an engineer must have a good working knowledge of the various metals to be cut or formed and the various capabilities of the machine tools available. The basic operation of the machine tools, the type of material being cut or formed, the size, shape, tolerance, and finish of the workpiece, and the types of cutting tools available are all factors which must be considered in the selection of the proper machine tool for a specific job.

Machine tools have changed little over the years with respect to their basic functions of metal cutting and metal forming. What has changed and what has caused most of the variations in machine tool design and construction are the methods by which the machine tool motions that enable it to cut and form metal are controlled. Early machine tools were entirely manually controlled. However, as component parts of machinery and equipment became more sophisticated, there developed a need for likewise sophisticated methods of production. Numerical control (NC) evolved from an electronic control system that was developed through a program funded by the U.S. Air Force in the late 1940's and early 1950's, and the first commercial NC machine tools appeared on the market in the mid-1950's. However, it took nearly 20 years for NC machine tools to gain acceptance. As late as 1976, only 1 percent of all types of machine tools in use in the United States were NC. 1/ This is not to say that NC lends itself to all production processes, but NC is the first step toward computer-aided manufacturing (CAM). The major factors inhibiting the adoption of NC in its early stages by machine tool purchasers were its price and the size of the control unit. The development of integrated circuits resulted not only in a substantial reduction in the size and price of NC units, but also in simpler operation and reduced programming complexity, faster, more flexible machine tool control, and the ability to interface computers with the control unit. Notwithstanding these developments, however, interest in NC machine tools has not increased significantly--in 1982, in the United States, only about 2.2 percent of all machine tools in use were NC. 2/ However, the

1/ "The Machines Behind The Machines," Iron Age, Aug. 30, 1976, p. 291.

2/ Based on "12th Inventory of Metalworking Equipment, 1976-1978," American Machinist, and industry shipment data for 1979-82, National Machine Tool Builders' Association.

Department of Commerce reports that about 3.5 percent of the quantity of U.S. shipments of machine tools in 1982 were NC. 1/ In, addition, testimony was presented at the U.S. International Trade Commission hearing 2/ that indicated U.S. consumption of NC machine tools in 1982 was 36 percent of the value of total machine tool consumption that year. Although NC machine tools have accounted for a relatively small portion of machine tool consumption in the past, they are the leading edge of technology and are expected to account for a significant portion of industry output and consumption in the future.

The most important function of numerical control is the accurate positioning of the tool in relation to the workpiece by means of signals or commands from a preprogrammed source. The command input to the control unit is typically in the form of numerical coding on punched paper tape. It can also be in the form of magnetic tape or punched cards, although these methods are not commonly used. The punched paper tape is scanned by a reader which sends signals to a control unit which, in turn, sends instructions to the stepping motors and drive units for each machine axis that is being controlled. Machine tools have been designed with up to eight axes numerically controlled. In addition to controlling the axes of motion, NC functions include selecting the proper tool from a magazine and controlling the speed and direction of spindle rotation. Numerical control was instrumental in the development of the machining center, since it was impossible to control more than two axes of motion simultaneously before the advent of NC. Numerical control programming can be either point-to-point or continuous path. Point-to-point programming locates the spindle or workpiece in one specific relative position after another, without the tool contacting the workpiece while moving from position to position. Continuous path programming provides the means for contouring operations since the tool is in contact with the workpiece as the tool or workpiece or both are moved about their axes of motion.

Other types of control for machine tools are programmable control (PC), direct numerical control (DNC), and computer numerical control (CNC). Programmable control allows the machine tool operator to interrupt the program at any time and interject another operation or machining sequence. Direct numerical control is a method by which a common computer directly controls one or more numerically controlled machine tools. This computer can also be used to provide information on machine utilization and for production reports. Computer numerical control systems utilize microcomputers to store machining programs in read-only memories. The computer is used to augment or replace a numerical control unit. The advantages of CNC are its adaptability to different types of machine tools, ease of programming and information retrieval, and the ability of one computer to simultaneously control two or more machine tools.

Some basic machining operations which require only one or a few parts are still most cost effective when performed by a skilled machinist on a manually controlled machine tool. However, complex machining and accurate reproduction of a number of similar parts are best accomplished by numerically controlled machine tools.

1/ U.S. Department of Commerce, Current Industrial Reports, Metalworking Machinery, 1982.

2/ Hearing held before the U.S. International Trade Commission, June 28 and 29, 1983.

THE WORLD INDUSTRY AND WORLD MARKET

World Production

During 1977-80, there was significant growth in world production of machine tools; the United States and West Germany shared the two top positions as world producers of metalworking machine tools (fig. 1). West Germany's machine tool production climbed from $2.64 billion in 1977 to $4.71 billion in 1980, before declining sharply to $3.95 billion in 1981 and $3.5 billion in 1982. U.S. production followed a similar trend; however, unlike that of West Germany, U.S. production growth was sustained through 1981, and in that year reached $5.11 billion, up from $2.44 billion in 1977, before plummetting to $3.62 billion in 1982.

During 1977-81, production by Japan increased greatly, from $1.60 billion, making it the world's fourth largest producer in 1977, to $4.8 billion in 1981, surpassing West Germany and putting it in second place behind the United States as the leading producer of machine tools. Japan's 1982 production, valued at $3.89 billion, surpassed that of the United States. Although Japan's production also fell in 1982, it did not fall to the extent experienced by United States and West German producers. During 1977-81, the value of U.S. production increased 109 percent, and that of Japan increased 200 percent. Production of machine tools by the Soviet Union, the world's fourth largest producer during 1977-82, fluctuated between $2.2 billion and $3.1 billion.

Other important producing countries displaying impressive production gains during 1977-80 were Italy and the United Kingdom, with growth rates of 97 and 137 percent, respectively. The current world slump in machine tool production began in 1981 for most countries except the United States and Japan, which, as mentioned earlier, sustained production growth through 1981.

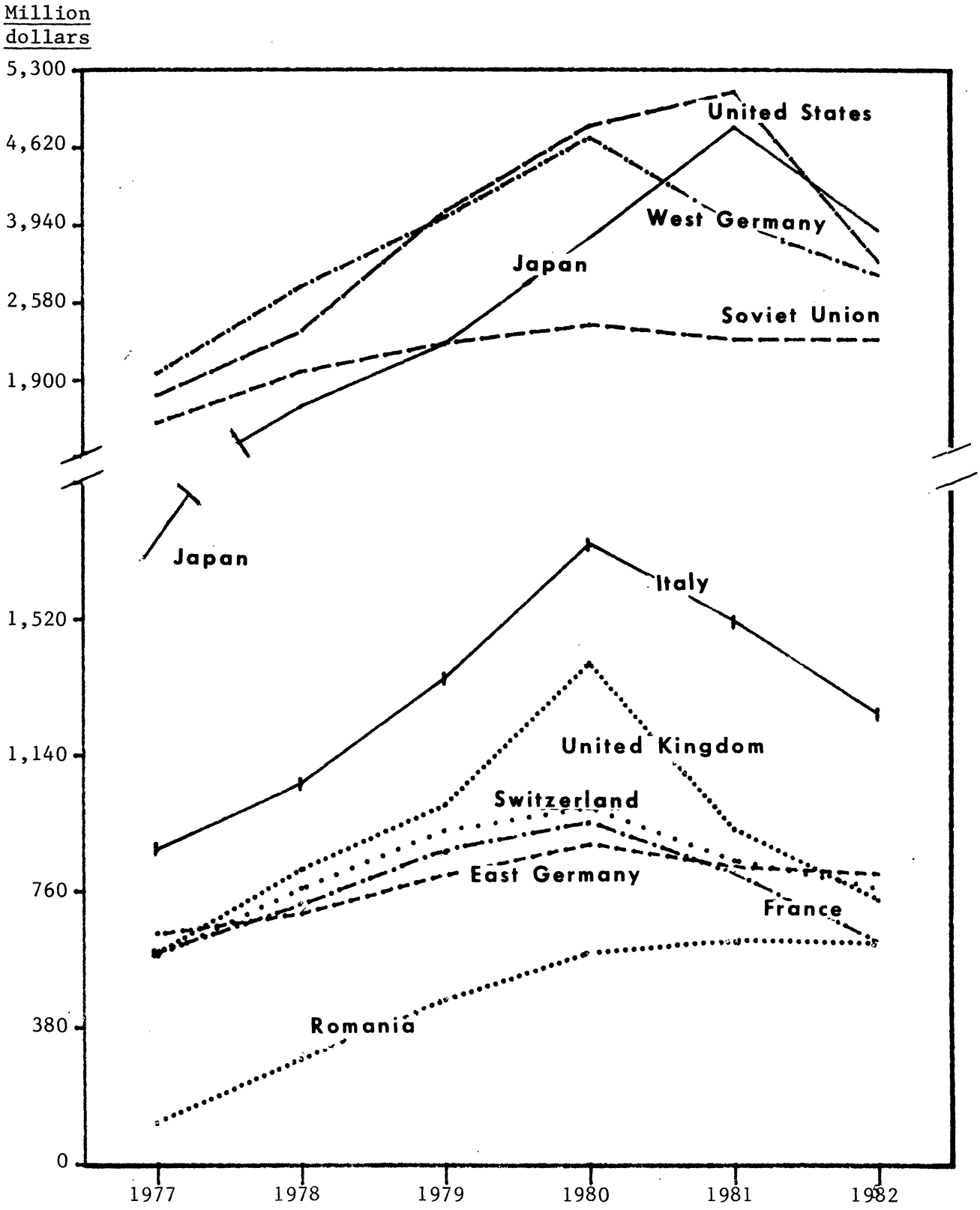
Total world production increased significantly during 1977-80, from $15.1 billion in 1977 to $26.7 billion in 1980, or by 77 percent, as shown in the following tabulation:

Year	Production (billion dollars)
1977	15.1
1978	19.1
1979	22.9
1980	26.7
1981	26.4
1982	22.7

Reflecting the beginning of the current world slump in machine tool demand, world production dropped slightly to $26.4 billion in 1981, and then fell more sharply to $22.7 billion in 1982, or by 14 percent. 1/

1/ If adjusted for inflation, the decline in world production in 1981 and 1982 would be much more precipitous.

Figure 1.--Metalworking machine tools: Production, by specified countries, 1977-82.



Source: Data compiled from various issues of the American Machinist.

In 1977, the four leading machine-tool-producing countries--West Germany, the United States, the Soviet Union, and Japan--together accounted for 58.7 percent of total world production (table 1). By 1982, these four countries had increased their share of world production to 61.3 percent, and the relative position among these countries had changed considerably. Japan's share of the world market increased 6.5 percentage points during 1977-82; conversely, West Germany's world share fell 2 percentage points. U.S. production of machine tools accounted for 16.1 percent of total world production in 1977 and the U.S. share of total world production reached 19.3 percent in 1981, before dropping to 15.9 percent in the following year. Japan's share of world production jumped sharply in 1981 to 18.2 percent, almost 4 percentage points higher than its share in 1980.

Table 1 .--Metalworking machine tools: Percentage distribution of world production, by major producing countries, 1977-82

Country	1977	1978	1979	1980	1981	1982
Japan	10.6	12.3	12.6	14.3	18.2	17.1
United States	16.1	15.8	17.7	18.0	19.3	15.9
West Germany	17.4	17.8	17.5	17.6	15.0	15.4
U.S.S.R	14.6	13.9	12.7	11.5	11.1	12.9
Italy	5.8	5.6	5.9	6.5	5.7	5.5
East Germany	4.2	3.7	3.5	3.3	3.1	3.6
Switzerland	3.8	4.0	4.1	3.7	3.2	3.4
United Kingdom	3.9	4.3	4.4	5.2	3.5	3.2
France	3.9	3.8	3.8	3.6	3.1	2.7
Romania	.8	1.5	2.0	2.2	2.4	2.7
Peoples Republic of China	2.4	2.1	1.8	1.6	1.7	2.1
Czechoslovakia	1.7	1.9	1.6	1.2	1.4	1.9
All other	14.8	13.3	12.4	11.3	12.3	13.6
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Data compiled from various issues of the American Machinist.

Most other machine-tool-producing countries of note decreased their share of world production during 1977-82. Such countries include Italy, East Germany, Switzerland, the United Kingdom, and France, which collectively saw their share of world production fall from 21.6 percent in 1977 to 18.4 percent in 1982. Of the lesser world machine tool producers, only Romania significantly increased its share of world production. Romania's share increased steadily from 0.8 percent of world production to 2.7 percent in 1982, or by more than 230 percent.

One measure of the importance of machine tool production to national economies is the ratio of the value of machine tool production to the total gross national product (GNP). This ratio varies significantly among the major non-Communist machine-tool-producing countries (fig. 2). For example, the value of machine tool production in Switzerland reached 0.094 percent of that country's total GNP during 1977-82, the highest such ratio of the major producing countries. Conversely, machine tool production in the United States accounted for 0.012 percent of U.S. GNP in 1982. Machine tool production in West Germany fluctuated between 0.051 and 0.058 percent of GNP during 1977-82, representing the second highest among major machine tool producers. The value of Japan's machine tool production to its total GNP reached almost 0.042 percent in 1981 from 0.023 percent in 1977, representing the largest such growth of all major machine-tool-producing countries.

World Imports

Although annual imports of machine tools by most major importing countries fluctuated considerably, U.S. import growth during 1977-81 was the most striking (table 2). U.S. imports grew from $401 million in 1977 to $1.44 billion in 1981, or by 259 percent. U.S. imports fell somewhat in 1982 to $1.3 billion. The Soviet Union's imports ranged between $803 million (1978) to $988 million (1980). West Germany's imports of machine tools grew 143 percent during 1977-80, from $320 million in 1977 to $802 million in 1980, before declining to $514 million in 1982. With few exceptions, most major importing countries saw their imports increase from 1977 through 1980 or 1981 and decline thereafter, reflecting the general downturn in the worldwide industrial cycle.

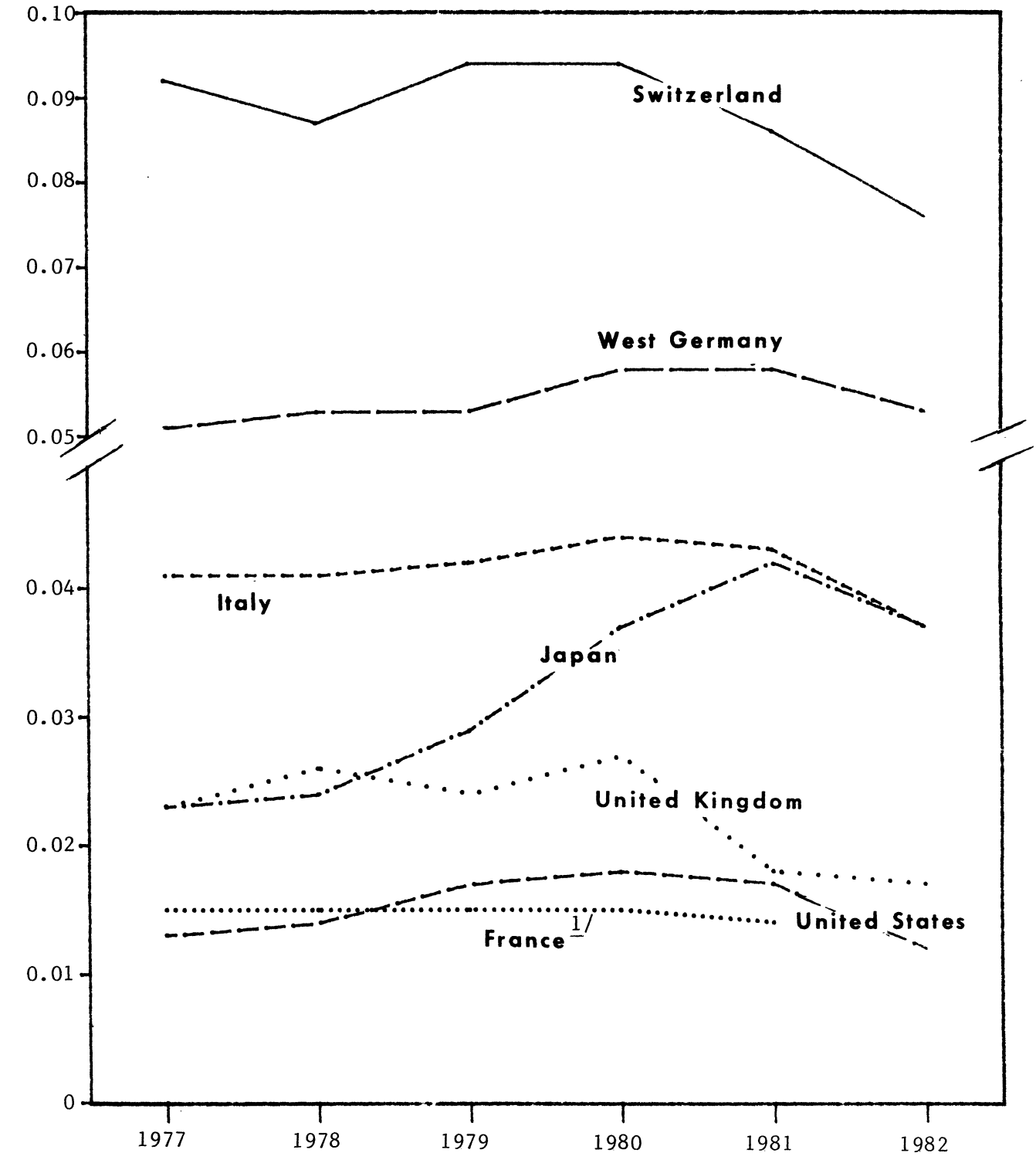
Table 2.--Metalworking machine tools: Imports, by specified countries, 1977-82

(In millions of dollars)

Country	1977	1978	1979	1980	1981	1982
United States	400.9	715.3	1,043.8	1,298.5	1,437.0	1,300.0
U.S.S.R	900.0	803.0	881.0	987.8	951.9	960.0
West Germany	320.4	462.0	620.9	802.1	616.4	514.5
France	286.2	289.6	371.4	554.0	566.6	484.2
United Kingdom	238.3	399.2	600.4	623.4	432.0	385.2
Bulgaria	35.0	25.0	23.0	24.0	267.8	273.0
Austria	86.3	98.9	135.6	165.6	290.2	271.9
Canada	190.9	228.0	260.5	433.0	557.4	260.6
Republic of Korea	130.0	156.0	397.6	344.3	324.5	250.0
Japan	87.8	119.9	164.3	229.3	215.8	228.4
Italy	187.7	194.4	255.9	379.7	300.0	221.4
Rep. of South Africa	46.0	80.5	140.5	205.7	250.0	212.0
Mexico	80.0	75.0	85.0	310.0	450.0	200.0
Romania	150.0	339.0	374.1	316.9	311.5	197.5
East Germany	173.9	217.8	243.8	257.5	214.6	197.0

Source: Data compiled from various issues of the American Machinist.

Figure 2.--Metalworking machine tools: The value of production of metalworking machine tools as a share of GNP, by specified countries, 1977-82



1/ 1982 data for France are not available.

Source: Derived from gross national product data published by the International Monetary Fund and from data submitted by interested parties to the U.S. International Trade Commission in this investigation.

World Exports

West Germany and Japan consistently ranked as the major exporting countries during 1977-82 (fig. 3). During this period, West Germany's exports climbed to almost $3.0 billion in 1980 from $1.8 billion in 1977, or by 67 percent. West Germany's exports then declined in each of the next 2 years, falling to $2.3 billion in 1982. Japan's exports increased steadily during 1977-81, to $1.7 billion in 1981 from $616 million in 1977, or by 176 percent. Japan's exports fell to $1.3 billion in 1982.

In 1982, the United States ranked sixth as an exporting country, with exports valued at $640 million. U.S. exports in 1982 represented a decline of 34 percent from the $972 million in exports recorded in 1981--the peak export year for the United States. During 1977-81, U.S. exports grew by 115 percent from $452 million in 1977. Other major exporting countries in 1982 were Italy, ($749 million in exports), Switzerland ($680 million), East Germany ($642 million), and the United Kingdom ($490 million). The peak years for exports during 1977-82 for all major exporting countries were, depending on the country, either 1980 or 1981.

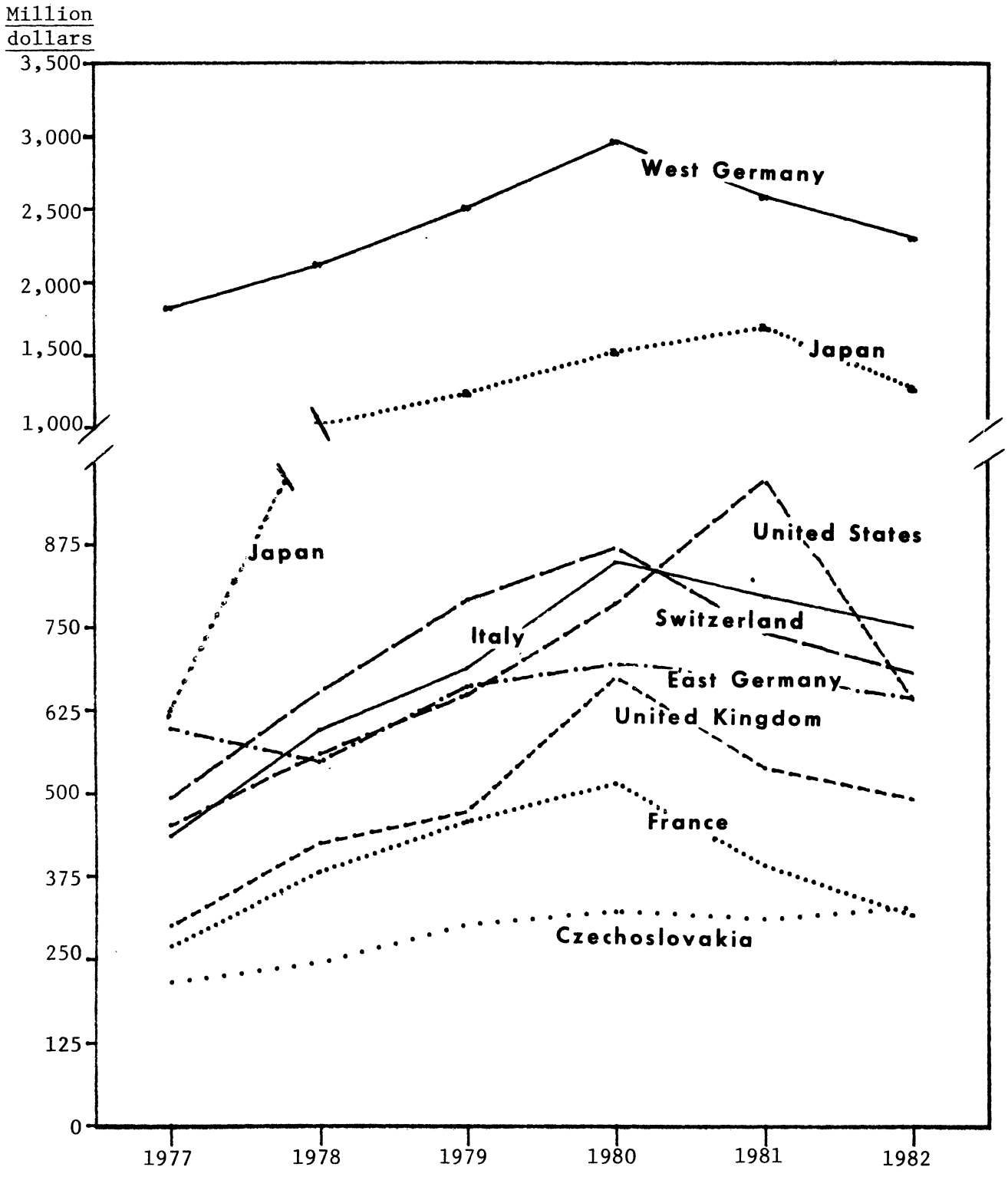
The level of exports as a share of total production for individual countries varied considerably. West Germany, for example, exported almost 66 percent of its total production in 1982, and it consistantly exported from 63 to 69 percent of total domestic production during 1977-82 (see fig. 4 for a comparison of 1977 and 1982 export-to-production ratios). Conversely, during 1977-82, the United States exported between 16 and 19 percent of domestic production, making its export-to-production ratio the second lowest of major machine-tool-exporting countries. Japan's export-to-production ratio ranged from 33 to 43 percent during the same period, and its export share of domestic production has declined since 1979.

The export market is much more important to most other countries in terms of total domestic machine tool production than it is for the United States. Switzerland, for example, exported as much as 89 percent of its production during 1977-82. East Germany's exports in 1977 reached 93 percent of production, the United Kingdom exported as much as 67 percent of domestic production, and Italy exported as much as 60 percent of its production during 1977-82.

Of the major exporting countries, only Japan, Italy, and the United Kingdom increased their shares of total world exports in 1982 compared with those of 1977. Japan's share of total world exports increased from 9.5 percent in 1977 to 13.4 percent in 1982 (fig. 5), that of Italy increased to 7.9 from 6.7 percent, and that of the United Kingdom increased slightly to 5.1 percent (1982) from 4.6 percent (1977).

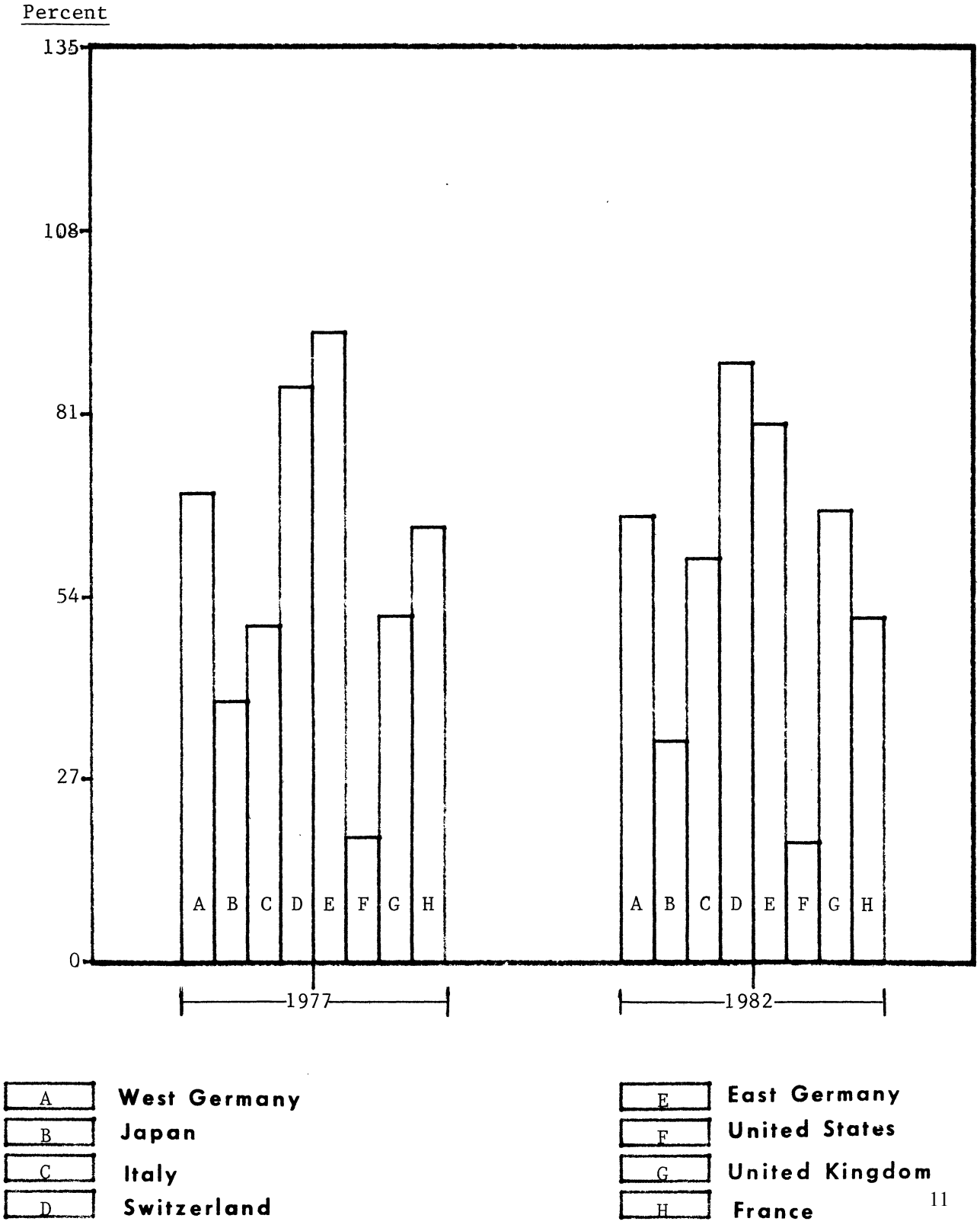
During 1977-82, Japan maintained its position as the world's second largest machine-tool-exporting country, trailing only West Germany. West Germany's exports as a share of total world exports declined almost 4 percentage points, from 28.0 percent in 1977 to 24.2 percent in 1982. This decline coupled with Japan's increase narrowed the gap between the two countries to 10.8 percentage points in 1982, compared with a gap of 18.5 percentage points in 1977.

Figure 3.--Metalworking machine tools: Exports, by specified countries, 1978-82.



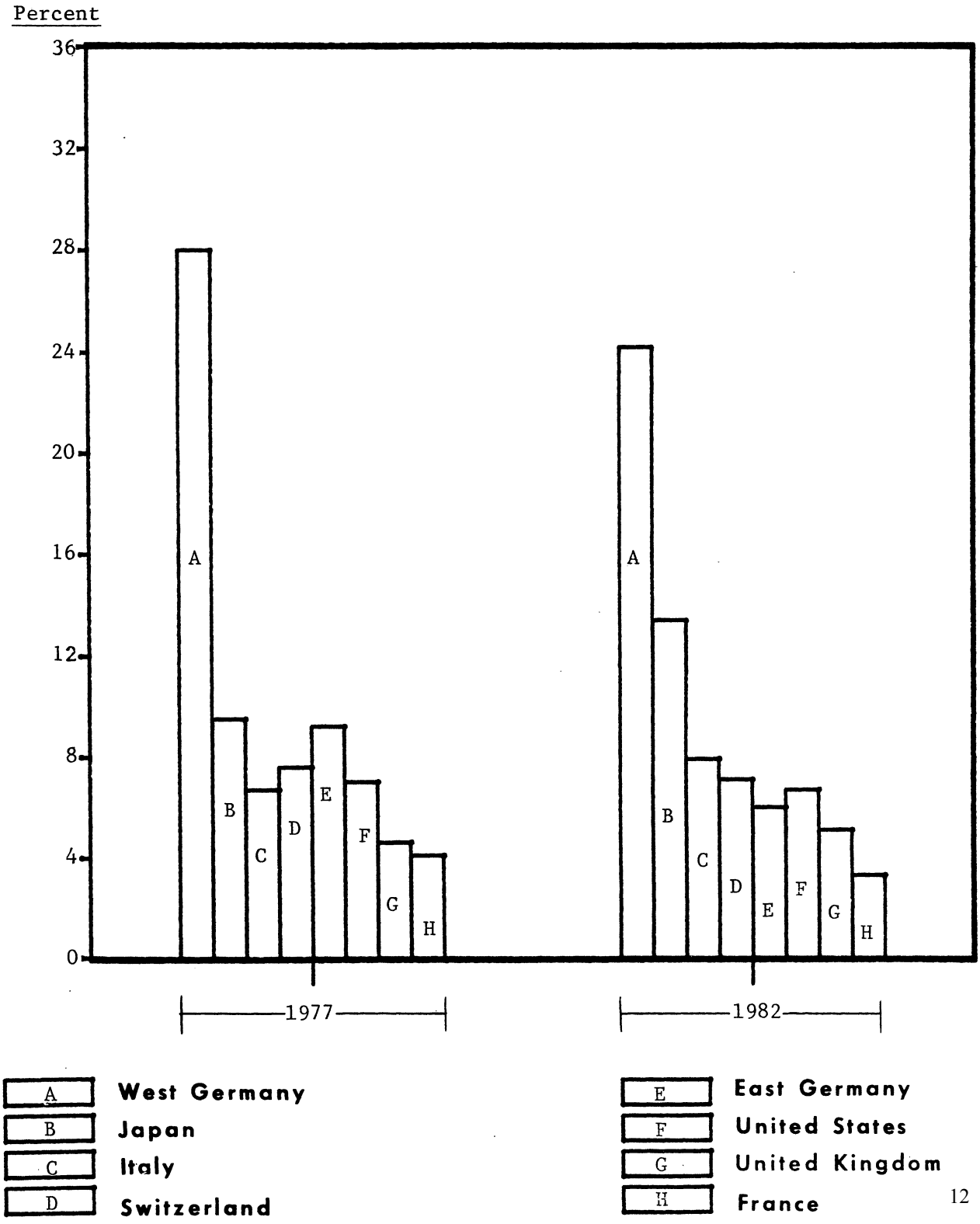
Source: Data compiled from vaious issues of the American Machinist.

Figure 4.--Metalworking machine tools: Exports as a share of domestic production, by specified sources, 1977 and 1982.



Source: Data compiled from various issues of the American Machinist.

Figure 5.--Metalworking machine tools: Exports as a share of total world exports, by specified sources, 1977 and 1982.



Source: Data compiled from various issues of the American Machinist.

The U.S. share of world exports declined to 6.7 percent in 1982 from 7.0 percent in 1977. The fall in U.S. exports in 1982 is much more pronounced when considering that it represents a declining share of a declining world export market. Other countries losing world export shares include East Germany, Switzerland, and France.

World Consumption

Apparent world consumption of machine tools by the 10 largest consuming countries increased dramatically to $19.1 billion in 1981, or by 93 percent, from the $9.9 billion consumed in 1977 (fig. 6). Consumption in these 10 countries dropped to $16.3 billion in 1982. With the exception of 1977, the United States was the largest consumer of machine tools during 1977-82. U.S. consumption peaked in 1981 at almost $5.6 billion, representing a gain of 133 percent over that in 1977, and then fell to $4.4 billion in 1982. Japan's consumption growth was the most significant of the 10 largest consuming countries. During 1977-81, Japan increased its consumption of machine tools more than 200 percent, from $1.1 billion in 1977, to $3.3 billion in 1981. Consumption of the second largest machine-tool-consuming country, the Soviet Union, fluctuated between $2.8 billion (1977) and $3.8 billion (1980). In 1982, the four largest machine-tool-consuming countries, the United States, the Soviet Union, Japan, and West Germany, together accounted for $8.2 billion in consumption, or 50 percent of the total consumed by the 10 major countries.

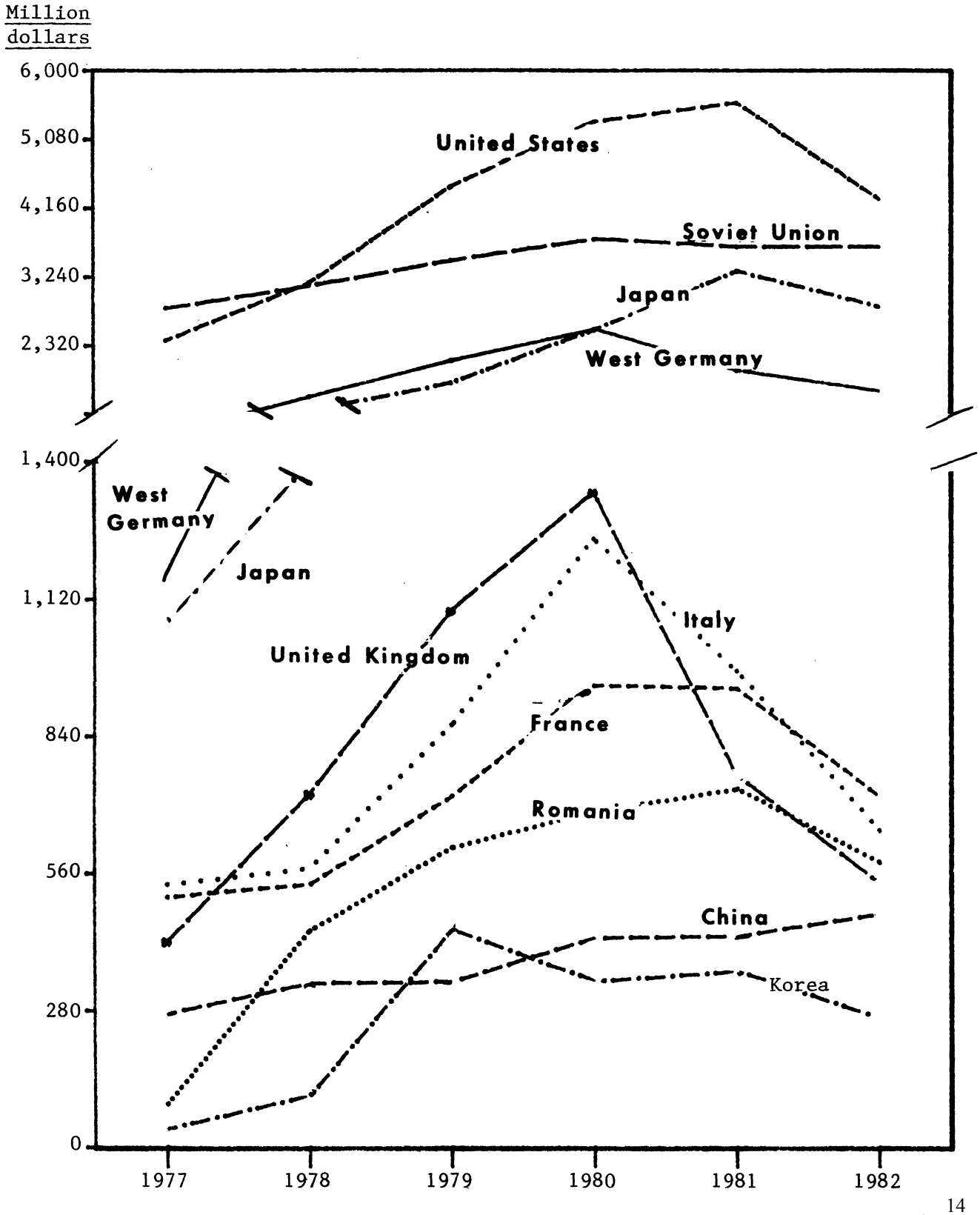
The share of domestic consumption accounted for by imports (commonly referred to as import penetration) varies widely among major machine-tool-consuming nations. For most years during 1977-82, imports accounted for more than half of domestic machine tool consumption in the Republic of Korea, France, and the United Kingdom (fig. 7). Among major machine-tool-consuming countries, the United States, the United Kingdom, and France experienced the greatest growth in import penetration during 1977-82. In the United States, imports as a share of consumption increased to just under 30 percent in 1982 from almost 17 percent in 1977--a gain of nearly 13 percentage points. Import penetration in both France and the United Kingdom was 61 percent in 1982, representing increases of 14 and 15 percentage points, respectively, over 1977 penetration ratios. Italy's and West Germany's import penetration ratio fluctuated slightly during 1977-82 between 28 and 32 percent. Imports of machine tools accounted for only 8 percent of Japan's domestic consumption in 1982--the lowest such ratio of the major machine-tool-consuming countries. During 1977-82, Japan's ratio of imports to consumption peaked in 1980 at just over 9 percent.

Romania's import penetration ratio declined dramatically to 30 percent in 1982 from just over 65 percent in 1977, representing a decline of more than 35 percentage points. The drop in Romania's import penetration is a measure of the successful development of the Romanian machine tool industry.

Productivity of World Machine Tool Producers

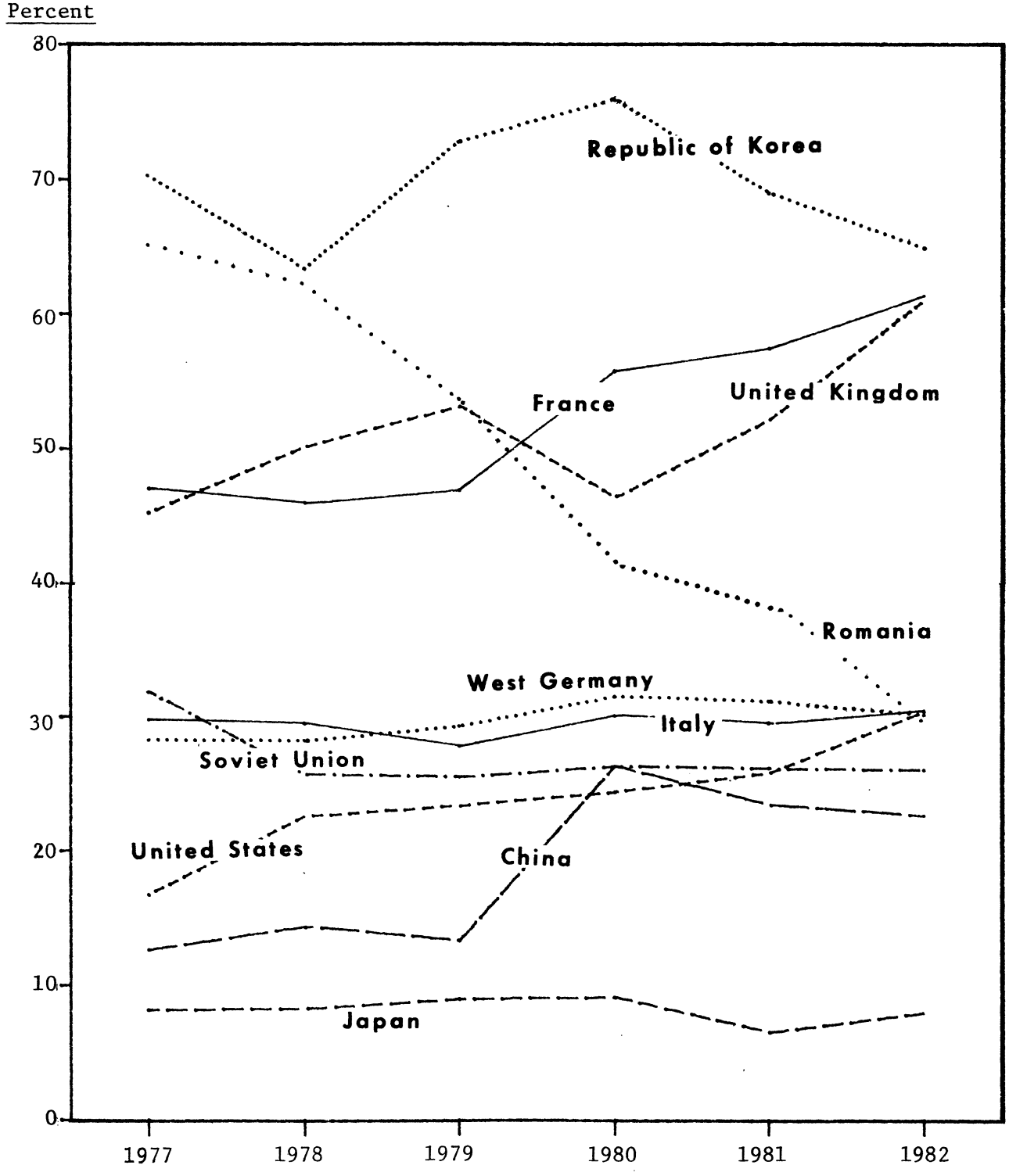
Machine tool productivity among major machine-tool-producing countries increased significantly during 1977 through 1980 (or 1981, depending on the

Figure 6.--Metalworking machine tools: Consumption, by specified countries, 1977-82.



Source: Data compiled from various issues of the American Machinist.

Figure 7.--Metalworking machine tools: Imports as a share of apparent domestic consumption, by specified countries, 1977-82.



Source: Data compiled from various issues of the American Machinist.

particular country), as shown in table 3. Japan's productivity gains during 1977-82 were the most pronounced among major producing countries, growing to $114,000 worth of production per employee in 1981 from $36,000 per employee in 1977. 1/ In 1981-82, Japan's productivity was more than twice that of its closest competitors. The principal reason for Japan's productivity gains was that Japan's machine tool producers concentrated on production of standard-type machining centers and lathes, and production of such machines was conducive to assembly line production. Other countries, the United States included, tended to concentrate on specialty machine tools requiring small batch production. The productivity of U.S. producers steadily increased from $29,000 per employee in 1977 to $53,000 per employee in 1981, before declining to $41,000 per employee in 1982. Productivity in the seven major non-Communist machine tool producing countries dropped in 1982, reflecting the decrease in worldwide demand for machine tools. During 1981-82, the productivity of U.S. producers dropped by $12,000 per employee and that of Japan dropped by $22,000 per employee to $92,000.

Table 3 .--Metalworking machine tools: Value of production per employee (productivity) for the major, non-Communist producing countries, 1977-82

(In thousands of dollars)

Country	1977	1978	1979	1980	1981	1982
Japan 1/	36	62	71	89	114	92
Switzerland	2/	44	55	59	51	48
United States	29	34	42	48	53	41
Italy	31	29	37	46	42	37
West Germany	27	34	40	48	40	37
France	28	35	44	49	43	35
United Kingdom	12	16	20	31	22	19

1/ Productivity data for Japan are based on production of metal-cutting machine tools only; productivity data for all machine tool production are not believed to differ significantly from the data shown.
2/ Not available.

Source: Compiled from data provided by the National Machine Tool Builders Association, American Machinist, and various submissions to the staff of the U.S. International Trade Commission by interested parties.

1/ Unadjusted for inflation.

EFFECT OF EXCHANGE RATES ON THE MACHINE TOOL INDUSTRY

From 1977 to 1982, the value of machine tools imported by the United States increased from $401 million to $1.3 billion, or by 224 percent. Part of the sharp increase may be due to the increase in competitiveness that the products of most countries have enjoyed since 1977 due, in large part, to changes in the exchange rates as reflected in the price of inputs available to foreign producers in their domestic market. Exchange-rate changes between the U.S. dollar and major foreign currencies are discussed in appendix E.

The price advantage that foreign products enjoy in the United States applies only to those products that are produced using inputs that are priced in foreign currency. If the price of all inputs are denominated in U.S. dollars, then no competitive advantage accrues to the foreign producer. 1/

Most of the inputs used in the production of machine tools are purchased from domestic sources: approximately 60 percent of the inputs in the machine tool industry are labor, and much of the remaining 40 percent consists of steel that is purchased domestically. Therefore, the evidence suggests that most foreign producers of machine tools have enjoyed an increase in competitiveness in the United States since 1977 because of the differences in relative inflation rates and changes in exchange rates.

1/ Wage rates and the cost of labor are nearly always denominated in the local currency, whereas the price of raw materials is often denominated in dollars.

THE U.S. INDUSTRY AND MAJOR FOREIGN COMPETITORS

Industry Profiles

United States

The U.S. metalworking machine tool industry has declined both in number of firms and in employment since 1977. However, industry shipments, imports, and exports increased from 1977 to 1981 and then decreased in 1982. The industry has attempted to help itself and has utilized various Government programs, including trade adjustment assistance and various petitions under public laws. The U.S. Government funds generic research and development programs of benefit to the machine tool industry, and particular agencies fund programs of specific benefit to the machine tool industry.

Industry

In 1982, there were approximately 1,140 establishments producing metalworking machine tools in the United States, representing a 15-percent drop from the 1,343 establishments reported in the 1977 Census of Manufactures. 1/ In addition to the primary producers, there are a small, but unknown, number of establishments, in other industries that manufacture machine tools and parts as secondary products. Since 1977, there have been significant changes involving the number of machine tool establishments. Because the number of new openings is relatively insignificant, compared to the total number of establishments mergers, acquisitions, consolidations, and closings have accounted for a decrease in the number of establishments. A total of about 200 establishments have been affected by mergers, acquisitions, consolidations, or closings since 1977. During 1977-82, there were 64 mergers, acquisitions, and purchases of assets in the metalworking machine tool industry. These mergers principally involved larger companies acquiring smaller companies. The number of corporate changes showed an increasing trend through 1980, but declined in both 1981 and 1982. The following tabulation shows merger, acquisitions, and asset purchases 2/ data obtained from the

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1/ U.S. Department of Commerce and Commission staff interviews with industry executives. It should be noted that the Bureau of the Census and the National Machine Tool Builders' Association estimate that only 60 percent of the reporting establishments produce primarily completed machine tools, whereas the remaining 40 percent produce primarily only machine tool accessories, dies, tools, jigs, and fixtures. This implies that the number of establishments engaged primarily in manufacturing machine tools dropped from about 800 in 1977 to approximately 600 in 1982.

2/ Includes machine tool builders taking over firms which manufacture products other than machine tools, but related to machine tool production, such as electronic controls or machinery. Includes takeovers of machine tool builders by corporations not in the industry.

Federal Trade Commission and various editions of the Yearbook on Corporate Mergers, Joint Ventures, and Corporate Policy, and other literature:

Year	Number of mergers, acquisitions, and purchases of assets
1977	8
1978	7
1979	10
1980	18
1981	10
1982	11
1983 (January-May)	4

Seven mergers involved foreign firms taking over U.S.-owned firms, and five involved a U.S.-owned firm acquiring a foreign firm.

In 1978, the Justice Department opposed the merger of the Cross Co. and Kearney and Trecker; however, this merger was completed in 1979. Other major acquisitions included Bendix acquiring Warner and Swasey, Ogden Corp. acquiring Danly Machine Corp., and AMCA International, Inc., (Canada) acquiring Giddings and Lewis. There is a consensus among manufacturers and purchasers of metalworking machine tools and industry analysts that mergers, acquisitions, and closings will accelerate in the 1980's. 1/ In response to the Commission's survey, 18 U.S. firms reported they are 25 percent or more beneficially owned by foreign entities. In addition, 24 U.S. producers reported that foreign companies have direct investments in their firms, or participate in joint ventures or licensing arrangements to produce metalworking machine tools. A total of 50 U.S. producers have direct investments abroad in foreign affiliates or subsidiaries, or participate in joint ventures or licensing agreements, according to survey responses.

The average U.S. metalworking machine tool establishment employs 77 persons, of which 48 are production workers. The majority of U.S. establishments employ fewer than 20 persons and less than 1 percent of the establishments employ 1,000 or more workers.

Employment in the U.S. metalworking machine tool industry fluctuates with the cyclical demand for its products. In 1977, when shipments totaled $2.4 billion, there were approximately 84,000 employees in the industry, 53,000 of whom were production workers. This figure rose dramatically in the ensuing years to a peak of about 100,000 in 1980, when U.S. shipments totaled approximately $4.8 billion. Employment in 1982 dropped to 88,000 (55,000 production workers) as shipments fell to pre-1979 levels. 2/ At present, employment totals approximately 69,000. 3/ The average employment reported by

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1/ Commission staff interviews with manufacturers and purchasers in Ohio, Illinois, and Michigan, and "Foreign Competition Stirs U.S. Toolmakers," Business Week, Sept. 1, 1980, pp. 68-70.

2/ Employment figures from U.S. Department of Commerce reports U.S. Industrial Outlook 1982 and U.S. Industrial Outlook 1983.

3/ Commission staff interviews with machine tool manufacturers revealed that total employment in the metalworking machine tool industry has been reduced by as much as 25 percent since December 1982.

questionnaire respondents followed a similar pattern, increasing from 36,950 in 1977 to 46,169 in 1980, before declining to 34,541 in 1982. Most of the increase and decrease in employment was reported in the metal-removing machine tool sector, however, employment in the metal-forming sector also changed, as shown in table 4. As the employment level drops, a certain number of highly skilled workers must be terminated. Generally, older, skilled machinists with tenure are retained, and younger employees are laid off. These younger people tend to migrate to other jobs and are not available when an upswing in the industry occurs. Others new to the industry are then recruited and put through a training period of 4 or 5 years. Since demand cycles are usually shorter than training periods, some newly trained machinists are laid off shortly before or shortly after their training period is completed. The results are a skilled manpower shortage in the machine tool industry and difficulty in recruiting qualified people. However, as technology advances are applied to the manufacturing process, fewer skilled machinists will be required to efficiently run the production equipment. For example, advances in numerical control have made it possible for one skilled machinist to run two or more machine tools, where before, one machinist was required for each machine tool. The application of new technology in the manufacturing process will continue to affect employment levels in the industry. Workers will still be required for the assembly and testing of machine tools; however, they are most affected by the cyclicality of the industry.

Table 4.--Average number of employees in U.S. establishments producing metal-working machine tools, by major types, 1977-82

Item	1977	1978	1979	1980	1981	1982
Metal-removing machine tools	31,087	34,310	37,087	39,467	38,778	30,378
Metal-forming machine tools	5,863	6,392	6,868	6,702	6,073	4,163
All metalworking machine tools	36,950	40,702	43,955	46,169	44,851	34,541

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Wages paid to machine tool industry production workers have increased from approximately $6.33 per hour in January 1977 to about $10.00 per hour in October 1982, the last month for which data are available. 1/ Production workers' wages in the machine tool industry have generally been above those of production workers in durable-goods industries, although motor-vehicle, transportation equipment, and aircraft industry production workers have maintained a 10- to 30-percent edge over machine tool production workers since 1977. 2/ Respondents to the Commission's survey reported man-hours worked increased from 1977 to 1980 and decreased in 1981 and 1982. Wages paid were reported to increase from 1977 to 1981 and decrease in 1982, as illustrated in table 5.

Table 5.--Man-hours worked by and wages paid to U.S. production and related workers producing metalworking machine tools, by major types, 1977-82

Item	1977	1978	1979	1980	1981	1982
	Man-hours (1,000 hours)					
Metal-removing machine tools	45,973	53,796	59,370	63,168	58,537	39,588
Metal-forming machine tools	8,839	9,962	10,561	9,792	9,360	5,555
Total	54,812	63,758	69,931	72,960	68,329	45,143
	Wages (1,000 dollars)					
Metal-removing machine tools	346,376	420,077	438,538	567,750	589,882	426,042
Metal-forming machine tools	68,708	83,094	95,101	98,393	102,729	70,250
Total	415,084	503,171	533,639	666,143	692,611	496,292

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

1/ U.S. Department of Labor, Bureau of Labor Statistics, "Employment and Earnings February 1978" and "Employment and Earnings December 1982."

2/ Ibid.

The major users of machine tools, transportation equipment producers, are concentrated predominantly in the East North Central region, and the largest share of machine tool production is also in that area. The major producing States for metalworking machine tools are Ohio, Michigan, and Illinois, which together accounted for approximately 54 percent of production, according to the 1977 Census of Manufactures, the latest available source.

U.S. shipments of metalworking machine tools, as reported by the Department of Commerce, increased from $2.5 billion in 1977 to $5.1 billion in 1981, and decreased substantially to $3.7 billion in 1982. 1/ In response to the Commission's questionnaire, U.S. producers reported that total shipments increased from $1.6 billion in 1977 to $3.4 billion in 1981, and decreased to $2.5 billion in 1982. As indicated in table 6, domestic shipments increased from $1.4 billion in 1977 to $3.0 billion in 1981, and decreased to $2.3 billion in 1982.

Table 6.--Metalworking machine tools: U.S. producers' domestic shipments, by major types, 1977-82

Item	1977	1978	1979	1980	1981	1982
	Quantity (units)					
Metal-removing machine tools	28,538	31,708	35,804	35,877	34,796	18,855
Metal-forming machine tools	5,037	5,657	6,035	4,955	3,464	2,302
Total	33,575	37,365	41,839	40,832	38,260	21,157
	Value (1,000 dollars)					
Metal-removing machine tools	1,216,905	1,604,255	2,007,257	2,447,553	2,699,357	2,067,749
Metal-forming machine tools	202,699	273,823	331,207	358,649	315,999	206,250
Total	1,419,604	1,878,078	2,338,464	2,806,202	3,015,356	2,273,999

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

During 1977-80, U.S. manufacturers' shipments of NC lathes and machining centers grew at an average annual rate of 32.5 and 21.1 percent, respectively. However, during 1980-82, manufacturers' shipments decreased roughly at an average annual rate of 26.3 percent for NC lathes. In contrast, shipments of machining centers decreased by 2 percent in 1981 and by 39 percent in 1982. Table 7 depicts U.S. Department of Commerce data and 14 respondents' data submitted in response to Commission questionnaires for domestic shipments of NC lathes and machining centers for 1977-82.

1/ Obtained from official statistics of the U.S. Department of Commerce.

Table 7.--Metalworking machine tools: U.S. producers' domestic shipments of numerically controlled lathes and machining centers, 1977-82

Year	Numerically controlled lathes		Machining centers	
	Quantity	Value	Quantity	Value
	Units	Million dollars	Units	Million dollars
Commerce data:				
1977 1/	1,178	195.3	1,201	175.0
1978 1/	1,464	237.2	1,486	246.0
1979	2,362	347.7	1,953	356.5
1980	2,739	481.2	2,132	413.0
1981	2,021	441.4	2,081	482.6
1982	1,489	333.4	1,264	338.8
Commission questionnaire data:				
1977	996	165.8	611	74.5
1978	1,213	203.3	724	98.7
1979	1,755	274.5	1,005	154.5
1980	2,183	399.2	1,193	189.3
1981	1,792	440.5	1,229	222.5
1982	1,317	340.8	756	167.9

1/ Data compiled from the National Machine Tool Builders' Association, Economic Handbook of the Machine Tool Industry, 1982 and 1983, pp. 100 and 101.

Source: Compiled from official statistics of the U.S. Department of Commerce and from data submitted in response to questionnaires of the U.S. International Trade Commission, except as noted.

Table 8 shows U.S. producers' export shipments of NC lathes and machining centers for 1977-82.

Table 8.--Metalworking machine tools: U.S. producers' exports of numerically controlled lathes and machining centers, 1977-82

Year	Numerically controlled lathes		Machining centers	
	Quantity	Value	Quantity	Value
	Units	Million dollars	Units	Million dollars
1977	44	7.1	30	4.9
1978	135	15.4	43	7.8
1979	184	17.6	73	12.7
1980	169	23.0	103	16.8
1981	151	23.8	84	10.1
1982	108	18.3	44	6.2

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

U.S. producers' domestic shipments and export shipments of NC lathes and machining center units peaked in 1980. However, the Commission's survey of U.S. importers reveals that both U.S. importers' shipments and imports peaked in 1981, in both quantity and value, declining only in 1982. Table 9 shows U.S. importers' shipments for 1977-82. U.S. imports for 1977-82 are shown in table 10.

Table 9.--Metalworking machine tools: U.S. importers' shipments of numerically controlled lathes and machining centers, 1977-82

Year	Numerically controlled lathes		Machining centers	
	Quantity	Value	Quantity	Value
	Units	Million dollars	Units	Million dollars
1977	434	33.0	65	3.7
1978	724	65.5	113	11.1
1979	1,122	109.0	270	25.6
1980	1,566	166.0	568	53.6
1981	1,740	219.5	767	94.9
1982	1,234	142.4	697	89.1

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table 10.--Metalworking machine tools: U.S. imports of numerically controlled lathes and machining centers, 1977-82

Year	Numerically controlled lathes		Machining centers	
	Quantity	Value	Quantity	Value
	Units	Million dollars	Units	Million dollars
1977	423	25.1	110	6.7
1978	745	55.5	137	11.3
1979	1,183	96.6	312	25.6
1980	1,739	143.5	615	48.4
1981	1,789	172.2	888	89.5
1982	1,353	119.1	699	72.3

Imports of NC lathes and machining centers by U.S. importers follow the pattern of U.S. importers' shipments. Both imports and shipments of NC lathes and machining centers increased fairly rapidly during 1977-80. However, the growth rate of NC lathes units slowed between 1980 and 1981; the growth rate of machining center units was approximately the same for 1980 and 1981 as it was in 1977-80. However, in 1982, both U.S. importers' shipments and imports declined. Shipments of NC lathes decreased by 29 percent, while imports decreased by 24 percent during 1981 and 1982. For the same period, machining center shipments decreased by only 9 percent, and imports decreased by about 24 percent. Differences in shipment values are apparent, depending on the source used. Table 11 shows shipment data for 1977-82 from three sources.

As shown in figure 8, U.S. shipments of metalworking machine tools (reported in millions of 1982 dollars) followed three distinct cycles during 1962-82. Shipments peaked in the years 1967, 1975, and 1980 at $5.6 billion, $4.1 billion, and $5.4 billion, respectively (in 1982 dollars). The bottoms of the cycles occurred in 1971 and 1976, when shipment values were $2.8 billion and $3.5 billion, respectively. At the end of 1982, U.S. shipments were valued at $3.7 billion, although industry sources predict 1983 shipments will be approximately 30 percent less than 1982 shipments. 1/

As reported by respondents to the Commission's survey, capacity utilization increased from 69 percent in 1977 to 76 percent in 1979, and then decreased in each subsequent year even though shipments continued to rise through 1981. In 1980, capacity utilization was reported at 72 percent; in 1981, 66 percent; and in 1982, 36 percent. Respondents also indicated that total capacity to produce metalworking machine tools increased 16 percent from 1977 to 1981, and decreased by 1 percent in 1982.

1/ U.S. Department of Commerce, U.S. Industrial Outlook 1983, and Commission staff interviews with machine tool industry executives.

Table 11.--Metalworking machine tools: Comparison of U.S. producers' shipment data from the U.S. Department of Commerce, the National Machine Tool Builders' Association (NMTBA), and the U.S. International Trade Commission, 1977-82

(In thousands of dollars)

Year	U.S. Department of Commerce 1/	NMTBA 2/	U.S. International Trade Commission 3/	
			Commission questionnaire returns	Adjusted 4/
1977	2,453	2,281	1,572	2,453
1978	3,142	3,013	2,120	3,307
1979	4,064	3,877	2,584	4,031
1980	4,812	4,692	3,209	5,006
1981	5,111	5,096	3,443	5,371
1982	3,724	3,604	2,525	3,939

1/ Data compiled from official statistics of the U.S. Department of Commerce, Current Industrial Reports; includes data on complete new machine tools, including machines with a value of under $2,500, and excludes data for machine tools designed for home workshops and rebuit machines.

2/ Estimated by the National Machine Tool Builders Association Statistical Department; includes data for complete machine tools and excludes data for machine tools costing under $2,500, machine tools designed for home workshops, rebuilt machines, and parts sold separately.

3/ Estimated by the staff of the U.S. International Trade Commission.

4/ Questionnaire respondents accounted for 64.1 percent of industry shipments in 1977, using Department of Commerce shipment data as a base. Applying this percentage to questionnaire responses for 1978-82 yielded the adjusted figures.

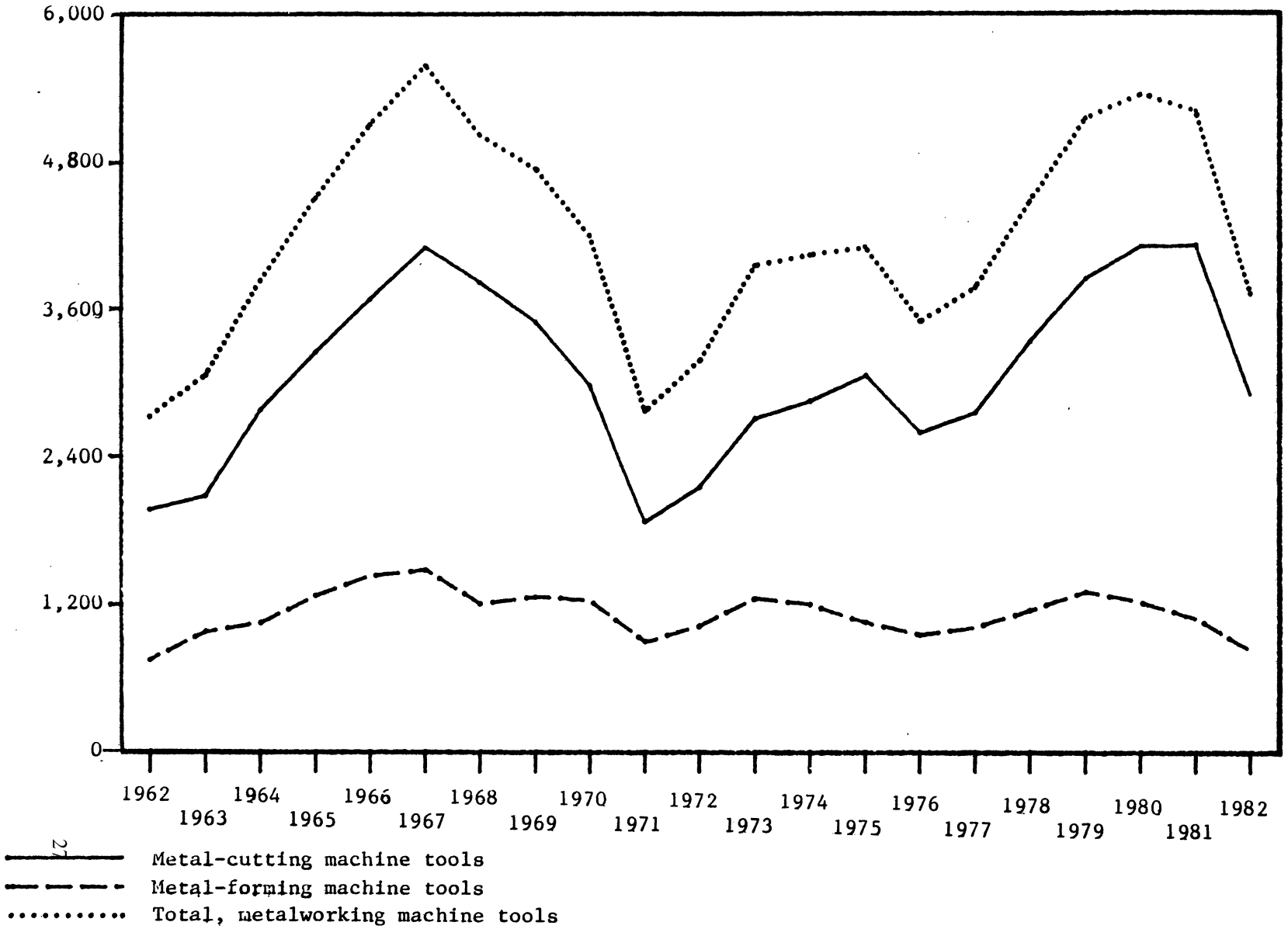
Productivity in the U.S. industry, measured in terms of dollars of production per employee, increased 83 percent, from $29,000 in 1977 to $53,000 in 1981, and decreased 23 percent to $41,000 in 1982. 1/ Productivity, as reported by respondents to the Commission's survey, 2/ increased 79 percent, from $43,000 in 1977 to $77,000 in 1981, and decreased 5 percent to $73,000 in 1982.

According to the Commission's survey, imports of metalworking machine tools increased from $152 million in 1977 to $695 million in 1981, and

1/ Based on U.S. Department of Commerce employment statistics and American Machinist production figures.

2/ Measured in terms of net sales per employee.

Figure 8.--Metalworking machine tools: U.S. shipments, 1962-82.



Source: U.S. Department of Commerce, Current Industrial Reports, Metalworking Machinery.

decreased to $549 million in 1982, as shown in table 12. Import shipments increased from $182 million in 1977 to $837 million in 1981, before decreasing to $641 million in 1982, as table 13 illustrates. The U.S. Department of Commerce reported imports of $401 million in 1977, $1.5 billion in 1981, and $1.3 billion in 1982. The major U.S. suppliers of imported machine tools during 1977-82 were Japan, West Germany, and the United Kingdom. Commerce reported that in 1977, Japan accounted for $105 million, or 26 percent of total U.S. imports; West Germany accounted for $91 million, or 23 percent; and the United Kingdom accounted for $46 million, or 11 percent. By 1982, the value of Japanese imports had reached $535 million, or 42 percent of total U.S. imports. Imports from West Germany had increased to $204 million, but accounted for only 16 percent of total imports. Likewise, imports from the United Kingdom increased to $108 million, but its share of total imports dropped to 9 percent.

Export shipments reported by producers in response to the Commission's survey totaled $152 million in 1977, $242 million in 1978, $245 million in 1979, $427 million in 1981, and to $245 million in 1982, as indicated by table 14. Exports reported by the Department of Commerce totaled $452 million in 1977, increased to $1.0 billion in 1981, and decreased to $623 million in 1982. 1/ Thus, the trade balance favored the United States by $51 million in 1977, and favored the U.S. trading partners by $500 million in 1981 and $677 million in 1982. The major markets for U.S.-made machine tools during 1977-82 were Mexico, Canada, and the United Kingdom. In 1977, Mexico imported 42 million dollars' worth of machine tools from the United States, or 9 percent of total U.S. exports. U.S. exports to Canada totaled $61 million, or 13 percent of the total, and exports to the United Kingdom amounted to $27 million, or 6 percent of the total. By 1981, U.S. exports to Mexico had increased to $257 million, accounting for 25 percent of U.S. exports. Exports to Canada increased to $270 million in 1981, accounting for 26 percent of U.S. exports, and the United Kingdom accounted for $64 million, or 6 percent. In 1982, U.S. exports of metalworking machine tools to these three countries and their shares of total U.S. exports were as follows: Mexico, $135 million (22 percent); Canada, $80 million (13 percent); and the United Kingdom, $59 million (9 percent). These three countries together accounted for $316 million, or 77 percent, of the $412 million decrease in U.S. exports between 1981 and 1982. U.S. exports of metalworking machine tools decreased significantly from 1981 to 1982, primarily because of the depressed automobile and energy industries in both Canada and Mexico.

U.S. exports of metalworking machine tools to Japan were valued at $22 million in 1977, and increased to $59 million by 1980. Annual decreases occurred in 1981 ($54 million) and 1982 ($51 million). U.S. exports to Japan accounted for 5 percent of total exports in 1977, rose to 8 percent in 1980, decreased to 5 percent in 1981, and then increased to 8 percent in 1982. U.S. metalworking machine tools exported to Japan are typically high-precision machine tools for such specialized uses as gearmaking, grinding, and milling. Japanese machine tool makers have not yet been able to match the technology of these U.S. machines. 2/ Apparent U.S. consumption of metalworking machine

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1/ Obtained from official statistics of the U.S. Department of Commerce.

2/ News Digest Publishing Co., Ltd., Japanese Machine Tool '81-'82 Guide, pp. A16 and A17.

Table 12.--Metalworking machine tools: U.S. imports for consumption, by major types, 1977-82

Item	1977	1978	1979	1980	1981	1982
	Quantity (units)					
Metal-removing machine tools	12,770	18,629	25,015	32,758	43,489	43,541
Metal-forming machine tools	474	674	1,425	2,269	3,870	6,779
Total	13,244	19,303	26,440	35,207	47,359	50,320
	Value (1,000 dollars)					
Metal-removing machine tools	139,941	250,668	386,040	532,194	641,122	494,792
Metal-forming machine tools	12,273	21,062	30,829	46,366	53,766	54,596
Total	152,214	271,730	416,869	578,560	694,888	549,388

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table 13.--Metalworking machine tools: U.S. importers' domestic shipments, by major types, 1977-82

Item	1977	1978	1979	1980	1981	1982
	Quantity (units)					
Metal-removing machine tools	11,715	16,035	24,930	33,881	45,927	48,956
Metal-forming machine tools	410	614	822	937	982	1,201
Total	12,128	16,649	25,752	34,818	46,909	50,157
	Value (1,000 dollars)					
Metal-removing machine tools	160,820	287,499	451,373	619,523	753,935	553,468
Metal-forming machine tools	21,291	35,839	51,092	70,278	82,635	87,076
Total	182,111	323,338	502,465	689,801	836,570	640,544

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table 14.--Metalworking machine tools: U.S. producers' export shipments, by major types, 1977-82

Item	1977	1978	1979	1980	1981	1982
	Quantity (units)					
Metal-removing machine tools	2,268	3,072	3,361	3,767	3,086	1,379
Metal-forming machine tools	401	384	471	509	456	209
Total	2,669	3,456	3,832	4,276	3,542	1,588
	Value (1,000 dollars)					
Metal-removing machine tools	131,406	218,180	214,420	355,047	386,450	229,340
Metal-forming machine tools	20,878	23,931	31,466	47,381	40,764	21,697
Total	152,284	242,111	245,886	402,428	427,214	251,037

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

tools increased from $2.4 billion in 1977 to $5.6 billion in 1981, and decreased to $4.4 billion in 1982.

Metalworking machine tool manufacturers sell their products predominantly through distributors and directly to end users. A limited number sell their products through agents or by other means. The major purchasers of machine tools, transportation equipment manufacturers, buy directly from the producer because of the sophisticated nature of the machine tools and the close working relationship that must be maintained between buyer and seller. Small job shops and other purchasers of metalworking machine tools generally buy from distributors, because they are buying standard "off the shelf" machine tools which do not require engineering changes that necessitate close association between buyer and manufacturer.

As shown in table 15, U.S. producers' capital expenditures for domestic facilities for production of metal-removing machine tools, as reported in response to the Commission's questionnaire, increased from $47 million in 1977 to $149 million in 1981, and decreased to $88 million in 1982. Reported capital expenditures for metal-forming domestic facilities decreased from $102 million in 1977 to $7 million in 1982, with slight variations in their downward trend in 1980 and 1981.

Table 15.--Metalworking machine tools: U.S. producers' capital expenditures for domestic facilities, by major types, 1977-82

(In thousands of dollars)

Item	1977	1978	1979	1980	1981	1982
Metal-removing machine tools:						
Land or land improvements	470	1,419	3,500	2,443	2,100	1,035
Building or leasehold improvements	5,967	13,826	15,540	32,694	27,953	14,919
Machinery, equipment, and fixtures	40,720	48,181	69,750	86,948	118,697	71,852
Subtotal	47,157	63,426	88,790	122,085	148,750	87,806
Metal-forming machine tools:						
Land or land improvements	405	228	105	937	122	346
Building or leasehold improvements	1,361	972	3,868	2,046	3,205	1,277
Machinery, equipment, and fixtures	100,259	41,134	7,432	9,772	12,017	4,997
Subtotal	102,025	42,334	11,405	12,755	15,344	6,620
Total	149,182	105,760	100,195	134,840	164,094	94,426

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Respondents to the Commission's survey reported yearly increases (except for a slight decrease in 1981) in research and development expenditures from 1972 to 1982. Table 16 shows that the metal-removing sector again experienced the most significant gain, increasing erratically from $12 million in 1972 to $55 million in 1982. Overall, producers reported that net operating income increased from $203 million in 1977 to $554 million in 1981, and decreased to $399 million in 1982. Table 17 shows U.S. producers' net sales and net operating income for 1977-82.

Table 16.--Metalworking machine tools: U.S. producers' research and development expenditures, by major types, 1972-82

(In thousands of dollars)

Year	Metal-removing machine tools	Metal-forming machine tools	Total
1972	12,003	2,915	14,918
1973	15,643	2,915	18,558
1974	15,023	4,195	19,218
1975	18,400	4,187	22,587
1976	22,164	4,455	26,619
1977	27,799	5,435	33,234
1978	31,715	6,813	38,528
1979	36,793	5,823	42,616
1980	48,053	8,285	56,338
1981	48,593	7,254	55,847
1982	55,142	7,425	62,567

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table 17.--Metalworking machine tools: U.S. producers' net sales and net operating income, by major types, 1977-82

(In thousands of dollars)

Item	1977	1978	1979	1980	1981	1982
Metal-removing machine tools:						
Net sales	1,348,311	1,822,435	2,221,677	2,802,600	3,085,807	2,297,089
Net operating income	140,224	209,580	275,488	414,785	419,670	310,107
Metal-forming machine tools:						
Net sales	223,577	297,754	362,673	406,030	356,763	227,947
Net operating income	63,049	83,073	105,175	123,433	134,143	88,443
Total:						
Net sales	1,571,888	2,120,189	2,584,350	3,208,630	3,442,570	2,525,036
Net operating income	203,273	292,653	380,663	538,218	553,813	398,550

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Research and development expenditures of U.S. producer respondents, expressed as a share of net sales, decreased from 2.1 percent in 1977 to 1.6 percent in 1979, increased slightly to 1.8 percent in 1980, decreased to 1.6 percent again in 1981, and increased to 2.5 percent in 1982.

The demand for machine tools not supplied by domestic production will be supplied by imports. Based on 1982 dollars and 1981 production/employment relationships for machine tools, each $100 million in demand not supplied by U.S. firms translates into an estimated $185 million in lost production opportunities in all sectors of the U.S. economy and 2,575 jobs not created. 1/ In the machine tool sector alone, approximately $94 million in potential production is lost, along with 1,492 jobs. The estimated effects on all U.S. industry, assuming lost production opportunities of $100 million, is summarized in table 18.

Table 18.--Metalworking machine tools: Effects of $100 million loss in U.S. demand of metalworking machine tools on the output and employment in all U.S. industry sectors

Industry sector	Employment lost	Output lost
	No. of employees	Million dollars
Metalworking machine tools	1,492	94
Other manufacturing	563	60
Other	520	31
Total	2,575	185

Workers in the U.S. metalworking machine tool industry have sought and received trade adjustment assistance benefits from the U.S. Department of Labor. Since the Trade Adjustment Assistance program's inception in April 1975, 2/ there have been 8 certifications, affecting 679 workers, and 28 denials, affecting 2,516 workers, for the metal-cutting machine tool sector, Standard Industrial Classification 3541. According to the U.S. Department of Labor, in the metal-forming machine tool sector, there was one certification, affecting 150 workers, and 13 denials, affecting 1,032 workers.

The first U.S. company to apply for loans under the Department of Commerce's trade adjustment assistance for firms which began in April 1975 was South Bend Lathe, Inc., which filed its petition in March 1981. Since then, and as of July 28, 1983, there have been 14 filings for assistance, 9 of which dealt with machine tools, 3 involved machine tools and parts, 1 involved machine tool components, and 1 involved machine tool controls. One filing involving machine tools was withdrawn, and four have decisions due in late summer 1983. The remainder of the filings received certification.

1/ These estimates are based on the BLS input-output model. In the BLS model, certain components of machine tools are double counted; therefore, the "output lost" data are overstated.

2/ The program was established under the Trade Act of 1974.

The U.S. metalworking machine tool industry has sought several times in recent years to limit imports of foreign-made machine tools into the U.S. market. In November 1977, the National Machine Tool Builders' Association publicly charged European and Japanese machine tool builders with "apparently illegal and predatory practices", 1/ and was investigating the possibility of initiating dumping charges with the Government. The NMTBA asked its members to obtain information on the situation. However, the U.S. Department of Justice launched a Civil Investigative Demand, suspecting that price fixing may have been proceeding between segments of the U.S. industry and the Japanese. The NMTBA subsequently refrained from its pursuit of investigating dumping.

In May 1982, Houdaille Industries, Inc., a diversified manufacturer of industrial products and also one of the top 10 manufacturers of machine tools in the United States, filed a petition with the United States Trade Representative asking that the investment tax credit be denied by the President to purchasers of Japanese-made machining centers and NC punching machines. The petition was submitted pursuant to section 103 of the Revenue Act of 1971, which empowers the President to deny investment tax credits to U.S. purchasers of foreign products which were manufactured in a country whose government pursued policies which restricted U.S. trade, such as cartels. Houdaille's petition presented information that Japan may indeed have fostered a cartel in the 1950's and 1960's, and that Japanese Government support was currently continuing. In April 1983, the petition's request was denied, but the Government chose instead to pursue negotiations with the Japanese Government to discuss Japan's industrial targeting policies in all areas of trade, not just in the machine tool sector.

In March 1983, the NMTBA filed a petition with the U.S. Department of Commerce requesting the imposition of import quotas under section 232 of the Trade Expansion Act of 1962. Under section 232, the President is empowered to restrict imports if they threaten the national security. The petition requests that "[i]mports of machine tools of one or more of the foregoing types would be permitted at levels between 17.5 percent and 20 percent of domestic consumption so long as the level of imports of other types was less than 17.5 percent of domestic consumption, provided that the sales-weighted average value of imports did not exceed 17.5 percent of domestic consumption in either the metal-cutting or metal-forming sector." 2/ The Department of Commerce will take 1 year to make its decision as to the petition's request.

In May 1983, a joint United States-Japan machine tool industry task force was created during talks between the Office of the United States Trade Representative and the Japanese Ministry of International Trade and Industry (MITI). So far, the U.S. delegation has requested information on MITI's Industrial Science and Technology Agency (AIST), subsidies received by the Japan Machine Tool Builders' Association from the Japan Keirin Association, and Japanese laws promoting the machine tool industry. 3/

1/ "Import Growth Worries Builders," American Machinist, December 1977, pp. 41-42.

2/ Petition Under the National Security Clause, sec. 232 of the Trade Expansion Act of 1962 (19 U.S.C. 1862), For Adjustments of Imports of Machine Tools submitted to the Department of Commerce by the National Machine Tool Builders' Association, p. 4.

3/ Tsukasa Furukawa, "US-Japan Machine Tool Task Force Formed as Outcome of Tokyo Talks," American Metal Market, May 23, 1983, p. 16.

Government involvement

The U.S. machine tool industry indirectly benefits from a variety of activities conducted by the U.S. Government. These activities are sponsored by a number of agencies which include the Department of Defense, National Aeronautics and Space Administration (NASA), the National Bureau of Standards' Center for Manufacturing Engineering, and the National Science Foundation (NSF). Also, the Department of Commerce and the Export-Import Bank (Eximbank) of the United States provide assistance in the area of exports through export promotion and finance. The machine tool industry, like other U.S. industries, benefits indirectly through the nation's patent laws. The industry also receives tax incentives, including tax credits, tax deductions, and other tax benefits such as those found in the Economic Recovery Tax Act of 1981. On the State level, a number of programs exist in support of high technology, manpower assistance, and capital formation. 1/

The Department of Defense is involved with the industry through purchases of machine tools, manpower training programs, and also through research and development programs. Department of Defense acquistion of machine tools occurs through direct and indirect purchases. Direct purchases of metalworking machine tools by the three branches of the U.S. armed forces is quite small, compared with the consumption of the entire U.S. market. In fiscal year 1982, the U.S. Air Force purchased $12.5 million of machine tools and the U.S. Navy purchased $19.7 million, while in calendar year 1982 the U.S. Army purchased $33.9 million. 2/ Consumption by direct purchases for each of the services are presented in appendix F. The share of foreign-made machine tools in direct purchases by each of the Services varies from year to year, however, in FY 1982 the percentage was 18.8 for the U.S. Air Force, 21.4 for the U.S. Navy, and in calendar year 1982, it was 3.6 for the U.S. Army.

There are a number of reasons why the armed forces purchased foreign-made machine tools. The U.S. Air Force decided to purchase imports over domestically made machine tools because the foreign source made the low bid. The foreign contractor made the only responsive bid in one-third of the foreign buys. 3/ The U.S. Navy, after either applying or waiving the Buy American Act requirements pursuant to the Defense Acquisition Regulations, decided to purchase foreign-made machine tools, because they represented the

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1/ Office of Technology Assessment, Congress of the United States, Technology, Innovation, and Regional Economic Development: Background Paper, Census of State Government Initiatives for High-Technology Industrial Development, 1983.

2/ Statistics compiled by the U.S. Department of Defense, Office of the Undersecretary of Defense, Research and Engineering, Acquisition Management, are by fiscal years for the U.S. Air Force and U.S. Navy and by calendar years for the U.S. Army. Figures for the U.S. Army in 1982 are incomplete.

3/ U.S. Department of Defense, Office of the Undersecretary for Defense, Research & Engineering, Acquisition Management.

lowest conforming bid to procurement specifications. 1/ During 1977-82, the U.S. Army purchased 99 foreign-built machines. 2/ As described in a recent memorandum, the justification for purchasing foreign-built machines by the U.S. Army at times involved several reasons, which are listed as follows: 3/

Reason	Number of responses
Exchange dollars (e.g., Foreign F-16 Buy)	7
Machines built abroad but U.S.-made controls were assembled to machine in United States	8
Lowest bid that met specifications	11
U.S. delivery lead time too long	11
Mainz Army Depot, West Germany, purchases not considered foreign	14
Memorandum of Understanding (MOU) 1/ with foreign country	19
U.S.-made machine did not have required capability	26
Lowest bid	46
Total	142

1/ MOU defined in sec. 6 of the Defense Acquisition Regulations. Currently, MOU's are in effect with the United Kingdom, Norway, Netherlands, the Federal Republic of Germany, Italy, Portugal, Belgium, Denmark, Switzerland, and Australia. The United States also has in effect the F-5 program with Switzerland.

The NMTBA perceives Department of Defense acquisition of machine tools in three categories--direct, indirect, and "induced capital" purchases, the last consisting of purchases by defense contractors, subcontractors, and suppliers for military equipment production. 4/ Estimates of Defense-related machine tool consumption are as follows: in 1977, consumption was $223 million; 1978, $255 million; 1979, $325 million; 1980, $364 million; 1981, $571 million; and 1982, $564 million. 5/ Military prime contract awards for machine tools are as follows: 1977, $31.3 million; 1978, $60.6 million; 1979, $253.8 million; 1980, $215.2 million; and 1981, $233.8 million. 6/

1/ Memorandum for the Deputy Under Secretary of Defense Research and Engineering from Assistant Secretary of the Navy (Shipbuilding and Logistics), Department of the Navy, undated, p. 7.

2/ These are foreign-built machines; however, not all are considered foreign purchases (app. D).

3/ Department of the Army, Office of the Assistant Secretary, memorandum for Deputy Under Secretary of Defense for Research and Engineering (Aquisition Management) from Office of the Assistant Secretary, Department of the Army, July 5, 1983, p. 5.

4/ Statement by Fred T. Arnold, senior managing consultant, and George F. Brown, group vice president, Data Resources, Inc., representing the National Machine Tool Builders' Association before the Joint Economic Committee, U.S. Congress, June 7, 1983, pp. 2 and 3.

5/ Ibid., fig. A.

6/ Otto Hintz, et al., U.S. Army Industrial Base Engineering Activity, Machine Tool Industry Study Final Report, Rock Island, Ill., Nov. 1, 1978, p. 22, estimate for 1977. For 1978-81, National Machine Tool Builders' Association, Economic Handbook of the Machine Tool Industry 1982-83, 1983, p. 120.

The Department of Defense also has extensive research programs oriented to manufacturing technology; the Department's Manufacturing Technology Program (ManTech) is a broad-based, production-oriented program, whose goal is to insure timely, economical, and reliable production of Department of Defense material. In the 1950's, the ManTech program was responsible for the development and initial bulk purchase of NC machine tools. Other accomplishments of the ManTech program include the establishment of Automatically Programmed Tools as a standard in the defense industry for NC machine tool programming and the establishment of isothermal forging as a net shape process for minimizing the use of critical materials and machining costs.

Table 19 illustrates the ManTech funding levels for fiscal years 1978-82.

Table 19.--Manufacturing Technology Program funding levels, by branches, fiscal years 1978-82

(In millions of dollars)

Branch	1978	1979	1980	1981	1982 1/
Army	64	73	68	76	93
Air Force	44	33	57	67	86
Navy	10	20	14	13	30
Total	118	126	139	156	209

1/ Estimated.

Source: Dr. Lloyd L. Lehn, Assistant for Manufacturing Technology, Industrial Resources, Office of the Secretary of Defense, Department of Defense, Manufacturing Technology Program, Nov. 2, 1981, p. 3.

The ManTech program will not buy capital equipment, but will provide "seed money" for projects whose feasibility has been demonstrated. ManTech results are frequently distributed to industry through the Manufacturing Technology Journal, the National Technical Information Service, the Defense Technical Information Center, and end-of-contract briefings.

A number of other programs under the Defense Department have the potential for benefiting the machine tool industry: the Integrated Computer Aided Manufacturing program, the Electronics Computer Aided Manufacturing program, the Air Force's TechMod and Manufacturing Science programs, and the Navy's Precision Engineering Program and Industrial Modernization Incentives Program (IMIP).

The Department of Defense maintains two programs which have the goal of maintaining the defense industrial base: the Defense Industrial Reserve and the Machine Tool Trigger Order Program.

The Defense Industrial Reserve was established by the Defense Industrial Reserve Act of 1973 and specifically authorizes the maintainence of a reserve of plants and equipment owned by the Department of Defense, including a

machine tool reserve and a reserve of other industrial manufacturing equipment, for use by the armed forces in contingencies. 1/

As of December 31, 1982, the Department of Defense managed 120 government-owned industrial plants and maintenance facilities. Aircraft, missiles, ammunition-propellant, combat vehicles, electronics and communications, and weapons were produced at the industrial plants; the maintenance facilities performed aircraft, electronic, ship, and weapon/vehicle repairs, as well as multimission services. There are 103 active plants and facilities with the 17 remaining retained "in an inactive status to satisfy contingency requirements." 2/ Contractors operate 68 of the plants/facilities, and the other 52 are Government operated. 3/

The Department of Defense General Reserve is made up of idle Industrial Plant Equipment, which is primarily general-purpose metal-cutting and metal-forming machine tools. Equipment redistributed in support of military service requirements had an acquisition cost of $45.8 million during 1982. During 1982, the General Reserve received 1,965 items from idle declarations for retention; 2,982 items were redistributed from the General Reserve for use. 4/

The General Reserve, under the Defense Industrial Reserve Act of 1973, is authorized to lend machine tools and other industrial equipment to qualified, nonprofit, educational institutions or training schools. Known as the Tools for Schools Program, the program had 735 active loans, with an acquistion cost of $48.9 million in 45 States by the end of 1982. The participating schools receive free use of the equipment. Several benefits are derived from this program: the tools are maintained in the reserve without cost to the Government and yet are readily accessible for meeting emergency needs; and a reserve of skilled labor is formed within the defense industrial base. The Defense Industrial Reserve Report for 1982 states that, "A majority of the trainees who have completed training under the Tools for Schools Program have obtained employment in private industry." 5/ Complementing active and idle Industrial Plant Equipment are Plant Equipment Packages (PEP's), which produce specific end items or material. PEP's may include either a few machine tools or a complete production line of machine tools. The following tabulation depicts the General Reserve as of December 31, 1982:

Status	Industrial plant equipment (units)	Acquisition cost (million dollars)
In storage----------	15,919	$377.3
On loan to schools------	4,421	39.3
On loan to other Government agencies---	630	13.9
Total----------	20,970	$430.5

1/ 50 U.S.C. pp. 451-455 (1976). See Public Law 93-155.

2/ Department of Defense, Defense Industrial Reserve Report, January 1982-December 1982, undated, p. 1.

3/ Ibid.

4/ Department of Defense, Defense Industrial Reserve Report, January 1982-December 1982, undated, p. 2.

5/ Ibid., pp. 2 and 3.

In August 1982, the Machine Tool Trigger Order Program was authorized under title III of the Defense Production Act. The purpose of the program is to reduce mobilization lead times for machine tools essential to defense production through standby purchase agreements between machine tool firms participating in the program and the Federal Government. The standby agreements identify the machine tools that a participating firm would produce during an emergency. The great majority of machine tools manufactured under the Machine Tool Trigger Order Program would be delivered directly to defense contractors, with the sale proceeding in a normal commercial fashion. Machine tools produced under contract in excess of actual needs would be purchased by the Government 1 year after the emergency had ended at 90 percent of the prevailing retail price and held until a buyer is located. Once a buyer is located, the manufacturer would be paid the remaining 10 percent of the purchase price. The agreements are to assure production for the first 6 months of an emergency and also to outline the financing, advance-payment agreements, the specifications and performance profiles for the production of the equipment, as well as the priority access to materials and components used in production. Production is initiated by the declaration of an emergency.

The estimated dollar value of the Standby Agreements to be signed over the next 3 years (1982-85) is $1.5 billion. 1/ However, no funds are paid for purchases in advance of an emergency. In late July 1983, there were 53 Standby Agreements signed, covering over 4,000 items, worth $710 million dollars. 2/ This puts the program one-third of the way towards its goal of 150 signed agreements. The dollar estimate for each major type of machine tool is as follows: $350 million for machining centers, $150 million for boring machines, $100 million for gear-cutting machines, $150 million for grinding machines, $80 million for automatic turning machines, $250 million for turning lathes, $340 million for metal-forming machine tools, and $80 million for other types of machine tools. 3/ These are predominately catalog items to be purchased at the then-prevailing retail price. The initial agreements have concentrated on CNC turning equipment, machining centers, grinding machines, gear cutters, and large vertical and horizontal boring mills. 4/

The overall responsibility for the Machine Tool Trigger Program rests with the Federal Emergency Management Agency (FEMA), with the participation of the Department of Defense and the Department of Energy for identifying the relevant requirements, the General Services Administration (GSA) for providing contract development and administration, and the Department of Commerce for identifying the machine tool products in the market matching the requirements, identifying the contractors, as well as reviewing Departments of Defense and Energy specifications, machine tool prices, and the quantity of machine tools required.

Other Government agencies are involved in supporting manufacturing research. The NSF has a number of programs which are sources of funds for production research. The Production Research Program provides funds directly

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1/ Federal Emergency Management Agency, FEMA Forum, November 1982, p. 2.

2/ Telephone conversation with Joe Minor, project officer, FEMA Machine Tool Trigger Order Program, July 25, 1983.

3/ Federal Emergency Management Agency, op. cit., p. 3.

4/ Rosanne Brooks, "US Tool Builders Sign $480 M Trigger Pacts", American Metal Market, May 23, 1983, p. 16.

for production research; the Industry/University Cooperative Research Program, the Innovation Process Research Program, and the Small Business Innovation Program are primary sources of funds for augmenting the budget of the Production Research Program. The Social and Economic Sciences Programs and the International Programs are other sources of funds. NSF's Production Research Program has the objectives of providing financial support for research, which leads to substantially higher productivity, and insuring a sufficient number of manufacturing engineers for university faculties and industry. NSF's Production Research Program performs several activities: (1) identifies major research needs and acquires the necessary resources to realize those needs; (2) provides funding for research by universities and nonprofit organizations, industry/university partnerships, and small business; and (3) works with universities which are trying to establish manufacturing research programs. Other activities are the establishment of international programs, which include staff visits, planning conferences, and the exchange of engineers, and participation of the Production Research Program in intra- and inter-agency activities. 1/ Table 20 depicts the NSF Production Research Program for fiscal years 1980-84.

Table 20.--National Science Foundation Production Research Program and Augmentation funding, fiscal years 1980-84

(In millions of dollars)

Item	1980	1981	1982	1983	1984
Production Research Program	2.3	2.8	3.1	3.5	4.6
Augmentation	1/ .2	2/	2/	1/ 1.5	2/

1/ Estimated.
2/ Not available.

Source: W. M. Spurgeon, "Production Research Program, National Science Foundation," Tenth NSF Conference on Production Research and Technology, Detroit, Mich., March 1983, p. 6.

Currently, there are two projects in NSF's Small Business Program which are in the area of production research: grinding and optical gaging. 2/ For a complete listing of NSF Production Research Program recent projects in FY 1983, see appendix G.

The Center for Manufacturing (CME) is an operational unit of the National Engineering Laboratory of the National Bureau of Standards. CME's program goal is to enhance the technology base which supports innovation and productivity in the discrete-parts-manufacturing industries. Currently, CME

1/ W.M. Spurgeon, "Production Research Program, National Science Foundation," charts used in talk at the Tenth NSF Conference on Production Research and Technology, Detroit, Michigan, March 1983, p. 33.
2/ Telephone conversation with Dr. W. M. Spurgeon, director, Production Research Program, National Science Foundation.

supports the discrete-parts-manufacturing industries through the development of technical data, findings, and standards in the areas of manufacturing engineering, mechanical metrology, automation and control technology, and industrial and mechanical engineering.

In 1968, the CME conducted research on developing computer-controlled coordinate-measuring machines (CMM), and by 1980, calibration routines had been developed, thus allowing their widespread adoption. Although the CMM program is still in operation in FY 1982, CME effort in this area is minimal. The result of the CMM program has been a proposed standard currently in draft form. Research on CMM's lead to efforts by the National Bureau of Standards to investigate quality-control systems from the perspective of the behavior of the systems, as opposed to the nature of the product. Much of CME's Automation Research Program is directed toward taking this concept from the work station and implementing it in a machining cell. Robots with enhanced sensory perception are required for this application to be realized. Thus, CME is researching robot vision systems.

Another area of activity at the CME has been the development of an interface standard for communication CAD systems and CAD/CAM systems, thus allowing small CAD/CAM systems to be integrated into larger CAD/CAM systems. Through a program sponsored by the U.S. Air Force Integrated Computer Aided Manufacturing and NASA, NBS coordinated a consortium of approximately 45 to 50 private companies and produced a national standard, ANSI (American National Standards Institute) Y14.26M, which was adopted on September 21, 1981. This program was organized in October 1979, and the ANSI Y14.26 M standard is the first of many standards to be developed by this organization.

In fiscal year 1981, the NBS began funding the Automated Manufacturing Research Facility (AMRF), located in the CME's Instrument Shop. The AMRF is to be completed in FY 1986. The AMRF, which superfically resembles an FMS, under current plans will have the following work stations: horizontal machining, vertical machining, turning, cleaning and deburring, inspection, materials inventory, transfer system, and housekeeping system. The AMRF is equipped with standard model, general-purpose machine tools which are representative of those in common use throughout the United States. The CME is presently conducting two projects--one in robotics, the other in precision machining--both of which will develop subsystems for the AMRF. 1/

The AMRF is available to universities and industry for "nonproprietary research in manufacturing engineering which lies further afield than the metrology and standards of NBS." 2/ Cooperative research efforts are conducted through the NBS Industrial Research Associate Program by employees of manufacturers. 3/ Indirect contacts between the CME and industry include completed negotiations between NBS and two corporations (but not machine tool

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1/ J.A. Simpson, R.J. Hocken, J.S. Albus, "The Automated Manufacturing Research Facility of the National Bureau of Standards," Journal of Manufacturing Systems vol. 1, No. 1, 1982, p. 23.

2/ Ibid., p. 31.

3/ Currently, the NBS Industrial Research Associate Program under the CME has the following participants: Brown & Sharpe, TRW, Hardinge Brothers, Monarch Machine Tools, the U.S. Bureau of Engraving and Printing, Science Applications, Inc., Honeywell, and John Deere.

builders) to commercially license the manufacture of sensors which detect the sharpness of a drill bit. The NMTBA's Technical Committee provides information and advice to the Automation Research Program; however, no formal relationship exists. The CME, through the Automation Research Program, also maintains relationships with universities encompassing small grant programs, cooperative work-study arranagements, and summer programs at the NBS for undergraduate engineers. Table 21 depicts the NBS's Center for Manufacturing Engineering budget for fiscal years 1982-84.

Table 21.--NBS's Center for Manufacturing Engineering budget, by programs, fiscal years 1982-84

(In millions of dollars)

CME programs	1982	1983	1984 1/
Mechanical engineering metrology	3.3	3.5	2/ 3.9
Automation manufacturing interface-standards	2.3	1.9	3/ 1.9
Total	5.6	5.4	5.8

1/ FY 1984 appropriations before Congress.

2/ Augmenting the Mechanical Engineering Metrology Program is another $3.8 million; $1 million is from the Navy; $200,000, from the Army; other U.S. Government agencies provide $300,000, miscellaneous funding sources contribute $200,000, NASA for $250,000, Treasury for $250,000; and $1 million for calibrations from the National Bureau of Standards.

3/ Augmenting the Automation Manufacturing Interface Standards Program is another $1.5 million, of which $1.0 million is from the Navy, Army, and Air Force.

Source: Hearings before the Appropriations Committee, Subcommittee on State, Justice, Commerce and Related Agencies, House of Representatives, U.S. Congress, 98th Congress, 1st Session.

The Eximbank's program in 1980 supported the machine tool industry with the following assistance: $230,000 in short-term insurance; $3.7 million in medium-term insurance; $849,000 under the Cooperative Financing Facility (CFF) program; $6.7 million in bank guarantees; $5.042 million in discount loans; and $5.1 million in financial guarantees (app. F shows annual Eximbank financial support to the machine tool industry). 1/ Table 22 presents Eximbank support for the machine tool industry for active cases as of the end of 1982. However, the Eximbank minimum loan requirements and payback period frequently are not conducive to machine tool exports. In some cases, the financing of a machine tool sale was denied by Eximbank on the grounds that the sale would ultimately harm another U.S. industry. If exported, the machine tool would be used to manufacture a product which would compete with a U.S. product. 2/

1/ United States Trade Representative, Trade Policy Sector, Draft Document 82-53, Sector Financing Review, 1980. Based on a survey of Eximbank users.

2/ Commission staff interview with Eximbank officials.

Table 22.--Eximbank support for the machine tool industry, by type of program, as of Dec. 31, 1982

(In thousands of dollars)

Program	Number of active cases	Export value	Authorization bank	Disbursed amount
Direct loans	2	41,200	20,700	19,000
Cooperative Financing Facility	41	20,100	14,000	8,500
Discount loans	49	35,500	27,900	15,400
Financial guarantees	6	1/	1,600	1,400
Bank guarantees	28	37,900	28,900	22,800
Medium-term insurance	7	7,386	5,700	5,400
Short-term insurance	92	103,400	95,300	94,400
Total	225	245,486	194,100	166,900

1/ Included in direct loans.

Source: Export-Import Bank of the United States.

In the area of patent law, the Bayh-Dole Act provides that organizations may elect to retain title to their inventions which were funded through Government research and development contracts or grants. 1/ In 1981, the law was expanded by presidential memorandum to include all organizations engaged in Government-funded research as opposed to just small businesses and nonprofit organizations, as was the case before 1981. 2/ Another law in the area of promoting innovation in technology is the Stevenson-Wydler Technology Innovation Act of 1980. 3/ The act authorizes Government units to actively promote technological development and the diffusion of technology to the private sector. One Government program created under the act is the Large Scale Industrial Partnership Program, established under the Office of the Assistant Secretary for Productivity, Technology, and Information in the Department of Commerce. The program allows for the establishment of Research and Development Limited Partnerships (RDLP's), which minimize antitrust problems, occur on a scale beyond that which any individual U.S. firm could implement, and are funded through tax incentives already in existance. RDLP's were promoted at a recent meeting of Commerce officials and the NMTBA to the machine tool industry. 4/

In the area of technology, at least within the U.S. Patent System, the United States maintains a slight edge in machine tool innovation and in innovation of machine tool controls as measured by the number of patents granted. During 1977-82, the share of patents of U.S. origin to total patents in the area of metalworking machine tools was roughly 60 percent; those of

1/ 35 U.S.C. 200 et seq. (supp. V 1981).
2/ Government Patent Policy, Memorandum from the President, Weekly Compendium of Presidential Documents 252, Feb. 21, 1983, p. 19.
3/ 15 U.S.C. 3701 et seq.
4/ May 6, 1983.

foreign origin accounted for roughly 40 percent. 1/ U.S. Government-owned patents for patents of U.S. origin and foreign-government-owned patents for patents of foreign origin accounted for 1 percent or less of the total number of patents in the machine tool area during 1977-82. 2/ The United States is followed by West Germany and then by Japan in the number of patents held in the U.S. Patent System in the area of metalworking machine tools. In the area of machine tool controls, the U.S. percentage of patents has declined slightly, from roughly 55 percent in 1977 to 51 percent in 1982; the percent of patents of foreign origin has increased from 45 percent in 1977 to 49 percent in 1982. Japan, so it would appear, is, by far, the most innovative foreign holder of U.S. patents in the area of machine tool controls, holding 18 percent of the total number of patents in 1977 and 31 percent in 1982. Japan is followed by West Germany and then the United Kingdom (app. F). Table 23 presents patent activity for metalworking machine tools and controls for machine tools in the U.S. Patent System for 1977-82 in terms of ownership by origin.

In the area of tax subsidies for private sector research and development and investment, the U.S. Government enacted the Economic Recovery Tax Act of 1981 (ERTA). The ERTA provided to businesses a tax credit of 25 percent of the actual increase in research and development expenditures over a 3-year base period. Other provisions in the area of research and development provided by the ERTA include a corporate charitable deduction for used research and development equipment 3/ and revised rules pertaining to research and development deductions allocated against U.S. source income. 4/

The ERTA also provided other tax incentives to spur new investment in production facilities, such as the accelerated-cost recovery system (ACRS) and safe-harbor leasing rules, which allow firms that are in a financially precarious situation to sell their unused tax credits. However, since the ERTA's enactment in 1981, the U.S. Congress has put "new limits on the investment tax credit, repealing increases in ACRS benefits scheduled for 1985 and 1986, halving the benefits of safe-harbor leasing, and then abolishing it altogether as of January 1, 1984." 5/ The Tax Equity and Fiscal Responsibility Act of 1982 reduces by 57 percent the tax benefits of 1981 when the 1982 tax act effects are calculated out to 1986. 6/ An estimate of how adversely the machine tool industry will be affected is shown in the effective tax rates in 1986 for the machinery industry. Under the 1980 law, the rate is 38.2 percent; under the 1981 law, the rate is 10.6 percent; and under the 1982 law, the effective tax rate is 25.7 percent. 7/

1/ Statistics compiled by U.S. Department of Commerce, Patent and Trademark Office, Office of Technology Assessment and Forecast.

2/ It was not possible to ascertain from the data the number of Government-funded inventions that have been patented.

3/ 26 U.S.C.A. 170(e) (West 1978 and supp. 1983).

4/ 26 U.S.C. 861 (supp. 1983).

5/ Richard I. Kirkland Jr., "Taxing the Business Lobby's Loyalty," Fortune, Oct. 18, 1982, p. 144.

6/ Ibid.

7/ Ibid.

Table 23.--Metalworking machine tools: Patent activity for metalworking machine tools and controls for machine tools in the U.S. Patent System, by origins, 1977-82 1/

Origin and ownership	1977	1978	1979	1980	1981	1982	Total
	Number of metalworking machine tool patents						
U.S. origin:							
U.S. corporate-owned	599	574	424	534	549	429	3,109
U.S. government-owned	8	5	13	9	4	9	48
U.S. individual-owned	318	323	219	259	296	231	1,646
Foreign-owned	4	4	4	2	4	6	24
Subtotal	929	906	660	804	853	675	4,827
Foreign origin:							
U.S.-owned	31	28	13	19	21	21	133
Foreign-owned:							
Foreign corporation	386	404	268	362	392	317	2,129
Foreign government	1	2	1	2	2	4	12
Foreign individual	154	132	105	165	131	99	786
Subtotal	541	538	374	529	525	420	2,927
Total, U.S.- and foreign-owned	572	566	387	548	546	441	3,060
Total	1,501	1,472	1,047	1,352	1,399	1,116	7,887
	Number of patents for controls of machine tools						
U.S. origin:							
U.S. corporate-owned	54	60	49	46	47	45	301
U.S. government-owned	2	2	0	1	2	1	8
U.S. individual-owned	8	7	3	3	5	7	33
Foreign-owned	0	0	0	0	1	1	2
Subtotal	64	69	52	50	55	54	344
Foreign origin:							
U.S.-owned	1	4	0	2	2	1	10
Foreign-owned:							
Foreign corporation	44	45	31	48	46	46	260
Foreign government	1	1	0	1	1	0	4
Foreign individual	6	4	5	4	7	5	31
Subtotal	51	50	36	53	54	51	295
Total, U.S.- and foreign-owned	52	54	36	55	56	52	305
Total	116	123	88	105	111	106	649

1/ U.S. Patent Classifications: Classes are 10, 29, 51, 76, 82, 83, 225, 234, 279, 407, 408, and 409 for metalworking machine tools; classes are 318 and 364 for controls for machine tools.

Source: U.S. Department of Commerce, Office of Technology Assessment and Forecast, Patent and Trademark Office.

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Japan

The Japanese metalworking machine tool industry today is recognized as a world leader in both the sophisticated technology of its machines and in the output of machine tools. The current position of Japan's machine tool industry is in part a result of Japanese Government involvement in the promotion of the industry through laws, guidance to the industry, preferential loans, subsidies, and tax incentives.

Industry

At the end of 1979, the Industrial Census of the Government of Japan listed 1,902 manufacturing facilities for metal-cutting machine tools, with 1,339 of these establishments employing fewer than 10 persons. In 1980, there were 1,972 firms in the Japanese metal-cutting machine tool industry. In 1975, the Japanese machine tool industry was composed of 1,949 firms which manufactured solely machine tools, 4 of which were subsidiaries of U.S. firms, and 1 that was a subsidiary of another foreign country. 1/ As of August 1982, the Japanese Machine Tool Builders' Association (JMTBA) had 113 members. Japanese machine tool builders can be categorized as manufacturers of general machine tools, machining centers and NC lathes, machining centers, NC lathes, and special machines in the areas of grinding machines, gear-making machines, and electrical discharge machines. In the first quarter of 1983, there were 148 builders in Japan supplying NC machine tools; 62 firms were manufacturing machining centers, 57 firms were producing NC lathes, and 29 firms were manufacturing other types of NC machine tools. 2/ 3/ The Japanese Machine Tool Builders' Association (JMTBA) listed 100 machine tool builders, 68 of which produced metal-cutting machine tools, and 10 trading firms as members in 1977, and 95 machine tool builders and 8 trading firms in 1978. 4/ 5/ In 1979, the 109 JMTBA members accounted for 87.9 percent of Japan's machine tool output. 6/ As of August 1982, the JMTBA had 113 members.

Employment in the Japanese metalworking machine tool industry during 1977-82 is depicted in table 24.

1/ U.S. Department of Commerce, Industry and Trade Administration, Country Market Survey: Machine tools-Japan, Washington, D.C., CMS 79-407, August 1979, p. 6. The Survey cites the Japanese Ministry of International Trade and Industry, Census of Manufacturers 1975: Report by Industries, and Marunouchi Research Center, Japanese Subsidiaries of Foreign Companies, 7th Edition, 1977.

2/"Study Says 148 NC Machine Builders Are Active in the Market," Metal-working Engineering & Marketing, May 1983, p. 44.

3/ Ibid. pp. 44 and 45.

4/ Japan Machine Tool Builders' Association, Japan Machine Tool Industry 1977, Tokyo, Japan, 1977, p. 123-148. Japan Machine Tool Builders' Association, Japan Machine Tool Industry 1978, Tokyo, Japan, 1977, p. 131-156.

5/ Japan Machine Tool Builders' Association, Japan Machine Tool Industry, Tokyo, Japan, 1977, p. 149.

6/ Japan Economic Yearbook 1977/78, The Oriental Economist 1978, p47 123.

Table 24.--Number of employees in the Japanese metalworking machine tool industry, by major types, 1977-82 1/

Year	Metal-cutting machine tool industry	Metal-forming machines industry 2/	Total
1977	32,168	7,566	39,734
1978	28,154	7,889	36,043
1979	31,113	7,374	38,487
1980	33,737	7,962	41,699
1981	33,883	8,346	42,229
1982	34,146	6,500	40,646

1/ Based on persons employed at facilities with 50 or more employees. Based on Current Production Statistics Survey, MITI, which may omit seasonal employees at facilities when the products under survey are not the principal product.

2/ Employment figures derived from share of metal-forming machine industry output, valued in yen, as a percent of the machine and casting machine industry, which includes rolling mill machine industry, tube mills and finishing equipment industry, roll industry, metal-forming machine industry, automatic gas cutting machine industry, and foundry machinery equipment industry.

Source: Information supplied by Wender, Murase, and White, counsel for the Japan Machine Tool Builders' Association, Japan Metal Forming Machine Builders' Association, and Japan Machinery Exporters' Association to the U.S. International Trade Commission, Aug. 5, 1983.

In 1975, employment in this industry totaled 54,080 persons, with 1,778 firms employing 1 to 49 persons, 132 firms employing 50 to 299 persons, and 34 firms employing over 300 persons. 1/ In 1980, the majority of Japanese metal-cutting machine industry firms, that is 1,593 firms, or 80 percent, employed from 1 to 19 workers; at the other extreme, 6 firms had employment of 1,000 workers or greater. Compiled from data in the MITI, Industrial Census, 1980, the following tabulation depicts the industry in 1980, by number and by sizes of firms and share of production.

Number of employees	Number of firms	Percent of total	Percent of total output
1 to 19	1,593	80.8	6.2
20 to 49	192	9.7	8.1
50 to 99	83	4.2	9.6
100 to 299	74	3.8	24.8
300 to 999	24	1.2	13.9
1,000 plus	6	.3	37.4
Total	1,972	100.0	100.0

1/ Op. cit.

Although a system exists for subcontracting to larger companies by smaller firms throughout the economy, usually utilizing nonunionized labor, it is not known to what extent this occurs in the machine tool industry. 1/ In 1981, the annual earnings of factory workers in the industry appeared to range from $12,000 to $18,000, including bonus, but excluding fringe benefits, such as company housing, free medical treatment, and other benefits. 2/ Earnings for professional employees, including engineers, ranged from $15,000 to $35,000 per year. 3/

In 1982, Japanese metalworking machine tool production was valued at $3.9 billion, decreasing from $4.8 billion in 1981. At the end of 1977, production was valued at $1.6 billion. 4/ Exports followed the same pattern as production, decreasing to $1.3 billion in 1982 from $1.7 billion in 1981. Exports totaled $616.4 million in 1977. Imports of metalworking machine tools increased to $228.4 million in 1982 from $215.8 million in 1981. In 1980, imports totaled $229.3 million, increasing from $87.8 million in 1977. Consumption followed the same trend as production, imports, and exports. In 1982, consumption totaled $2.8 billion, decreasing from $3.3 billion in 1981. Consumption totaled $1.1 billion in 1977.

In 1982, exports as a share of production decreased to 33 percent from 43 percent in 1978. Exports as a share of total production were 38.5 percent in 1977. Over the same period, imports as a share of apparent consumption remained fairly stable, averaging around 8 percent. In 1982, imports as a share of consumption were 8 percent, down from 9 percent in 1980. However, another trend that is very pronounced in the Japanese metalworking machine tool industry is the increase in metal-cutting machine tools relative to metal-forming machines. In 1977, the ratio of metal-cutting to metal-forming machine tools was 2.6:1, rising to 4.1:1 in 1981 and 5.1:1 in 1982.

Over the past few years, Japanese machine tool builders have established assembly and production operations overseas. In 1978 and 1979, Japanese manufacturers were "either opening plants or contracting to have machines built in Korea, Singapore, and Taiwan." 5/ Yamazaki Machinery Works Ltd. established Yamazaki Machinery Corp. (U.S.) in Kentucky to produce machining centers and NC lathes. Makino Milling Machine Co. Ltd. acquired majority ownership of LeBlond to form LeBlond Makino Tool Co. Ltd. in Cincinnati. Japanese firms such as Hitachi Seiki Co. Ltd., Mitsubishi Heavy Industries Ltd., and Toyoda Machine Works Co. Ltd. have either assembly operations in the United States or licensing arrangements with U.S. manufacturers to produce Japanese-designed machines. Japanese machine tool builders also have licensing and joint ventures with European firms, such as between Fanuc Ltd. and Siemens to produce NC lathes.

1/ Robert C. Wood, "Japan's Multitier Wage System," Forbes, Aug. 18, 1980, pp. 53-58.

2/ Meeting the Japanese Challenge, National Machine Tool Builders' Association, McLean, Va., Sept. 14, 1981, p. 26.

3/ Ibid.

4/ Figures for production, exports, imports, and consumption are from American Machinist, February issues, 1979-83.

5/ Anderson Ashburn, "Collapsing Dollar Distorts Study," American Machinist, Feburary 1979, p. 83.

Japanese machine tool builders may have been dissuaded from establishing manufacturing facilities overseas because of their subcontractor relationships. For Japanese firms in general--

> "The design and production capabilities of equipment manufacturers are generally linked to an intricate network of subcontractors whose quality and prices they are able stringently to control. It is for this reason that Japanese manufacturers are seriously inhibited when they attempt to set up overseas manufacturing operations, since they generally encounter considerable difficulties in duplicating the intricate networks of reliable subcontractors that can deliver quality components at low costs." 1/

Government involvement

In the 1950's and 1960's, the Japanese Government used a variety of approaches to develop the country's industrial machinery industry. These included: the enactment of laws to promote the industry; low-interest loans from the Japan Development Bank; 2/ authorization of cartels for purchasing parts and importing materials; Government formation of industry associations and their subsidization; rationalization of the industry, 3/ decreed by law, through elimination of inefficient firms and later through allocation of product categories to companies; import bans on foreign machinery to spur domestic production; 4/ and tax incentives, including tax-free export income and a series of depreciation schedules. 5/

The Japanese Government enacted three laws and Cabinet orders which have specifically affected the promotion of the machine tool industry,

- Extraordinary Measures Law for Promotion of Machinery Industry, Law No. 154 of June 15, 1956. This law promotes the machinery industry through rationalization.

- Enforcement Order for the Extraordinary Measure Law for Promotion of Machinery Industry, Cabinet Order No. 238, July 20, 1956. This order specifies the metal-cutting machine tool sector for promotion and authorizes funds or loans.

1/ Jack Baranson, Automated Manufacturing: The Key to International Competitiveness--And Why the United States is Falling Behind. Developing World Industry and Technology, Inc. Washington, D.C., 1983, p. 111.

2/ Available to all industries. Industry members must request the loan.

3/ Not used by the Ministry of International Trade and Industry (MITI) after 1960, although the option was available. Rationalization was pursued subsequently by the industry, with the Government approving or dissapproving the action requested.

4/ In the 1950's.

5/ I. Magaziner and T. Hout, Japanese Industrial Policy, 1980, pp. 90-97.

- Extraordinary Measures Law for Promotion of Specific Electronic Industries and Specific Machinery Industries, Law No. 17 of 1971. This law authorizes appropriation of the necessary funds or facilitates loans for the industry.

- Enforcement Order of the Extraordinary Measures Law for Promotion of Specific Electronic Industries and Specific Machinery Industries, Cabinet Order No. 197, June 21, 1971. This order designates metal-cutting machines, NC metal-cutting, CNC metal-cutting, metal-forming, NC Metal-forming, and CNC metal-forming machine tools as types of machinery to be promoted.

- Extraordinary Measures Law for the Promotion of Specific Machinery and Information Industries, Law No. 84 of 1978. This law promotes the introduction of modern production techniques and rationalization of production, as well as securing the necessary funds or facilitating loans to the industry.

- Enforcement Order of the Extraordinary Measures Law for Promotion of Specific Machinery and Information Industries, Cabinet Order No. 342, September 29, 1978. This order specifies CNC metal-cutting machine tools with simultaneously controlled multiple spindles, high performance module structure numerically controlled metal- cutting machines tools, as well as the most advanced types of metal-forming machine tools for promotion by industry. 1/

In 1978, under Public Law No. 84, the Japan Development Bank and the Small Business Finance Corporation were able to make loans available to the industries designated by legislation. This law is presently in effect in Japan. The loans have preferred interest rates. Loan interest rates under this legislation are as follows:

Special interest rate	7.3-8.3%
Regular interest rate (long term prime rate)	8.4% 1/

1/ MITI, Japan.

The Small Business Finance Corporation (SBFC) loans have an expenditure ceiling of Y220 million (approximately $883,000 at 1982 exchange rates) for direct loans when combined with general loans and Y30 million ($121,000) for agency loans aside from general loans. A grace period of up to 2 years was given to borrowers with up to 10 years for loan maturity. Loans from the Japan Development Bank could pay for up to 50 percent of the total equipment and construction costs of a project. The typical loan maturity was 7 years, but could fall within a period of greater than 5 years but less than 10 years. The borrower receives a grace period of approximately 1 year.

1/ Computer-Aided Manufacturing: The Japanese Challenge, comments submitted to the U.S. International Trade Commission, investigation No. 332-149, by Cravath, Swaine, and Moore, counsel for Cincinnati Milacron, Dec. 14, 1982, App. 4.

Projects involving primarily machines, parts, and semifinished goods for parts for NC metalworking machine tools with precision position via feedback central, NC automatic forging equipment, industrial robots, and high-performance, computer-operated, automatic design equipment (presumably CAD) were eligible to receive loans with interest rates of 6.65 percent under legislation to promote industrialization. Loans received for projects involving machines, parts, and semifinished goods for parts of NC metalworking machine tools and industrial robots under legislation for promoting rationalization qualified for interest rates of 7.7 percent. 1/

During 1978-82, the Japan Development Bank (JDB) gave the following loans for the "Elevation Plan" of the Electronics and Machinery Industry: for the metal-cutting machine tool industry in fiscal year 1979, one loan for 170 million yen ($774,840); in 1980, one loan for 100 million yen ($441,033); and in 1982, two loans totaling 1,300 million yen ($5.2 million). However, during 1978-82, the JDB did not provide any loans to the metal-forming sector of the industry. 2/ The SBFC, under the Elevation Plan of the Electronics and Machinery Industry, provided the following loans: for the metal-cutting sector, four loans in fiscal year 1979 totaling 345 million yen ($1.57 million); in 1980, one loan for 80 million yen ($352,827); in 1981, three loans for 420 million yen ($1.9 million); and in 1982, two loans for 270 million yen ($1.08 million). 3/ The SBFC provided one loan for 60 million yen ($264,620) for the metal-forming sector, and in 1981, four loans totaling 535 million yen ($2.4 million). 4/

Although the total corporate tax rate in Japan is 54 percent, depreciation deductions for newly purchased capital equipment and for employee benefits significantly reduce a company's tax burden. 5/ In the area of tax incentives, Japanese machine tool builders receive a partial tax exemption on royalty income from abroad. Also, a tax credit of up to 25 percent is received if research and development expenditures in the current year exceed those of the previous year. Finally, twice the normal 12-year depreciation rate is granted for capital investment in pollution control devices. 6/

The involvement by the Japanese Government in the financial markets through institutions such as the Japan Development Bank or the Japan Export and Import Bank has significantly reduced the amount of investment risk when those Government institutions are party to the loan consortia for a project. 7/ Such institutional arrangements are, in part, responsible for the low costs of capital to corporations in Japan. The average weighted cost of capital in 1977 was 6.6 percent in Japan, compared with 9.4 percent in the United States, and in 1980, it was 8.5 percent in Japan and 13.1 percent in the United

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1/ MITI, Machine and Information Bureau, Trade and Industry Research Group, Commentary on Public Law 84, Semiconductor Industry Association Translation.

2/ MITI, Japan.

3/ Ibid.

4/ Ibid.

5/ Meeting the Japanese Challenge, National Machine Tool Builders' Association, McLean, Va., Sept. 14, 1981, pp. 17 and 18.

6/ Ibid., p. 16.

7/ Eisuke Sakakibara, Robert Feldman, and Yuzo Harada. The Japanese Financial System in Comparative Perspective, Joint Economic System in Comparative Perspective, Joint Economic Committee, U.S. Congress, Washington, D.C., Mar. 12, 1982, p. 21.

States. By the end of 1981, the average weighted cost of capital was 7.8 percent in Japan and reached 16.2 percent in the United States. 1/

In the area of research and development, the Japanese Government is involved in providing grants and loans for projects, and tax subsidies to industry, as well as operating research and development facilities itself. The Agency for Industrial Science and Technology (AIST), directly under the MITI, administers research and development grants, including matching grants for specific projects. The large-scale research project also administers research and development grants, combining resources from industry and the Government. This has included a 7-year joint project to develop a laser-applied control system for machinery. 2/ This project, called Machines for Unmanned Manufacturing (MUM), involved three research institutes in the MITI and 20 manufacturers of materials, machine tools, and controls which were formed into an Engineering Research Association. Through the Subsidies for Important Technologies budget, subsidies are granted to small businesses for research and development. 3/

The AIST operates a number of research laboratories, including the Mechancial Engineering Laboratory (MEL) in Tokyo, and the Industrial Research Institutes in Osaka (materials) and Nagoya (forming processes). The research primarily benefits the industrial machinery sectors and has resulted in the first electrical discharge machines (EDM) in Japan and the introduction of the first direct numerical control (DNC) units. 4/ Contacts between the Mechanical Engineering Laboratory and companies are not strong, and this is especially true for the smaller companies. 5/

The Japanese Government also influences research and development through taxes. In addition to the tax measure for research and development depreciation cited above, the Japanese Government allows tax credits for dues for establishing cooperative research associations among companies. 6/

Other sources of financing by the Government to the machine tool industry include Export-Import Bank loans and government-to-government credit in yen. The latter is frequently alleged to be "indirectly tied to machinery sales." 7/ The Overseas Economic Cooperation Fund, a public company under the direction of the Ministry of Finance, the Ministry of Foreign Affairs, and the Economic Planning Agency, arranges for large national projects purchased by foreign governments. Project financing falls under the heading of economic aid and is

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1/ Cabinet Council on Commerce and Trade, An Assessment of U.S. Competitiveness in High-Technology Industries, Appendices, May 19, 1982, p. 79.

2/ I. Magaziner and T. Hout, Japanese Industrial Policy, 1980, p. 98

3/ Ibid.

4/ EDM machine technology was first pioneered and commericalized in Switzerland. Today there are three Japanese manufacturers of EDMs, who are major competitors to the Swiss counterparts.

5/ George P. Sutton, "Trip Report on the Technology of Machine Tools in Japan," Visiting Team, Machine Tool Task Force, Lawrence Livermore National Laboratory, February 1980.

6/ J. Magaziner and T. Hout, Japanese Industrial Policy, 1980, p. 99.

7/ Ibid.

therefore not regulated by the Organization for Economic Corporation and Development (OECD). 1/ The Overseas Economic Cooperation Fund is financed through the Government's Fiscal Investment and Loan Program (FILP). 2/

The Japanese Government has also involved itself in the pricing of machine tools through the MITI. In December 1982, the MITI raised the U.S.-dollar-based export prices of NC lathes and machining centers made in Japan. This system of "floor prices" is based on a predetermined formula which includes the machine itself, machine weight, horsepower, workpiece capacity, and the country where purchased. The "floor price" system was implemented for NC lathes and machining centers exported to the United States and Canada in March 1978 and was expanded in January 1981 to include exports to the European Community. 3/ This "floor pricing" system is reviewed annually.

The Japanese machine tool industry also received support from bicycle racing, sponsored by the Japan Keirin Association (also known as the Bicycle Rehabilitation Association (JBRA), and motorcycle racing, sponsored by the Japan Motorcycle Racing Organization. Grants from the proceeds of these activities are made to the JMTBA, but not to the Japan Metal Forming Machine Builders' Association. The JMTBA uses the racing proceeds to print literature, collect statistics, and hold trade shows. 4/ Bicycle-racing proceeds are also donated to the Technical Research Institute of the Japan Society for Promotion of Machine Industry (the institute reportedly represents other types of industrial machinery, rather than just machine tools). 5/ Estimates of the proceeds from the motorcycle-racing activities donated to the machinery industry are depicted in the tabulation below (in millions of dollars):

Year	JMTBA 1/	Japanese Machinery Industry 2/
1978	.499	919
1979	.319	823
1980	.472	3/
1981	.322	3/

1/ Comments on Foreign Industrial Targeting and Its Effects on U.S. Industries, United States International Trade Commission investigation No. 332-162, submitted by Wender, Murase, and White, June 8, 1983, p. 5.
2/ Statement of John Latona, Vice President of Law, Houdaille Industries, Inc., before the Joint Economic Committee of the U.S. Congress, hearing on the U.S. Machine Tool Industry and the Defense Industrial Base, June 7, 1983, p. 10.
3/ Not available.

1/ Ibid., p. 100
2/ Ibid.
3/ "MITI Boosts Prices of Japanese Machines," American Machinist, February 1983, p. 27.
4/ Comments on Foreign Industrial Targeting and Its Effects on U.S. Industries, United States International Trade Commission investigation No. 331-162, submitted by Wender, Murase, and White, June 8, 1983, p. 5.
5/ Ibid.

The Japan Keirin Association also provided $1 million annually to the Technical Research Institute of the Japan Society for the Promotion of Machine Industry. 1/

In 1979, a temporary tariff was imposed on imports of machine tools ranging from 5 to 11 percent. Import duties of 7 to 10 percent were usually imposed on machine tool imports from countries adhering to the General Agreement on Tariffs and Trade (GATT). Higher tariffs, 12.5 to 15 percent, have been levied on some types of metal-cutting and metal-forming machines. 2/ Computerized numerical control units on machine tools in the recent past have on occasion been classified as computers, and the unit and machine tool were subject to a 17.5 percent duty. 3/

European Community

The machine tool builders in the European Community (EC) 4/ countries have traditionally produced sophisticated machines with a worldwide reputation for quality. In recent years, however, the share of total world production claimed by the EC industry has declined. In 1982, the EC share of world production was approximately 27.4 percent, a decline from about 32.5 percent in 1977. 5/ The EC industry exported approximately 61 percent of its production in 1977, compared with 64.7 percent in 1982. The EC countries have also been traditional trading partners with the CMEA (Council for Mutual Economic Assistance) countries of Eastern Europe.

As a supranational governmental body, the EC has involved itself in promoting its industries. Since 1977, the EC has conducted a dialog with the Japanese with the goal of restoring a better balance of trade. According to the EC, one of the specific problems was "the Japanese tactic of waging an all-out export drive in a limited number of industries--notably cars, television sets, machine tools, and electronic goods." 6/ During 1976-80, the EC market was penetrated by Japanese exports of machine tools, notably NC lathes and machining centers. In 1976, market penetration of Japanese NC lathes was 7.8 percent, by value, and 17.9 percent, by quantity, and for machining centers was 2.4 and 4.2 percent, respectively. By the end of 1980, penetration of Japanese NC lathes had increased to 18.7 percent, by value, and 29.9 percent, by quantity, and for machining centers, penetration was 13.1

1/ Comments on Foreign Industrial Targeting and Its Effects on U.S. Industries, United States International Trade Commission investigation No. 331-162, submitted by Wender, Murase, and White, June 8, 1983, p. 5.

2/ U.S. Department of Commerce, Industry and Trade Administration, Country Market Survey: Machine Tools-Japan, U.S. CMS 79-407, August 1979, p. 10.

3/ U.S. General Accounting Office, United States-Japan Trade: Issues and Problems, Washington, D.C., Sept. 21, 1979, p. 120.

4/ Excludes Austria, Sweden, and Switzerland, which are major producers of specialized machine tools.

5/ American Machinist, February issues, 1979-82. Production figures are for France, Italy, Belgium, Denmark, the Netherlands, United Kingdom, and West Germany.

6/ Commission of the European Communities, Bulletin of the European Communities Commission, No. 2, vol. 16, 1983, p. 81.

and 35.9 percent, respectively. 1/ During 1976-80, EC production of machining centers and NC lathes was dramatically surpassed by that of the Japanese. By 1980, EC production totaled 6,319 units, but Japanese production amounted to 17,267 units. 2/ In early 1983, the EC, through ministerial talks, successfully negotiated with the Japanese a continuation of the moderation, introduced in 1982, of exports to the EC of 10 sensitive products, including numerically controlled machine tools. 3/ However, this was partly the result of efforts begun in March 1982, when EC Council delineated a comprehensive common strategy to restore the balance of trade, including "(c) acknowledgement of the need to complete a Community policy which would enable European firms to develop positive strategies to meet Japanese competition." 4/ In late December 1982, the EC Council reported that, "As regards the moderation of Japan's exports of 10 sensitive products, the Commission considered it had obtained from the Japanese authorities the assurance called for by the Council on 13 December that a policy of clearly defined and effective moderation towards the Community as a whole would be pursued." 5/ Regarding the success of the machine tool industry in Japan, the European Council's view was that this was due to " . . . intervention by the [Japanese] public authorities in all its many forms, the successful integration of the electronics and mechanical-engineering industries and the vigorous efforts to stimulate demand. . ." 6/ On February 11, 1983, the European Commission sent to the European Council its comments on the machine tool industry and a document dealing with the situation and prospects. The report outlined an operational program consisting of Commission actions to be undertaken in the areas of revival of investment, matching supply to demand, structural adjustments, social aspects of the industrial transformation, the diffusion of advanced technologies, and trade (app. H).

The actions the EC undertook in encouraging the spread of advanced technology included the stimulation of NC production; standardization of interfaces between machines, control systems, and operators; coordinating the needs of the machine tool industry with other EC programs on data processing, microelectronics, fundamental technological research and Esprit (a European-wide, cooperative program among companies and organizations performing basic research, including electronics and computer firms); and coordination among machine tool research organizations in both the public and private sectors. 7/ In the area of finance, the EC's financial instruments, the European Investment Bank (EIB) and New Community Instrument (NCI), will permit EC

1/ Commission of the European Communities, The European Machine Tool Industry, Commission Statement, Situation and Prospects, sec. (83) 151 Final, Brussels, Belgium, Feb. 8, 1983, Annex 13. Share of penetration calculated in nominal dollars.

2/ Ibid., p. 1.

3/ Commission of the European Communities, Bulletin of the European Communities Commission, No. 2, vol. 16, 1983, p. 9.

4/ Ibid., pp. 8-9.

5/ Ibid., p. 9

6/ Ibid., p. 19.

7/ Commission of the European Communities, The European Machine Tool Industry, Commission Statement, Situation and Prospects, sec. (83) 151 Final, Brussels, Belgium, Feb. 8, 1983, pp. 10-11.

machine tool firms to have adequate access to financial resources. 1/ The EC Commission has allocated $1.2 million for the European Committee for Cooperation of Machine Tool Industries (CECIMO) 2/ to conduct a market survey with the goal of directing the European Community's machine tool firms toward becoming more competitive. 3/ Another action to be taken by the Commission in this program is the standardization of customer specifications for the machine tool industry, such as by the aerospace and motor industries. 4/

The following industry profiles describe the major producers of metalworking machine tools in the EC, namely, West Germany, Italy, the United Kingdom, and France, and Government actions in these countries involving the machine tool industry.

West Germany

Industry.--Currently, the West German machine tool sector is made up of 440 establishments, 328 of which are members of the German Machine Tool Builders' Association, accounting for 80 percent of German machine tool sales. 5/ In 1977, according to CECIMO estimates, there were 460 firms in the industry. During 1978-80, the industry had approximately 450 firms. 6/ In contrast, in 1976, the machine tool industry in West Germany was composed of 965 firms. This included 13 U.S. subsidiaries and 20 subsidiaries of other foreign companies. There were 20 firms each employing over 1,000 persons, 185 firms each employing between 100 to 1,000 persons, and 760 firms each employing less than 100 persons. Domestically owned firms together accounted for 96 percent of total sales, with foreign subsidiaries accounting for the remaining 4 percent. 7/ In 1976, several companies closed or merged with others. 8/ In 1977, Pittler, a major manufacturer, received a substantial

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1/ Ibid., pp. 5 and 6.

2/ Comite European de Cooperation des Industries de la Machine-Outil (CECIMO), an association which represents machine tool builders in Austria, Belgium, Denmark, France, West Germany, Italy, the Netherlands, Portugal, Spain, Sweden, Switzerland, and the United Kingdom.

3/ Commission of the European Communities, The European Machine Tool Industry, Commission Statement, Situation and Prospects, sec. (83) 151 Final, Brussels, Belgium, Feb. 8, 1983, p. 12.

4/ Ibid.

5/ Comments of the German Machine Tool Manufacturers' Association before the Secretary of Commerce in the matter of National Security Investigation Under Section 232 of the Trade Expansion Act of 1962 (19 U.S.C. 1862), Barnes, Richardson & Colburn and the German Machine Tool Builders' Association, Washington, D.C. June 1, 1983, p. 8.

6/ CECIMO.

7/ U.S. Department of Commerce, Industry and Trade Administration, Country Market Survey: Machine Tools-West Germany, CM 79-403, June 1979, p. 6. Differences in figures for 1976 and 1977 may be accounted for by various data sources used by the Department of Commerce and CECIMO.

8/ Anderson Ashburn, "World Machine-Tool Output Down", American Machinist, February 1977, p. 107.

infusion of capital from two banks which were primary shareholders, thus preventing the firm's bankruptcy. 1/

The West German machine tool industry employed 94,000 persons in 1982, decreasing from 99,000 persons in both 1980 and 1981. In 1981, the West German machine tool industry employed an estimated 225 workers per firm. However, employment did increase to 101,000 in 1979 from 98,700 persons in 1978. 2/ The composition of the workforce as of the end of December 1982 was 39 percent, white collar workers; 42 percent, skilled workers; 8 percent, apprentices; and 11 percent, all other workers. Foreign nationals constituted 7 percent of the workforce. 3/

In 1982, West German machine tool production was valued at approximately $3.5 billion, down from $4.7 billion in 1980. Production totaled $2.6 billion in 1977. 4/ Exports were valued at $2.3 billion in 1982, decreasing from $2.9 billion in 1980. Exports totaled $1.8 billion in 1977. Imports decreased to $514.5 million in 1982 from $802.1 million in 1980. Imports totaled $320.4 million in 1977. Consumption followed the same pattern as that of production, exports, and imports, decreasing to $1.7 billion in 1982 from a high of $2.5 billion in 1980 and, in 1977 totaled $1.1 billion.

Exports as a share of production increased gradually to about 66 percent in 1982 from 63 percent in 1978. However, in 1977, exports accounted for 69 percent of production. Imports as a share of consumption decreased to about 30 percent in 1982, from 31 percent in 1980. Imports as a share of consumption decreased to 9 percent in 1979 from 28 percent in 1977.

The West German ratio of metal-cutting to metal-forming machine tool production (based on value) remained stable during 1977-82, at approximately 2.3 to 1.

In early 1982, capacity utilization among members of the German Machine Tool Manufacturers' Association (VDW) averaged 80 percent, but declined to 77 percent by the end of the year. In order for a machine tool manufacturer to break even, an 85-percent capacity utilization rate is customary. 5/

The Association of Industrial Research Groups (AIF), a nonprofit organization, consisting of the German Machine Tool Manufacturers' Association, the West German Government, and universities, compose a large consortium to conduct research. 6/ The AIF's corporate members cover 60 percent of the country's industrial production.

1/ Anderson Ashburn, "World Machine-Tool Output Up Slightly", American Machinist, February 1978, p. 84.

2/ CECIMO.

3/ German Machine Tool Builders' Association.

4/ Figures for production, exports, imports, and consumption are from American Machinist, February issues, 1979-83.

5/ "Exports of German Tools to U.S. Off 0.7% in 82," American Metal Market, vol. 91, No. 60, Mar. 28, 1983, p. 8.

6/ The Competitive Status of the U.S. Machine Tool Industry: A Study of the Influence of Technology in Determining International Industrial Competitive Advantage, National Academy Press, Washington, D.C., 1983, p. 33.

Government involvement.--In 1972, the Ministry of Research and Technology (Bundesministerium fur Forschung and Technologie (BMFT)) was created to organize and bring efficiency to industries in decline, and to promote "knowledge-intensive" businesses. The Government granted funds directed especially toward those knowledge-intensive industries that are export oriented. It appears that only marginal results were achieved by research and development in the mechanical area through the traditional industry and university ties, especially for small machine tool businesses. 1/ In 1979, the BMFT granted 94 percent of its budget to companies which had a turnover of more than $110 million. 2/ Many major machine tool manufacturers were excluded from receiving these research and development funds. In 1979, the Ministry of Economics gave grants totaling approximately $176 million to 4,600 small companies for "personnel improvement," averaging about $38,500 per company, or 13 percent of total annual personnel costs. Many West German machine tool companies received grants from this program. 3/

It is not known to what extent the Lander (the collection of political units of Government, except the Federal Government, such as cities, school boards, States, and similar organizations) assists the machine tool industry or individual companies. It is known that the Lander does assist businesses in order to improve local employment opportunities. 4/

The West German Government participates in the financing of exports through a number of organizations--Banks with Special Functions, the Hermes Corp. (official Government capital aid to foreign countries), and the Deutsche Bank (Central), which heads the traditional banking network.

Banks with Special Functions include the Ausfuhrkredit-GmbH (AKA), the Export Credit Bank, the Kreditanetalt fur Wiederaufbau (Reconstruction Loan Corp.), the Industrie-kreditbank AG, and the Berliner Industrie-bank AG. The AKA is composed of member banks and basically underwrites "any worthy export product or service." 5/ The Kreditanstalt fur Wiederaufbau, which finances overseas development projects, is 80-percent owned by the West German Government and 20-percent owned by the States of West Germany. The Foundation to Promote Research for Trade and Industry owns approximately 28 percent of the Industrie-kreditbank AG's stock, with the remainder owned by major banks, insurance companies, and small investors. The West German Government owns the Berliner Industriebank AG and provides tax writeoffs for those investing in the bank.

The Hermes Corp. is a public corporation owned and operated by the Ministry of Economics on the Government's behalf. The corporation offers guarantees for exports of products produced by West German companies. A Hermes' guarantee allows an exporter to receive preferential financing rates from special-function banks or private sector banks.

1/ The Case for Specialized Productivity Programs in Support of Basic Industries' in the National Interest, Case II: Machine Tool Industry, Bedell Associates, Washington, D.C., December 1980, p. 47.

2/ Ibid., p. 48.

3/ The Case for Specialized Productivity Programs in Support of Basic Industries in the National Interest, Case II: Machine Tool Industry, Bedell Associates, Washington, D.C., December 1980, p. 48.

4/ Ibid., p. 49.

5/ Ibid., p. 36.

In early 1977, West German Government research-funding policy was established to support activities where scientific, technical, and economic risks were high, when a large expenditure of funds was required, or for long-term projects generating marginal profits in the projects' early stages. 1/ Research funding came from both the West German Federal Government and the State governments. The BMFT was instrumental in actively promoting knowledge-intensive industries with export orientation and supported other nonuniversity activities; the State governments supported programs in the universities. 2/ In 1977, the Gesellschatt fur Kerntechnik (GFK) and the Deutsche Forschungs- und Versuchsanstalt fur Luft- und Raumfahrt (DFVLR) were leading research centers in the areas of advanced manufacturing technology and automation. The two centers together employed 5,600 scientists, with employment totaling 17,000 persons. The GFK research center coordinated projects in Process Control by Computer (PDV) and CAD. In the CAD program, a participating institute received 100-percent funding; other firms received 50-percent funding for their projects. The DFVLR had two programs directed towards FMS technology: humanization of the work environment; and advanced manufacturing technology (P&F). The DFVLR also investigated industrial robots, FMS research and development, and pattern recognition.

The German Research Society (DFG), a nonprofit, selfgoverning organization including universities and technical colleges, was organized to avoid duplication of research efforts and to disseminate research results. The DFG initiated research activities among different organizations, especially at universities. Research in manufacturing was established at Universities in Aachen, Berlin, and Stuttgart. The "Hochschulgruppe Fertigungstechnik" (HGF), an informal organization consisting of 16 chaired professors in the area of production engineering and manufacturing technology with 500 research assistants, 600 part-time student assistants, and 230 support personnel, was "the most important influence on manufacturing research." 3/

In 1968, the Technical University of Aachen was designated a special research area for manufacturing technology. In 1977, the Laboratory for Machine Tools and Production (WZL) at the Technical University of Aachen conducted research in the areas of production engineering, production processes technology, machine tools, measurement technology, and automated production. Other projects at Aachen included the areas of CAD/CAM and FMS. The Laboratory employed three chaired professors and a staff of 400 persons. Another major research laboratory in 1977 was the Institute for Machine Tools and Manufacturing Technology (IWF). The Institute, which employed 150 persons, was divided into the Machine Tool Group, the Programming Group, and

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1/ G.K. Hutchinson, Flexible Manufacturing Systems in the Federal Republic of Germany (BRD), Management Research Center, the University of Wisconsin-Milwaukee, December 1977, p. 1.

2/ "The Case for Specialized Productivity Programs in Support of Basic Industries in the National Interest, Case II: Machine Tool Industry," Bedell Associates, December, 1980.

3/ G.K. Hutchinson, op. cit., p. 5.

the Control Group. The Control Group conducted research on control systems, robotics, and flexible manufacturing systems. The University of Berlin joined in a cooperative venture with Zahrahfabrik Friedrichschafen, a gear manufacturer, to develop an FMS for the early 1980's. 1/ Another venture between IWF and an industrial machine tool builder involved the development of a Flexible Manufacturing Cell (FMC). 2/ In 1977, the research program in industrial manufacturing systems at the University of Stuttgart was conducted through the Institute for Machine Tool Control Systems, the Institute for Production and Automation, and the Institute for Machine Tools. The University of Stuttgart was also designated as a special research area of the German Research Society.

Italy

Industry.--By early 1983, the number of firms manufacturing machine tools in Italy totaled 450. 3/ Employment in these firms is as follows: 40.9 percent of the firms employed from 0 to 20 workers; 27.7 percent employed from 30 to 50 workers; 20.8 percent employed from 50 to 150 workers; 7.1 percent employed from 150 to 300 workers; 1.4 percent employed from 300 to 500 workers; and 2.1 percent employed more than 500 workers. 4/ In 1981, according to CECIMO estimates, there were approximately 430 firms in the industry, decreasing from 450 firms in 1978, 1979, and 1980. In 1977, there were 480 firms, of which 1 was a U.S. subsidary, and 2 were subsidiaries of other foreign companies. 5/ The majority of machine tool manufacturers (256 firms) each employed less than 99 persons; 74 firms each employed between 100 and 499 persons; and 5 firms employed over 500 persons. 6/

The Association of Italian Machine Tool Builders (UCIMU), which represents the Italian machine tool industry, had 150 members by the end of 1982, of which it is estimated 25 went into bankruptcy proceedings and were not producing machine tools. 7/ Of the 25 firms in bankruptcy proceedings, 5 were large firms employing over 600 persons each. 8/ One large firm which went into the Italian equivalent of Chapter 11 proceedings was the family owned firm Canavese Srl. During 1977-82, family ownership of machine-tool-manufacturing companies continued to be the dominant pattern in the industry. Frequently, a company's owner is also an engineer who designs many of the products himself.

The subcontracting approach is widespread in the machine tool industry and came about as a way to mitigate the impact of Italian labor unions,

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1/ Ibid., p. 10.
2/ Ibid., p. 11.
3/ U.S. Department of State Telegram, U.S. Embassy, Rome, Italy, Mar. 3, 1983.
4/ Ibid.
5/ CECIMO and U.S. Department of Commerce.
6/ U.S. Department of Commerce, Industry and Trade Administration, Country Market Survey: Machine Tools-Italy, Washington, D.C. CMS 70-413, Nov. 1979, p. 7.
7/ Telephone interview with David Wolstenhome, machine tool consultant, Italian Institute of Foreign Trade, June 2, 1983.
8/ Ibid.

specifically, union resistance to automation technologies and labor laws which restrict overtime and layoffs. Italian companies in the industry are turning towards purchasing basic parts, which can be produced cheaper by outside suppliers, and then assembling the components. As a spokesman for UCIMU described this trend, "you have suppliers who are buying finished machine tools to make parts for other machine tools, for the people from whom they bought the original equipment." 1/

The Italian machine tool industry is quite decentralized, allowing for flexibility in responding to changes in the marketplace. For example, in April 1980, Graziano & Co SpA, a major machine tool builder specializing in lathes, entered into a 50/50 joint venture with Jobs SpA, Piacenza, forming a new firm called Quota to combine machining centers with robot manipulators. 2/ However, in autumn of 1982, when Graziano & Co SpA, began having financial troubles, Jobs SpA pulled out of its joint venture and sold the product line to Olivetti. 3/

Italian firms have also formed joint ventures with foreign firms. In 1972, SAIMP began producing machining centers with Forest, a French builder, and the relationship was continuing as of the end of 1980. 4/ In mid-1982, Allen-Bradley (U.S.) and Olivetti Sistemi per l'Automazione Industriale (OSAI) agreed on a joint venture to merge Allen-Bradley's European operation with OSAI, forming a new firm to market numerical controls. OSAI received an infusion of capital, and Allen-Bradley acquired options on the manufacture of OSAI equipment in the United States and servicing of equipment by OSAI. 5/ In early 1983, Bendix Corp. established a joint venture with Comau SpA, a subsidiary of Fiat SpA, to build in the United States production systems, stand-alone machines such as turning, grinding, and chucking machines, and nonmachine tool products which were produced by Comau SpA. Comau gained access to market other systems and equipment not covered in the agreement, such as machining systems, boring machines, boring and turning mills, and chuckers--many of which are CNC machines--through the joint venture's new organization. 6/

UCIMU, the industry association which represents the Italian machine tool builders, has taken an active role in supporting the industry. UCIMU offers its members export-marketing services, as well as other services. CEU, an arm of UCIMU, sponsors machine tool exhibitions. In the autumn of 1980, UCIMU was attempting to encourage the standardization of certain components. 7/ In

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1/ Rupert Cornwall, "Producers Plead for Government Aid", Financial Times: Financial Times Survey--Italian Engineering, June 25, 1983, p. VI.

2/ "Tool Pushcart Rolls to New Machining Center", American Machinist, December 1980, p. 45.

3/ "More Untended Chip-Making Machines", American Machinist, November 1982, p. 57.

4/ "Tool Pushcart Rolls to New Machining Center", American Machinist, December 1980, p. 45.

5/ "Allen-Bradley's Olivetti Door to NC in Europe," American Machinist, June 1982, pp. 44-48.

6/ "Bendix in Pact with Fiat on Comau Venture," American Metal Market, Jan. 24, 1983, pp. 1, 14.

7/ "Italy Boosts Machine-Tool Exports," American Machinist, October 1980, p. 57.

1980, UCIMU established UCIMU of America, Inc., with an office in McLean, Va., to coordinate the imports of Italian machine tool builders into the United States by performing market analysis and locating dealer networks. The office currently acts solely as an information bureau for UCIMU.

FINCIMU (Finanziaria Costruttori Italiani Macchine Utensili SpA), established in 1973 as a subsidiary of UCIMU, specializes in arranging financing and intermediary services strictly for the machine tool industry. In early 1983, FINCIMU had 4 to 5 billion lire in capital (approximately $2.9 to $3.6 million at 1st quarter 1983 exchange-rates), 50 member firms, and a 25 person staff. 1/ FINCIMU does not provide preferential credit; rather, it pays the prime rate. 2/ The company provides "easier, faster access to credit when speed counts in competing for contracts," especially when a producer needs financing from the beginning to the end of an order which may take years to fill. 3/

By the end of 1982, employment in the Italian machine tool industry totaled 33,800, of which approximately 23,000 were production workers. 4/ In 1981, employment was 36,000 persons with an estimated 84 workers employed per firm. In 1980, employment was 37,200, an increase from 36,500 in 1977.

By the end of 1982, Italian machine tool production was valued at $1.25 billion. 5/ Production declined in 1981 to $1.51 billion from $1.73 billion in 1980. Production grew steadily to $1.35 billion in 1979 from $878.3 million in 1977. Italian exports, imports, and consumption followed the same pattern as production, reaching a peak in 1980. In 1982, exports were valued at $749 million, a decrease from $847.7 million in 1980. Exports grew to $689 million in 1979 from $436.5 million in 1977. Imports totaled $221.4 million in 1982, having peaked in 1980 at $379.7 million. Imports increased to $255.9 million in 1979 from $187.7 million in 1977. Consumption was valued at $726.9 million in 1982, representing a decrease from $1.26 billion in 1980. Consumption grew steadily through 1980 from $629.5 million in 1977.

In 1982, exports as a share of production were approximately 60 percent. In 1980, exports as a share of production were approximately 49 percent, decreasing from 56 percent in 1978, but were 50 percent in 1977. In contrast, the ratio of imports to consumption was fairly stable, ranging from about 28 to 30 percent during 1977-82. During the same period, the ratio of production of metal-cutting to metal-forming machines was also fairly stable. In 1982, the ratio was 2.1:1, however, in 1977 the ratio was 1.9:1, based on production value.

1/ "Italy's Captive Machine Financier," American Machinist, March 1983, p. 39.

2/ Ibid.

3/ Ibid.

4/ U.S. Department of State Telegram, U.S. Embassy, Rome, Italy, Mar. 3, 1983.

5/ Figures for production, exports, imports, and consumption from American Machinist, February issues, 1979-83.

Government involvement.--Italian government involvement in the country's machine tool industry dates back to at least 1965 with the enactment of the Sabatini Law. 1/ The law provides for a system of deferred payments of up to 5 years for the purchase of machine tools. In addition, the seller receives the benefit of being able to discount the bills in medium-term credit establishments. An interest rebate may be applied to the financing. Currently, the law is used to stimulate capital investment in the Italian economy. The law applies to purchases of any industrial equipment regardless of origin and is designed to benefit domestic purchasers. Under the law, financing is provided at a low rate, currently 9 percent annually, with an initial payment of 15 percent required on all equipment purchases. Also, the seller must guarantee the financing. If the purchaser does not repay the loan for any reason, the seller is responsible for assuming the loan. Currently, because of this guarantee, a number of Italian machine tool firms are paying outstanding balances on debtors' loans. 2/

In mid-June 1982, the Italian machine tool builders lobbied the Government to be included the Government's $1.17 billion program for technological innovation. 3/ Other industry efforts focused upon developing Government aid for stimulating machine tool purchases. 4/

The Italian Government maintains research ties with the machine tool builders in Italy. The Italian National Council of Research has established a manufacturing research program at several Italian universities in which industry also participates. 5/ Also, the IMI, a financial agency, sponsors research projects on manufacturing through low-interest loans and grants from the Government. The IMI especially tries to promote the occurrence of the research projects in small- and medium-sized companies. 6/

1/ Legge 28 Novembre 1965, n. 1329. Provvedimenti per l'acquisto di nuove macchine utensili. Gazzetta Ufficiale Della Republica Italiana, No. 311, Dec. 14, 1965, pp. 6255-6258.

2/ Staff telephone interview with David Wolstenhome, machine tool consultant, Italian Institute of Foreign Trade, Aug. 31, 1983.

3/ Rupert Cornwall, "Producers Plead for Government Aid", Financial Times: Financial Times Survey--Italian Engineering, June 25, 1983, p. VI.

4/ Ibid.

5/ The Competitive Status of the U.S. Machine Tool Industry: A Study of the Influences of Technology in Determining International Industrial Competitive Advantage, National Academy Press, Washington, D.C., 1983, p. 35.

6/ Ibid.

United Kingdom

Industry.--In both 1980 and 1981, there were approximately 200 firms producing machine tools in the United Kingdom according to CECIMO estimates. 1/ Based on 1980 data from the United Kingdom's Industial Census, machine tool firms with a workforce of over 1,000 accounted for 1.7 percent of all firms, 25.8 percent of all employees, and 25.5 percent of production. 2/ In contrast, in 1976, there were 165 firms in the United Kingdom manufacturing machine tools, of which 45 firms were U.S. subsidiaries, and 31 firms were subsidiaries of other foreign operations. Total employment in the industry was 53,891, with 11 firms each employing 1 to 99 persons, 104 firms each employing 100 to 999 persons, and 50 firms each employing over 1,000 persons. 3/

In 1982, machine tool production in the United Kingdom totaled $735.5 million, declining from approximately $1.4 billion in 1980. 4/ Production totaled $587.9 million in 1977. Exports were valued at $490.3 million in 1982, declining from $674.6 million in 1980. Exports were valued at $300.4 million in 1977. Imports totaled $385.2 million in 1982. During 1977-82, imports peaked at $623.4 million in 1980, increasing from $238.3 million in 1977. Consumption in 1982 was valued at $630.4 million. In 1980, consumption totaled $1.34 billion, increasing from $525.8 million in 1977.

Machine tool exports as a share of production stood at 67 percent in 1982, increasing from 48 percent in 1980 and 47 percent in 1979. In 1977, exports as a share of production were 51 percent. Imports as a share of consumption increased to 61 percent in 1982 from 45 percent in 1977. During 1981-82, the share registered its largest gain of 9 percentage points, increasing from 52 percent in 1981. The ratio of metal-cutting to metal-forming machine tool production (based on value) increased gradually to about 6:1 in 1982 from 3.7:1 in 1977.

In 1982, employment in the United Kingdom machine tool industry declined to 39,300 persons from 43,400 in 1981. In 1981, the United Kingdom's machine tool industry employed an estimated 217 per firm. The greatest reductions in the workforce occurred in 1979 and 1980, from 51,000 in 1979 to 45,000 in 1980. 5/ In 1977, the industry employed 52,000 persons.

By 1979, the machine tool industry was not able to meet the needs of sophisticated end users, because the industry had neither maintained capital investment for modernizing the production process nor introduced new products

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1/ CECIMO.

2/Commission of the European Communities, The European Machine Tool Industry, Commission Statement, Situation and Prospect, Sec. (83) 151 Final, Brussels, Belgium Feb. 8, 1983, Annex 3 and Annex 8.

3/ U.S. Department of Commerce Industry and Trade Administration, Country Market Survey: Machine Tools United Kingdom,CMS 79-411, September 1979, p. 4.

4/ Figures for production, exports, imports, and consumption are from American Machinist, February issues, 1979-83.

5/ Statistics are from CECIMO.

embodying higher technologies. 1/ This was reflected in the unit prices of machine tools, which averaged $10,173 for imports and $7,294 for exports during January-September 1978. 2/

Government involvement.--In 1975, the Government of the United Kingdom provided $54 million to the machine tool industry for the purpose of improving production and introducing products embodying higher technologies. Some $360 million in new capital investment was generated in the process. 3/ In April 1983, as part of the proposed Department of Industry's support for the information technology program, the Department committed $1.83 million to flexible manufacturing systems (FMS) out of approximately $91.9 million available. 4/

The United Kingdom Government provides a number of services and support programs to the whole of the country's industry. These include technical advice, information and services, support for innovation, assistance for investment or restructuring, export services, and regional assistance from both the British Government and the European Community. The Department of Industry's program of support for information technology includes several areas pertinent to the development of machine tool technology. These include microelectronics industry support program (MISP), microelectronics application program (MAP), computer-aided-design/computer-aided-manufacture (CAD/CAM), computer-aided-design/manufacture and testing (CAD/MAT), hardware for (CAD/CAM/MAT), flexible manufacturing systems (FMS), robotics, and software. Approximately $310 million was allocated by the Department of Industry to the above areas during May 1982-May 1983. 5/ Information technology research and development is also funded by the Department of Education and Science (approximately $150 million during May 1982-May 1983) and the Ministry of Defense, for which estimates are not available. 6/ Another Government program likely to benefit the United Kingdom machine tool industry is the Small Engineering Firms Investment Scheme 2 (SEFIS 2), one of several programs to aid small firms.

In the area of technical advice information and services, there is the manufacturing advisory service, the goals of which are to promote efficiency in small- and medium-sized firms and to encourage firms to seek outside technical assistance. These services are designed for firms employing 60 to 1,000 persons and include, at no cost: 15 man-days of consulting services regarding organizational and manufacturing techniques; a further 15 man-day period of assistance, with the company paying half the cost; and limited training assistance. 7/

1/ Department of Commerce, Industry and Trade Administration, Country Market Survey: Machine Tools-United Kingdom, CMS 79-411, September 1979, p. 4.

2/ Hazel Duffy, "Machine Tool Exports Up By Nearly 30 percent," Financial Times, Jan. 6, 1981, p. 8.

3/ U.S. Department of Commerce, Industry and Trade Administration, Country Market Survey: Machine Tools-United Kingdom, CMS 79-411, September 1979, p. 4.

4/ Alan Cane, "Britain Enters the Great Race," Financial Times, May 9, 1983, p. 14.

5/ Alan Cane, "Britain Enters the Great Race," Financial Times, May 9, 1983, p. 14.

6/ Ibid.

7/ "Guide to Industrial Support," British Business, Mar. 25, 1983, p. 10.

In support of the innovation area, several United Kingdom programs potentially may enhance United Kingdom machine tool competition. These include CAD/CAM, CADMAT, computer-aided design and testing equipment (CADTES), flexible manufacturing systems, microelectronics application projects, microelectronics industry support programs, software products schemes, and industrial robots.

The Department of Industry (DOI) has five research and development requirements boards in the department to provide advice concerning DOI's support for research and development. These are textiles and other manufactures; electronics and avionics; materials, chemicals, and vehicles; advanced manufacturing technology (formerly mechanical and electrical engineering); and metrology and standards. 1/ The DOI awards grants toward the costs of eligible projects. Currently, the maximum level of a grant is 25 percent of the qualifying costs; however, for company applications received by May 31, 1984, and claims for incurred expenditures received by May 31, 1987, the maximum level of the grant is 33-1/3 percent, with the company paying the remainder of the costs. The DOI can also negotiate a shared-cost contract in which the Department contributes up to "50 percent of qualifying costs recoverable by a levy on commercial sales." 2/ The DOI will also subsidize a "pre-production order," where a user, on a trial basis, can take delivery of those products embodying new technology, prior to actual purchase. Expenditure limits for such individual projects usually range from approximately $37,500 to $7.5 million.

The SEFIS program is currently in its second phase (SEFIS 2), and in March 1983, was allocated 100 million pounds (US $153.2 million). 3/ The program's objective is to assist small firms in the purchase of certain types of technologically advanced capital equipment. 4/ The first phase of the program began in March 1982, and its 30-million-pound allocation was committed in just 8.5 weeks. The second phase of the program provides Government grants of up to 33.3 percent for investments, regardless of the country of origin. Also included in the second phase are machine shops employing up to 500 persons. 5/ Companies participating in SEFIS 2 also receive from the Scottish Government a land development grant of 25 to 26 percent of the purchase price. 6/

Under the United Kingdom's program of support for innovation, the application of flexible manufacturing systems is promoted. DOI will provide up to 50 percent support, with a maximum grant of about $75,000, toward the cost of consultant feasibility studies. For FMS installation, up to 33-1/3 percent of the grant may be applied toward development costs and capital expenditures. A qualifying FMS project requires a minimum expenditure of

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1/ Ibid., p. 13.

2/ Ibid.

3/ Industrial Support Guide in British Business Mar. 25, 1983 p. 28. See also "UK Pushes Aid Plan For Small Companies," American Metal Market, May 16, 1983, p. 15.

4/ Ibid.

5/ Sam L. Jones, "Automatic EDM Ready for US Push: Swiss Execs," American Metal Market, June 20, 1983, p. 12.

6/ Ibid.

$300,000, with no expenditure ceiling or time limit. Projects involving the industrial application and manufacture of robotic devices generally receive the same types of assistance as that given to FMS projects; however, the maximum grant for feasibility studies is about $4,500, and the normal minimum amount for project expenditures is about $37,500. 1/ Under the FMS program, second-hand equipment is not eligible for assistance. 2/

Among the DOI's research facilities, the National Engineering Laboratory (NEL) conducts research for mechanical engineering, development design, testing, and consulting activities. Its activities include the areas of robotics, FMS, and CAD/CAM.

The European regional development fund provides aid for consultancy and services relating to technological innovation and information and access to risk capital. Regional development grants are also made available for the rental and sale of factories, warehouses, offices, and land. United Kingdom firms may obtain loans through the European Investment Bank (EIB) for investment in manufacturing, industry-related services, and tourism projects. Up to 50 percent of the fixed capital investment costs in projects can be provided for by fixed-interest loans from the EIB. Qualifying projects are limited to companies employing less than 500 persons, and projects must cost over $22,500, with a time limit of 8 years.

Like many other major industrialized countries, the British Government does provide export services. The Exports Credits Guarantee Department, directly under the Secretary of State for Trade, provides insurance to exporters against possible nonpayment by foreign countries, and it also provides guarantees to banks so exporters can obtain financing, often at favorable rates. Other services by the Exports Credits Guarantee Department are lines of credit, consortium insurance for United Kingdom consortium members in major overseas projects, bond guarantees for export contracts on cash or near cash terms, cost-escalation protection against United Kingdom cost increases, external-trade guarantees for the risk of nonpayment of goods in overseas transit, and interest on new United Kingdom private, overseas investment. 3/

By May 1983, the DOI had committed $52.5 million for the development and procurement of flexible manufacturing systems by industry in its FMS program under support for innovation. 4/ Since June 1982, when the program was established, some degree of consideration has been provided to 50 projects. 5/ Approximately $12 million of FMS program funds have been allocated for supporting robotics. 6/ Under the Science and Technology Act, $37.5 million in aid has been allocated for projects entailing high risk in the FMS field. 7/

1/ "Guide to Industrial Support," British Business, Mar. 25, 1983, p. 13.

2/ "Flexible Manufacturing: One Way to Keep Ahead of the Competition," British Business, June 3, 1983, p. 390.

3/ "Guide to Industrial Support," British Business, Mar. 25, 1983, p. 24.

4/ David Krammer, "New Technology Urged for Britain," American Metal Market, May 2, 1983, p. 19. See also David Krammer, "British Group Builds FMS," American Metal Market, Dec. 13, 1982, p. 8.

5/ David Krammer, "New Technology Urged for Britain," American Metal Market, May 2, 1983, p. 19.

6/ Ibid.

7/ Ibid.

Prior to the establishment of the DOI's FMS program, the United Kingdom Government provided assistance to several FMS projects. The largest and most complex FMS in the United Kingdom is the "Scamp" system, manufactured by the 600 Group Plc, a major machine tool manufacturer. The "Scamp" system is located in the company's facility in Colchester, England. The British Government provided at least 50 percent of the $4.5 million cost of the "Scamp" system. Anderson Strathclyde Plc, Matherwell, Scotland, a mining machinery manufacturer, will be installing an FMS system tied into five CNC horizontal borers. Government grants and EC programs will constitute $6.7 million of the estimated $11.2 million cost of the system. 1/ Other FMS installations include a $1.5 million system manufactured by Kearney & Trecker Marwin Ltd., located at Normalair-Garrett Ltd., Yeovill, Somerset.

In the area of robotics, Unimation (Europe) Ltd., Telford, the British subsidiary of Unimation, Inc., recently received $5.4 million in United Kingdom Government grants for plant expansion totaling $15 million. 2/

France

Industry.--By the end of 1981, there were 163 firms in France engaged in producing machine tools. In 1977 and 1978, according to estimates from CECIMO, there were approximately 173 firms producing machine tools. In 1979, the number of firms dropped to 167 and in 1980 to 165 firms. 3/ In contrast, in 1976, the number of firms manufacturing machine tools totaled 130, of which 9 were subsidiaries of U.S. firms, accounting for 18 percent of sales, and 20 were subsidiaries of firms in other foreign countries, generating 24 percent of total sales. Employment in the French industry was 17,089 persons, with 59 firms employing 1 to 100 persons, 42 firms employing 101 to 499 persons, and 29 firms each employing 500 or more persons. 4/ However, despite Government efforts during 1976 to the present to consolidate and revive the industry, there have been a number of business failures (see Government involvement).

Employment in the French machine tool industry has declined steadily from 1978 to the present. The industry employed 17,661 persons in 1982, a decline from 18,984 persons in 1981. 5/ In 1981, the French machine tool industry employed an estimated 115 workers per firm. Employment decreased to 19,650 in 1980 from 20,158 in 1979, and 20,745 in 1978.

In 1982, French machine tool production was valued at $619.8 million, a decrease from $953.9 million in 1980. 6/ Production increased to $877.2 million in 1979 from $590.6 million in 1977. Exports totaled $315.7 million in 1982, decreasing from $515.9 million in 1980. In 1977, exports were valued

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1/ Ibid.

2/ David Krammer, "New Technology Urged for Britain," American Metal Market, May 2, 1983, p. 21.

3/ CECIMO.

4/ U.S. Department of Commerce, Industry and Trade Administration, Country Market Survey: Machine Tools-France, CMS 79-405, Aug. 1979, p. 7.

5/ Statistics from CECIMO.

6/ Figures for production, exports, imports, and consumption are from American Machinist February issues, 1979-83.

at $269.3 million. Imports declined to $484.2 million in 1982 from $566.6 million in 1981. Imports were valued at $286.2 million in 1977. French machine tool consumption was valued at $788.3 million in 1982, a decline from peak consumption of $992 million in 1980. Consumption increased to $790.2 million in 1979 from $630.2 million in 1978 and $607.5 million in 1977.

Exports of machine tools as a share of production stood at about 51 percent in 1982, up from 48 percent in 1981. The percentage grew approximately to 54 percent in 1980 from 45 percent in 1977. The ratio of imports to consumption generally increased to about 61 percent by the end of 1982, from 47 percent in 1977. Similarly, the ratio of metal-cutting to metal-forming machine tool production increased during 1977-82. In 1982, the ratio was 3.8:1, an increase from 2.4:1 in 1977.

In 1982, France had a negative balance of trade in machine tools, which was also the case in 1981, 1980, and 1977. In 1978 and 1979, the country maintained a positive balance of trade in machine tools.

Government involvement.--The French Government has continually attempted to revive the machine tool industry by restructuring and consolidating firms. In 1976, the Government proposed consolidating some of the largest manufacturers, as well as reducing imports and promoting the rapid production and use of NC equipment. 1/

In November 1981, the French Government adopted a 3-year development program for the machine tool industry. The program was designed to generate $410 million in direct Government aid and $290 million in Government-backed loans. 2/ It was developed around three main concepts: (1) the machine tool industry had to be "pushed into concentrating on the high-technology sectors of the market;" (2) the firms in the industry were to be "regrouped and refinanced in order to develop larger companies with more competitive resources in management, research, and distribution;" and, (3) the French Government intended to reduce imports of numerically controlled machines from 60 to 30 percent by 1984. 3/ Also, in November 1981, the French Government was reported to have required importers of machine tools to obtain licensing visas in advance of delivery, effectively creating a nontariff trade barrier. 4/

In 1980, the French Government stated that French manufacturing companies used only 10,000 numerically controlled machines, compared with 50,000 in Japan and 30,000 in West Germany. 5/ In late 1981, one of the mechanisms the French Government implemented in order to expand and modernize the nation's machine tool stock was the MECA system (Machines et Equipments de Conception Avancee). The MECA system provides for an increase of public orders for the nationalized industries, education, and research. It also granted operating subsidies for purchasing new equipment. The French Government also supported

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1/U.S. Department of Commerce, Industry and Trade Administration, Country Market Survey: Machine Tools-France, CM79-405, Aug. 1979, p. 6.

2/ Business Week, Dec. 28, 1981, pp. 69 and 70.

3/ Terry Dodsworth, "Test Case for Industrial Policy: How France is Trying to Revive its Machine Tool Industry," Financial Times, Dec. 10, 1981, p. 19.

4/ "Trying Protection to Curb Job Losses," Business Week, Dec. 28, 1981, p. 69.

5/ Ibid.

a "public ordering scheme, valued at about 1.2 billion francs (US $220 million in 1981 dollars), to equip engineering training schools with more advanced tools." 1/

In December 1981, the French Government adopted a research plan for the machine tool industry. The plan focused on three key fields: machine tool design, manufacturing processes, and automation. Research is to be conducted at existing facilities, particularly at CERMO (Centre d' Etude et de Recherche de la Machine-Outil) and at CETIM (Centre Technique des Industries Mecaniques). The research plan relies on public financing and selection of research topics, and followup research, with the evaluation of results performed by a special committee.

In 1981, the French Government allocated 2.3 billion francs (US $423.2 million in 1981 dollars) in direct State aid to be matched by 1.7 billion francs (US $312.8 million in 1981 dollars) from firms in the machine tool industry and private-sector sources for the restructuring of firms in the machine tool industry. 2/ The Government had envisioned 15 main groups in the industry, with firms tied to the restructuring program through about 15 contracts between the Government and the industry's larger firms. 3/ In July 1981, a State-run holding company was created, Machines Francaises Lourdes, and divided into two subsidiaries--one for milling and boring machines and the other for lathes--to regroup the major heavy-machine tool builders. 4/ The holding company was to be capitalized with 200 million to 300 million francs (US $31.7 million to US $47.6 million in 1982 dollars) with the holding company's ownership divided among a State investment corporation, Institut de Development Industriel "IDI" (35 percent), other State-owned companies in the automotive, aeronautics, and mechanical engineering industries (51 percent), and private interests (14 percent). 5/ During 1982-85, the holding company would invest 500 million francs (US $76 million in 1982 dollars). 6/ The lathes subsidiary, called BS, comprised the operations of Saint-Etienne Machine Outil and a plant of Berthiez, a subsidiary of the State-owned SNECMA. 7/ The boring and milling subsidiary, Line-Forest, comprised the

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1/ Ibid.

2/ Terry Dodsworth, "Test Case for Industrial Policy," Financial Times, Dec. 10, 1981, p. 19. See also Commission of the European Communities, The European Machine Tool Industry, Commission Statement, Situation and Prospects,SEC (83) 151, Brussels, Belgium Feb. 8, 1983 p. 45.

3/ "Frogmarched by Dreyfus," The Economist, Dec. 26, 1981, p. 90.

4/ "France's Machine Builders Are Regrouped", American Machinist, August 1982, p. 49.

5/ J. Russell Kraus, "French Gov't Would Regroup Machine Tool Manufacturers," American Metal Market, Apr. 19, 1982, p. 5. See also Martyn Chase, "French Set US Tool Sales Drive," American Metal Market, Jan. 17, 1983, p. 25. State-owned companies with an interest in Machines Francaises Lourdes include a State investment corporation, Institut de Development Industriel (IDI); automobile manufacturers Renault and Peugeot; SNECMA, a jet engine builder; SNIAS, an airframe manufacturer; Alsthon, a large manufacturer of electrical equipment and turbines, and Usinor SA and Sacilor SA, large steel producers.

6/ J. Russell Kraus, "French Gov't Would Regroup Machine Tool Manufacturers," American Metal Market, Apr. 19, 1982, p. 5.

7/ "France's Machine Builders are Regrouped", American Machinist, August 1982, p. 49.

activities of Line SA plant in northern France at Albert and the central southern plant at Capdenac of Travail Mecanique Industries (TMI). 1/ However, the regrouping left out four other Line SA's plants. In the Line SA group, Gambin, a manufacturer of milling machines, and Gendron, a manufacturer of grinding machines, were temporarily detached from the Line Group to be integrated with another major group at a later date. Albert Machine-Outil, also a member of the Line group, was to be converted into a used-machine-tool rebuilding firm. 2/ In 1981, Line SA, TMI, Saint-Etienne, and Berthiez did less than $100 million in business and employed approximately 2,000 persons. 3/ As of the summer of 1981, the estimated investment for the successful regrouping of the BS and Line-Forest subsidiaries totaled $115 million. 4/

In the summer of 1981, another State-run holding company was established by the nationalized Banque de L'Indochine et de Suez in order to merge the activities of Graffenstaden, a subsidiary of the nationalized Compagnie Generale d'Electricita group specializing in machining centers, Hure SA, specializing in boring machines, and H. Ernault Somua (privately owned), which manufactures "catalog" NC lathes, boring and milling machines, and machining centers. In 1980, H. Ernault Somua (HES) split with the private Empain-Schneider Group. At the time of its regrouping with Graffenstaden and Hure, HES was in a joint venture where it held 35 percent of the joint company with Toyoda (Japan) for the production of machining centers. 5/ Line SA, TMI, Saint-Etienne, Berthiez, Hure SA, and Graffenstaden were all either heavily indebted to the French Government or were subsidiaries of nationalized corporations. 6/

Companies participating in the French Government's restructuring and aid program were required to sign contracts with the Government stating the firm's area of specialization and agree to increase training, expand domestic and foreign sales efforts, and commit about 5 percent of sales to research. 7/

In early 1983, MFL Machine Tool, Inc. in Essex, Conn., received $3 million from the French Government. MFL Machine Tool, Inc., is owned by the State-run holding company Machines Francaises Lourdes of Paris and is a sales and service company in the United States for the French machine tool firms of Forest, Line, Saint-Etienne and Berthiez. The company allows French firms to sell direct to customers, rather than through importers. 8/

1/ Ibid.

2/ J. Russell Kraus, "French Gov't Would Regroup Machine Tool Manufacturers," American Metal Market, Apr. 19, 1982, p. 5.

3/ "France's Machine Builders are Regrouped," American Machinist, August 1982, p. 49.

4/ Ibid.

5/ "France's Machine Builders Are Regrouped," American Machinist, August 1982, p. 49.

6/ J. Russell Kraus, "French Gov't Would Regroup Machine Tool Manufacturers," American Metal Market, Apr. 19, 1982, p. 5.

7/ Terry Dodsworth, "Test Case for Industrial Policy," Financial Times, Dec. 10, 1981, p. 19.

8/ Martyn Chase, "French Set US Tool Sales Drive," American Metal Market, Jan. 17, 1983, pp. 1 and 25.

In the spring of 1983, the French Government extended its restructuring plan for the machine tool industry by 1 year, through 1986. The reason cited was the recent lack of demand. Also, as of the spring of 1983, approximately 30 of the 160 French machine tool builders had signed Government-industry investment contracts worth 400 million francs (US $55 million). The French Government has yet to allocate around 3.3 billion francs (US $455 million) to investments as well as 200 million francs (US $29 million) worth of research and development aid. 1/

Despite the French Government's restructuring efforts, several French machine tool firms have recently failed. In April 1982, Promat, which in 1980 acquired Dufour, a manufacturer of heavy milling machines, filed for bankruptcy. 2/ In April 1983, Realisations d'Appareils et Machine Outils (Ramo), a major French manufacturer of NC lathes, filed for bankruptcy. The firm's failure was caused by "the sharp deterioration in market conditions and because of large imports of competing Japanese machines." 3/ Under the French Government's restructuring plan, Ramo was to merge in July 1984 with another firm, Cazeneuve, with about 88 million francs (US $12.7 million) in aid allocated by the Government for the two companies. 4/

Other countries

The following industry profiles focus on those countries whose industries have either increased their shares in the U.S. machine tool market (Taiwan, Switzerland, Spain, and Korea) or are themselves sizable markets and world-ranked producers (U.S.S.R., East Germany, and Romania). The People's Republic of China is also discussed, since it has the potential to become a world leader in consumption and production as China's Government increases its drive toward production and use of machine tools.

U.S.S.R

Industry.--In 1982, Soviet machine tool production was valued at $2.93 billion, of which metal-cutting machine tools accounted for about $2.27 billion and metal-forming machine tools, $665.3 million. 5/ Production amounted to 205,000 metal-cutting machines and 57,100 metal-forming machines. In 1981, NC machine tool production totaled 10,055 units and increased slightly to 10,560 units in 1982. However, the quality of the NC machines was reported as unreliable to the degree that production of precision parts, such as for robot arms, was not currently possible. 6/ In contrast, in 1977,

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1/ J. Russell Kraus, "French Tool Restructuring Extended," American Metal Market, Apr. 18, 1983, p. 18.

2/ J. Russell Kraus, "French Gov't Would Regroup Machine Tool Manufacturers," American Metal Market, Apr. 19, 1982, p. 5.

3/ "French Lathe Maker Files for Bankruptcy," American Metal Market, May 2, 1983, p. 6.

4/ Ibid.

5/ Figures for production, exports, imports, and consumption are from American Machinist, February issues, 1979-83.

6/ Anderson Ashburn, "Collapsing Dollar Distorts Study," American Machinist, February 1979, p. 83.

Soviet production of machine tools totaled $2.2 billion, of which metal-cutting machine tools accounted for $1.7 billion and metal-forming machine tools accounted for $494.2 million. 1/ Actual quantities produced in 1977 totaled 237,560 metal-cutting machines, of which 6,300 embodied digital-program (including NC and peg-board), and 54,000 consisted of metal-forming machines. 2/ In 1977, the U.S.S.R. ranked second in world consumption of machine tools, accounting for $2.82 billion; this compares with $3.6 billion in 1982. Additional Soviet data are presented in table 25.

Table 25.--Metalworking machine tools: U.S.S.R. production, by major types, 1977-82

(In thousands of units)

Type	1977	1978	1979	1980	1981	1982
Metal-cutting machine tools 1/	237.56	237.88	230.00	216.00	205.00	195.00
Metal-forming machine tools 2/	54.30	55.40	56.30	57.20	57.10	57.30
Total	291.86	293.28	286.30	273.20	262.10	252.30

1/ Power-driven metal-cutting machines that are not portable by hand and are used to remove metal in the form of chips; these machines include lathes and planers and milling, honing, lapping, grinding, electroerosion, and ultrasonic cutting machines.

2/ Power-driven metal-forming machine tools that are not supported in the hands of an operator when in use and are designed to press, forge, emboss, hammer, extrude, blank, spin, shear, and bend metal into shape.

Source: Central Intelligence Agency, Handbook of Economic Statistics 1983, September 1983.

Government involvement.--During 1977-81, the machine tool industry in the U.S.S.R., which is under the control of the Ministry of Machine Tool and Investment Building, was frequently criticized by the State-controlled press for not meeting production targets. Reasons cited for the poor performance were poor management, excessive red tape, and wastage of metal. Another problem was the increasing labor shortage throughout the Soviet economy. 3/

The main Soviet research facility for the machine tool industry is the Experimental Research and Development Institute for Machine Tools (ENIMS), founded in 1931. The institute staff includes 200 doctors and doctoral candidates of the technical sciences, as well as hundreds of research workers,

1/ Ibid., p. 82. and Handbook of Economic Statistics 1983, Central Intelligence Agency, September 1983.

2/ Ibid., p. 81.

3/ See also James Grant, "Soviet Machine Tools: Lagging Technology and Rising Imports," Soviet Economy in a Time of Change, Joint Economic Committee, U.S. Congress, Vol. II, Oct. 10, 1979, pp. 554-580.

engineers, and technicians. 1/ ENIMS has several functions: the formulation of technical policy for the industry, development of new areas of machine tool engineering, forecasts of machine tool development, and coordination of efforts of the many organizations engaged in the design and engineering of the equipment. 2/ Some of the principal areas of investigation of ENIMS are hydraulic and pneumatic equipment, lubrication and electrical switch gear, and NC and electrical drive systems. 3/ One area of concern appears to be the degree of accuracy in Soviet machining. In this regard, ENIMS has made significant contributions to the development of laser interferometers for machine-tool-building applications. 4/ ENIMS has cooperation agreements with research and development organizations in Hungary, East Germany, Poland, Czechoslovakia, and Bulgaria. Other ENIMS ties include working relationships with British, Italian, French, and Japanese machine tool manufacturers. 5/ An example of some of the research and development relationships are those which existed between the U.S.S.R. and France in 1981. The French Machine Tool Builders' Coordination Committee was accredited at the U.S.S.R. State Committee for Science and Technology. Cooperation between major research and development centers in both countries included Centre d'Etude et de Recherche de la Machine-Outil (CERMO) and ENIMS, Centre Technique des Industries Mecaniques (CETIM), and the Soviet Forging and Pressworking Equipment Institute (ENIKMASH), and the French National Agency for the Development of Automated Production (ADEPA) and ENIMS. 6/ In 1981, there were also a number of joint ventures between French and Soviet manufacturers, e.g., Promecan-Sisson-Lehman (France) and Soyuzkuzmash (U.S.S.R.) for the development of guillotine shears with production in Azov, U.S.S.R., using some French components; and Line SA (France) and the Minsk Machine Tool Production Amalgamation (U.S.S.R.) in the joint production of milling and boring machines. 7/ During 1981-84, joint ventures are to include the following: TMI (France) and Ulyanovsk Machine Tool Works (U.S.S.R.), for the production of heavy milling machines; St. Etienne Machines-Outils (France) and the Kramatorsk Works (U.S.S.R.), for the production of heavy lathes; and Constructions de Clichy (France) and the 50 Years of the U.S.S.R. Works (U.S.S.R.), for the development of high-capacity internal grinding machines. 8/ Also in 1981, Berthiez and the Kolomna Heavy Machine Tool Works were negotiating for joint production of large machine tools. 9/ The channel for marketing Soviet machine tools in France is Stanko-France. V/O Stankoimport, the Soviet Union's machine-tool-trading company, is a shareholder in Stanko-France.

The Soviets have exhibited their machine tools at the East German Leipzig Spring Fair and also at other Eastern European machine tool trade fairs. The

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1/ "ENIMS: Research and Development of Metal-Cutting Machine Tools for Fifty Years of Its Existence," Soviet Export, Jan. 30, 1981, p. 13.
2/ Ibid.
3/ Ibid, p. 15.
4/ Ibid., p. 14.
5/ Ibid., p. 15.
6/ "10 years of Stanko-France," Soviet Export Jan. 30, 1981, p. 33.
7/ Ibid.
8/ Ibid.
9/ Ibid.

Soviets have scheduled their first international machine tool show for the spring of 1984; the show, to be held in Moscow, is sponsored by the Soviet Ministry of Machine Tool Building and Stankoimport. 1/

East Germany

Industry.--Currently, the East German metalworking machine tool industry is made up of four combines, or "kombinats," which are vertically integrated groups of companies. These are the Fritz Heckert Combine, 7 Oktober Combine, Herbert Warnke, and Schmalkalden. The four machine tool combines are under the direction of the Ministry of Machine Tool and Processing Machine-Building. The industry's current structure is the result of a reorganization in 1969 and 1970 of enterprises which were then under the Machine-Building VVB (Association of State Enterprises). During 1979-81, the organizational structure of the machine tool combines was used as the example for establishing the combine system throughout East Germany's entire industry. The Ministry of Machine Tool and Processing Machine-Building has two other combines under its direction: the Textima Combine, founded in 1979, producing machines for the textile industry, household sewing machines, and bicycles; and Polygraph, producing printing and bookbinding machines. In 1979, the Kombinat Umformtechnik "Herbert Warnke" (Erfurt) was expanded by the addition of plastics- and elastics-machine-building enterprises, as well as by the Erfurt High-Intensity Current System Construction VEB (Volks Eigene Betrieb, or people's own plant). 2/ The following table depicts the structure of the four combines making up the East German machine tool industry.

The combines were formed in 1969 and 1970 according to types of products manufactured, and therefore are the sole producers of certain types of machines. The Umformtechnik Combine does the pressing for shaping metal, the Fritz Heckert Combine performs cutting processing of prismatic work pieces, and the 7 Oktober Machine Tool Combine does cutting and rotation-symmetry processing. 3/ However, new technologies such as improved shaping methods, microelectronics, and robotics affect the combines in different ways. The combines have developed within their own organizations supplier capacities, research facilities, and marketing functions. For example, both the Fritz Heckert Combine and the 7 Oktober Combine have their own foundries. Also, the combines have built-up capacities for the development of modern nonnumerical controls. 4/ Most of the combines in the industry have their own research facilities. For instance, the Fritz Heckert Combine has under its direction the Machine-Tool-Building Research Institute in Karl-Marx-Stadt (1,600 employees), and the Shaping Process Research Institute in Zwickau (300 employees) has been integrated into the Umformtechnik Combine. The 7 Oktober Combine maintains research laboratories in Dresden. Financial support for the research centers comes almost entirely from combine funds. Individual plants

1/ "Soviets Slate 1st Int'l Tool Show," American Metal Market, June 13, 1983, p. 6.

2/ Cord Schwartau, German Institute for Economic Research (DIW), West Berlin, "Machine Tool Construction in the GDR," "Machine Tool Construction in the GDR," translated as "Machine Tool Industry Structure, Production Outlined," East Europe Report, Economic and Industrial Affairs, No. 2309, Foreign Broadcast Information Service, JPRS 81633, Aug. 26, 1982, p. 25.

3/ Ibid., p. 26.

4/ Ibid.

Table 26.-- Metalworking machine tools: Combines in the East German industry, 1981.

Combine	Date established	State enterprises in combine	Employees	Output	Export share	Products
				Billion marks	Percent	
Werkzeugmaschinenbaukombinat "Fritz Heckert" Karl-Marx Stadt.	Jan. 1, 1970	19	27,000	1.75	80	Milling, drilling, and processing prismatic workpieces.
Werkzeugmaschinenbaukombinat "7 Oktober", Berlin.	Jan. 1, 1969	12	20,000	1.60	1/ 75	Lathes and gear-cutting machines, grinding machines for processing rotation-symmetry workpieces.
Kombinat Umformtechnik "Herbert Warnke", Erfurt.	Jan. 1, 1970	16	20,000	1.50	90	Shears and presses for metalworking, machines for plastics processes.
Werkzeugmaschinenbaukombinat Schmalkaden.	Jan. 1, 1969	18	14,000	1.15	2/	Tools of all kinds, machine-tool and workpiece holders, hand-controlled machine tools, hard metals.
Total	-	65	81,000	6.00	-	

1/ 1979.
2/ Not measurable; large share exported indirectly.

Source: Cord Schwartau, German Institute for Economic Research, West Berlin, "Machine Tool Construction in the GDR," translated as, "Machine Tool Industry Structure, Production Outlined," East Europe Report, Economic and Industrial Affairs, No. 2309, Foreign Broadcast Information Service, JPRS 81633, Aug. 26, 1982, p. 25.

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(VEB's) and the military purchase research time and facilities from the centers. 1/ In late 1979, several joint programs in machine tool research were underway. The Fritz Heckert milling machine plant, the combine's research center, and the Technical High School in Karl-Marx-Stadt conducted a joint research project on machine tool modular design and welding of machine tool structures. The VEB Schleifkorper (grinding heads) Union, the Technical High School in Dresden, and the Machine Research Institute in Leningrad (U.S.S.R.) were engaged in different grinding research programs with VEB Schleifmaschinenwerk (part of the 7 Oktober Combine). 2/ In the area of marketing, the foreign trade organization responsible for the entire indusry--Werkzeugmaschine and Werkzeug (WMW) Export-Import--has been under the direction of the 7 Oktober Combine since 1970. WMW Export-Import maintains technical/commercial offices in 20 countries, including the United States.

The sole manufacturer of NC systems is VEB Numerik in Karl-Marx-Stadt of the Automation Systems Building Combine. VEB Numerik also produces robot controls, modern nonnumerical controls for milling machines, and CNC's. VEB Numerik receives microcomputers from the Robotron Combine in Dresden.

The industry is primarily located in southern East Germany, in Karl-Marx-Stadt, Leipzig, Gera, Dresden, Suhl, Erfurt, and Halle. The 7 Oktober Combine is located in East Berlin.

In 1981, the four combines of the machine tool industry together employed 81,000 persons. The major factories of the Fritz Heckert Combine had the following employment in 1982: Fritz Heckert parent plant, 4,500; Mikromat, 2,500, including 85 design engineers; and Aschersleben, 2,100, including 100 design engineers. 3/ MODUL, a major factory of the 7 Oktober Combine, employed 2,000 workers. 4/ The Shaping Process Research Institute of the Umformtechnik Combine in 1981 employed 300 persons, and the Machine-Tool-Building Research Institute of the Fritz Heckert Combine employed 1,600 persons. In early 1982, wages of workers in the machine shops at VEB Aschersleben--a manufacturer of planers and planomillers, bed grinders, and forging presses--were 4.5 to 7 marks per hour. 5/ Apprentices at the enterprise were trained according to the traditional "Meister" system, which also exists in West Germany. 6/

In 1982, machine tool production in East Germany was valued at $808.0 million. In 1980, the value of production reached a high point of $891.5 million, increasing from $641.4 million in 1977. In 1977, East Germany was ranked sixth in world production by American Machinist, and at the end of 1982, East Germany was again ranked sixth. However, during 1978-80, East Germany was ranked ninth in world production, and eighth in 1981. In 1982, exports were valued at $642 million, or 79.5 percent of production, but had reached a high point of $695.3 million in 1980, accounting for only 78.0

1/ Michael Page, "Trends in GDR Machine-Tool Research," American Machinist, January 1980, p. 135.

2/ Ibid., p. 136.

3/ Shigeru Kobayashi, "The Advanced Machine Tool Industry of the German Democratic Republic," Metalworking Engineering & Marketing, May 1982, pp. 102, 104, 106 and 108,.

4/ Ibid., p. 106.

5/ Ibid., p. 109.

6/ Ibid.

percent of production. In 1977, however, exports totaled $596.6 million and accounted for 93 percent of production. In 1982, imports totaled $197 million and accounted for 54 percent of consumption. In 1980, imports were valued at $257.5 million, and represented around 56 percent of consumption. In 1977, imports totaled $173.9 million or 79.5 percent of consumption. During 1977-82, exports averaged 82.1 percent of production, and imports averaged 61.7 percent of consumption.

The first NC machine tools produced in East Germany were manufactured by the Fritz Heckert Works in 1964. In late 1976, East Germany decided to domestically produce CNC controls, and in 1979, the first East German CNC system, the CNC 600, was commercially available. The CNC 600 offered "multiple-axis, continuous-path programming, control of simultaneous movement through three axes, and ancillary functions for directing robots, tool changers, workpiece pallets," and similar functions. 1/ In 1981, although computer-integrated, storage-programmed NC machine tools predominated in West Germany, the widespread production of permanently wired, connection-programmed, numerical machine tools prevailed in East Germany. 2/ By early 1983, 35 to 40 percent of the new products from the Fritz Heckert Combine embodied CNC's or PC's, and all conventional, tape-type NC systems were replaced by CNC systems. 3/ Machine tools in production facilities and units which will be sold are currently being equipped with robotic tool-changing capabilities. 4/ By 1982, several major plants of the Fritz Heckert Combine (Fritz Heckert, Mikromat, Aschersleben) had installed NC machines equipped with material-handling robots which were also integrated with the production line. 5/ However, "industrial robot equipment according to the East German categorization criteria encompasses all automation aids which are used for independent handling of work pieces, tools, and materials." 6/ In the mid-1970's, East Germany, as well as the United States and Japan, were at a higher technological level than West Germany in the areas of processing centers and flexible finishing systems. However, East Germany was not able to exploit this technological lead because of a breakdown between research, application to production, and sales, which resulted only in the production of prototypes. In 1981, processing centers were just beginning to play a role in exports from East Germany. 7/ In early 1981, the East German metalworking industry was using about 280,000 cutting machine tools and 18,500 presses, including 2,000 NC machine tools. 8/

Government involvement.--Since East Germany has a centrally planned socialist economy, the Government is not only deeply involved in the planning of the metalworking machine tool industry, but also is responsible for many of the factors within the overall economy that also affect the machine tool industry. Within the past few years, the East German metalworking machine

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1/ Michael Page, op. cit., p. 135.
2/ Cord Schwartau, op. cit., p. 30.
3/ "Advanced CNC is Shown at Leipzig Fair," American Machinist, May 1983, pp. 31 and 32.
4/ Ibid, pp. 31-32.
5/ Shiogeru Kobayashi, "The Advanced Machine Tool Industry of German Democratic Republic," Metalworking Engineering & Marketing, May 1982, p. 98.
6/ Cord Schwartau, op. cit., p. 32.
7/ Ibid., p. 31.
8/ Ibid., p. 32.

tool industry has been confronted with a number of problems which threaten to affect the international competitiveness of the industry. In the area of price formation, market forces have been disregarded, and machine tool prices have risen. High prices charged by suppliers of controls have cut into the profitability of exports of finished products. In the product area, East German machine tools, on average, are too heavy--by as much as 50 percent in some cases. Other problems include the breakdown between research and production, the inadequate supply of microcomputers for CNC controls, and investment policy. 1/ In recent years, the economic goals of Government leadership have not coincided with those of managers and engineers in the industry. Government leadership views the economic planning process in terms of limited resources. Therefore, it is against policies which would require new investment to raise productivity while at the same time removing so-called obsolete capital stock from use. Such a policy is viewed as a waste of national assets. The economic leadership perceives that automation can be integrated into existing capital stock through applying structural components, subsystems, and controls. In contrast, the industry's managers and engineers recognize that existing equipment cannot be fitted with robots and transportation systems because of the design differences of existing machine tools with respect to current operating spaces. Leading engineers and scientists at the 1982 Leipzig International Metalworking Congress expressed the view that automation could not be successfully applied to existing equipment, stating, "We know from the lessons learned since the introduction of NC equipment about a decade and a half ago that a subsequent adaptation and equipment of existing machines cannot achieve working solutions." 2/

East Germany's current economic target for the metalworking machine tool industry calls for a growth rate of 41 to 43 percent during 1981-85; the target for industry as a whole is only 28 percent. 3/

Switzerland

Industry.--In 1981, there were around 175 firms in the Swiss machine tool indusry, of which about half were members of the Machine Tool Division of the Swiss Association of Machinery Manufacturers (Gruppe Werkzeugmaschinen, Verein Schweizerischer Maschinen-Industrieller (VSM)). The 1979 and 1980, there were approximately 178 firms, decreasing from 180 in 1978 and 181 in 1977. 4/

During 1978-82, employment in the Swiss machine tool industry steadily decreased. In 1982, employment numbered 16,000 persons, representing a decrease from the 17,300 persons employed in 1978. 5/ The largest yearly decrease in employment occurred during 1981 and 1982. In 1981, employment was

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1/ Ibid., p. 31.

2/ Cord Schwartau, op. cit., pp. 33-34.

3/ Eugene DiMaria, "E. Germany Eyes Ways to Build US Tool Sales," American Metal Market, p. 10.

4/ Swiss Machine Tools: Information 1981, Verein Schweizerigeher Maschinen-Industrieller, 1981 and CECIMO.

5/ Post-hearing submission of the European Committee for Cooperation of the Machine Tool Industries (CECIMO), U.S. International Trade Commission, investigation No. 332-149, July 13, 1983, attachment D, citing CECIMO Member Reports.

16,600 with an estimated 94 workers per firm, and by 1982, it had declined by 600 persons.

In 1981, Swiss machine tool manufacturers' profits showed a major decline. Machine tool builders in September 1981 had a 7.8-month backlog of orders, but by September 1982, this backlog had declined to 6.5 months, and has since continued to decline. 1/ Swiss machine tool builders appear to be moving toward the development of specialized machinery and parts with an "emphasis on engineering and planning" and away from standardized machines. 2/ Swiss manufacturers of CNC lathes and machining centers were the hardest hit in the industry by the recent market downturn. 3/ During the recent business slowdown, Swiss machine tool builders began to restructure both their domestic and foreign manufacturing operations. Efforts are being focused on "maintaining a technological edge for sophisticated, high-precision machine tools and boosting automation." 4/ Traditional controls are being replaced wherever possible by programmable controllers or microprocessor controlled systems, that is, by NC or CNC systems. 5/ The use of standardized components in the production of basic machine tool units, as well as the manufacture of products permitting the attachment of automated peripheral equipment, are being expanded. 6/ Swiss machine tool builders also have realized that some products may be overengineered. Ateliers des Charmilles SA (Geneva), which specializes in EDM machines, recently realized that the company had overengineered its machines, thereby making them too expensive to produce. Also, the company had not placed enough emphasis on marketing. 7/

There have recently been a number of corporate restructurings. These restructurings include a joint venture between Charmilles (51 percent ownership) and Georg Fischer (49 percent) in the production and sales of EDM machines--the venture occurred after Charmilles sold its turbine and heating installation operations, and a joint venture between the Georg Fischer Group and Toyoda Machine Works Ltd. (Japan) for the production of NC lathes, computer-controlled flexible lathe systems, and associated equipment to be marketed in Japan by Georg Fischer's Japanese manufacturing and sales subsidary, Nissin Machine Co., Ltd. In October 1982, Georg Fischer, after selling its textile machinery subsidiary, Reuti Maschinenfabrik, acquired a 51-percent share of Burkhardt & Weber GmbH & Co., Reutlingen, West Germany (it is estimated the acquisition almost doubled the production capacities for specialized machinery centers and multipurpose workshops for the George Fischer Group). 8/ In another restructuring of foreign operations, five small- and medium-sized Swiss machine tool firms (Ewag AG, Wahli AG, Kummer AG, Tripet AG, and Agfura Automatisch-Fiering) were planning to establish a cooperative sales and service center with a possible assembly or partial manufacturing operation in Rhode Island in February 1983.

1/ J. Russell Kraus, "Swiss Tool Builders Badly Hit by Order Slump," American Metal Market, Mar. 21, 1983, p. 8.

2/ Ibid.

3/ Ibid.

4/ J. Russell Kraus, "Swiss Tool Builders Restructuring Operations," American Metal Market, Mar. 14, 1983, p. 8.

5/ U.S. Department of State Telegram, U.S. Embassy, Bern, Switzerland, Mar. 16, 1983.

6/ J. Russell Kraus, "Swiss Tool Builders Restructuring Operations," American Metal Market, Mar. 14, 1983, p. 8.

7/ Ibid.

8/ Ibid.

By 1982, Swiss machine tool production had declined to $768.4 million from $994.1 million in 1981. 1/ In 1977, Swiss production of machine tools totaled $580.3 million. In 1982, Swiss exports of machine tools totaled $679.8 million, compared with $869.9 million in 1980; in 1977, such exports totaled $493.4 million. Imports in 1982 totaled $172.4 million, representing a decrease from $225.1 million in 1980; imports in 1977 totaled $76.9 million. Consumption followed the same pattern, declining to $261.1 million in 1982 from $349.3 million in 1980. Consumption totaled $163.8 million 1977.

During 1977-82, Swiss exports of machine tools, as a share of total production, increased only slightly, to 88.5 percent in 1982 from 85.0 percent in 1977. However, imports as a share of apparent consumption increased to 66.0 percent in 1982 from 46.9 percent in 1977. In production, the ratio of metal-cutting machine tools to metal-forming machine tools, based on value, was 6:1 in 1977. However, by 1980, there was a dramatic shift in the ratio, to 19:1, which decreased to 18:1 in 1982.

Government involvement.--Limited information available in this study indicates that the Swiss machine tool industry receives support from the Swiss Government. The Federal Institute of Technology in Zurich maintains a special institute for machine-tool-related research. The institute, in cooperation with private industry, conducts basic research in the fields of new materials and electronic controls, especially CNC controls for future applications. 2/

Romania

Industry.--In January-March 1983, approximately 30 major plants in Romania were manufacturing machine tools. The activity of the machine tool industry is coordinated by the Industrial Group for Machine Tools of the Ministry of Machine Tool Industry, Electrotechnics, and Electronics. The most important metalworking machine tool enterprises and their products are as follows:

- Machine Tools and Aggregate Enterprise, Bucharest: vertical boring and turning mills; horizontal boring-drilling-milling machines; machining centers, grinding machines; jig and boring machines.
- Heavy Equipment Enterprise, Cariova: heavy lathes; gantry plane-milling machines; cylindrical gear machines; presses; cylindrical grinding machines.
- Lathe Enterprise, Tirgoviste: single-spindle, automatic lathes; automatic turret lathes.
- Infratirea Enterprise, Oradea: boring machines; threading machines; planing machines; milling machines.
- Lathe Enterprise, Arad: slide lathes; frontal lathes; turret lathes.

1/ American Machinist, February issues, 1979-83.

2/ U.S. Department of State Telegram, U.S. Embassy, Bern, Switzerland, Mar. 16, 1983.

- o Mechanical Enterprise, Roman: vertical boring and turning mills.
- o Machine Tool Enterprise, Bacau: horizontal boring and milling machines; gantry milling machines.
- o Mechanical Enterprise, Suceava: forging machines, presses.
- o Special Machine Tool Enterprise, Iasi: machining centers; multistation machines.
- o Mechanical Enterprise, Cugir: milling machines.
- o Mechanical Enterprise, Baia Mare; hydraulic control mortising machines; broaching machines; honing machines. 1/

New production facilities are being constructed at Cluj-Napoca (grinding machines), Bistrita-Nasuad (various types of machine tools), and Dorohoi (metal-forming machine tools). The Heavy Machinery Plant in Bucharest, as well as some other industrial enterprises, has been commissioned to manufacture special machine tools for the Romanian nuclear energy program. 2/

In 1982, Romanian machine tool production totaled $615.5 million, declining from $624.9 million in 1981. In 1977, however, production was valued at only $120 million. 3/ Romanian production (table 27) of metal-cutting machine tool units totaled 32,040 in 1982, representing a decrease from 36,070 units in 1981. In 1979, production totaled 29,000 units, a decrease from 30,070 units in 1977. 4/

In 1982, Romanian imports of machine tools totaled $197.5 million, compared with $374.1 million in 1979. Imports total $150 million in 1977. Exports in 1980 and 1982 were valued at $145 million, compared with $134 million in 1981. In contrast, exports in 1977 were valued at $40 million.

Romanian consumption of machine tools declined to $668.5 million in 1982 from $803.3 million in 1981; consumption was valued at $230 million in 1977. During 1977-82, Romania experienced a negative balance of trade in machine tools, measured by value. In 1982, the ratio of the value of imports to exports was 1.3 to 1; however, in 1977, the ratio was 3.7 to 1. Both the ratio of exports to production and the ratio of imports to consumption decreased during 1977-82. In 1977, exports as a share of production were 33.3 percent. Exports declined to 21.4 percent of production in 1981, but increased slightly to 23.5 percent in 1982. Imports as a share of consumption declined from 65.2 percent in 1977 to 29.5 percent in 1982.

1/ U.S. State Department Telegram, U.S. Embassy, Bucharest, Romania, Mar. 1, 1983.

2/ Ibid.

3/ Figures are from American Machinist, February issues 1979-1983.

4/ Central Intelligence Agency, Handbook of Economic Statistics 1980, September 1983. These statistics vary from the statistics used in table 27 because of different data sources.

Table 27.--Metalworking machine tools: Romanian production, by types 1977-81

(In units)

Item	1977	1978	1979	1980	1981
Metal removing:					
Lathes	7,427	7,288	7,393	7,779	7,944
Horizontal boring and milling machines	421	438	436	607	1/
Milling machines	2,888	2,992	2,977	3,033	3,349
Grinding machines	966	1,028	988	1,228	1/
Gear-cutting machines	208	249	222	311	336
All other	18,161	15,202	15,173	16,481	25,085
Total	30,071	27,197	27,189	29,439	36,714
Metal forming:					
Hydraulic presses	216	118	272	395	771
All Other	2,212	2,741	2,727	3,074	2,266
Total	2,428	2,859	2,999	3,469	3,037
Grand total	32,499	30,056	30,188	32,908	39,751

1/Not available.

Source: U.S. Department of State Telegram, U.S. Embassy, Bucharest, Romania, Mar. 1, 1983, citing official Romanian Government statistics.

Government involvement.--Until 1981, the machine tool industry was coordinated by CIMUMFS (the Industrial Central for Machine Tools Precision Machinery and Tools). In 1981, CIMUMFS was separated into two independent agencies, CIMU (the Industrial Central for Machine Tools) and CIMF (the Industrial Central for Precision Machinery). Both agencies are a part of MIMUEE, the Ministry of the Machine Tool Industry, Electrotechnics, and Electronics. CIMU had 21 plants under its control in 1981, and CIMF controlled 13 plants which produced tools, gaging equipment, and hydraulics. 1/ CIMU's plans in 1981 included the beginning of production on assembly lines and the development of cooperative arrangements with firms in CMEA (Council for Mutual Economic Assistance), the West, and in developing countries. 2/

In 1979, Romania had signed a series of technical agreements with foreign producers, including Berthiez and H. Ernault Somua of France, Pama of Italy, and Toshiba and Mitsui Seiki of Japan. In 1980, agreements on machining centers were reached with Scharmann (West Germany), TMI Forest (France), and Yasuda (Japan).

Romania's current Five-Year Plan for 1981-1985 has targeted the metal-working machine tool industry for an annual growth rate of 19 percent. However, the machine-building industry as a whole is projected to have an

1/ Ashburn, Anderson "The 1981 Machine-Tool Standings," American Machinist, February 1982, pp. 110 and 111.

2/ Ibid., p. 111.

average annual growth rate of only 8.8 percent. The 1983 plan allocates $600 million to projects in the production of metalworking machine tools. 1/ Development plans for the industry through to 1985 call for a significant upgrading of technology, including the production of sophisticated machine tools such as NC and CNC types. During 1983-85, the metalworking machine tool industry will focus on the development and production of the following:

- o New range of grinding machines,
- o High-speed presses with large production capability,
- o Heavy presses, between 200 and 1,000 tons, and
- o Machine tools for the automotive industry including--
  - CAM profile grinding machines,
  - Crankshaft machines and testing equipment,
  - Balancing machines,
  - Gear-box-hardening equipment,
  - Connecting rod machines for axle shaft manufacturing, and
  - Robots for the operating of cutting machine tools and forging presses. 2/

People's Republic of China

Industry.--The General Bureau of Machine Tools (GBMT) of the First Ministry of Machine Building governs factories which produce metal-cutting machines, metal-forming and forging machines, foundry equipment, machine tool parts, measuring instruments, cutting tools, abrasive materials, grinding tools, synthetic diamonds, borazon, and timber-processing machines. The divisions in the General Bureau of Machine Tools determine machine tool development policy, as well as annual and long-term plans. 3/

In 1981, the General Bureau of Machine Tools of the First Ministry of Machine Building had under its direction 121 major factories and 7 large research institutes. 4/ In 1979, 1 source estimated the number of machine tool establishments at 30 large-scale plants (not defined, but probably greater than 4,000 persons) and 150 to 200 small-sized plants. 5/

Basic and applied research in the machine tool industry is promoted through an association of major plants, research institutes, and technical universities. Fundamental theory and new technology development occur at the following universities which have machine tool research centers: Qinghua University, Beijing; Jiaontong University, Xian; the Central-China Institute

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1/ U.S. Department of State Telegram, U.S. Embassy, Bucharest, Romania, Mar. 1, 1983.

2/ Ibid.

3/ Liang Xunxian, "China's Machine Tool Industry," The China Business Review, November-December 1981, p. 30.

4/ Ibid., p. 30.

5/ Shigeru Kobayashi, "China's Machine Tool Industry 'Yesterday and Today' - The March Toward Modernization--An On-the-Spot Report;" Metalworking Engineering & Marketing, November 1979, p. 23.

of Technology; the Dalian Institute of Technology; and the Northeast China Institute of Technology. 1/ The Machine Tool Research Institute in Beijing, the largest of its kind in China, conducts fundamental research on machining and manufacturing technology, machine tool structure, measuring, testing, and automation techniques, and also acts as the national information center for machine tool technology. Some major machine tool plants have established their own research institutes, such as the Shanghai Grinding Machine Research Institute (Shanghai Machine Tool Plant) and the Beijing Milling Machine Research Institute (Beijing No. 1 Machine Plant). 2/

The Beijing Machine Tool Research Institute and the Chinese Mechanical Engineering Society jointly publish the monthly magazine Machine Tool, China's most authoritative magazine on the subject.

Large-scale plants frequently provide services to their employees and sometimes function like communes. Facilities include kindergartens, elementary and middle schools, hospitals, day-care centers, and living quarters. 3/

The major problems in the industry in 1979 were lack of coordination between research and development and applications resulting in stagnant innovation, inefficient production technology with low operating rates (30 to 40 percent) and no inventory control, and plants unable to achieve an area of specialization since so much of their resources were devoted toward manufacturing most of their own parts. 4/ Japanese executives noted the following problems in 1982 in the Chinese machine tool industry: antiquated machine design, crude electrical parts, an inefficient production process where each plant produces most of its supplies of specialty steel, and the inadequate technical level of the workers and their lack of enthusiasm for quality control. 5/

In 1982, Chinese machine tool production totaled $470 million, an increase from $355 million in 1977. 6/ Although the value of production during 1977-82 steadily increased, the number of machine tools decreased to 103,000 in 1982 from 200,000 in 1977. 7/ In 1982, Chinese imports of machine tools totaled $130 million, representing a decrease from $140 million imported in 1981. Between 1977 and 1981, imports grew substantially, but totaled only $50 million in 1977. Consumption of machine tools in China was valued at $495 million in 1982, representing a decline from the consumption peak in 1981 of $535 million. In 1977, consumption was valued at $395 million.

1/ Liang Xunxian, op. cit., p. 30.

2/ Ibid., p. 31.

3/ Shigeru Kobayashi, "China's Machine Tool Industry 'Yesterday and Today' - March Toward Modernization-An On-The-Spot Report," Metalworking Engineering and Marketing, November 1979, p. 25.

4/ Ibid., pp. 23-25.

5/ Shigeru Kobayashi, "The Reality of 'Readjustment' in China," Metalworking Engineering & Marketing, January 1982, pp. 104 and 105.

6/ Figures for production, imports, exports, and consumption are from American Machinist February issues 1979-82.

7/ Central Intelligence Agency, Handbook of Economic Statistics, September 1983.

In 1979 and 1980, China annually exported over 10,000 metal-cutting and metal-forming machine tools. In 1979, the types of machine tools exported were as follows: lathes, 30 percent; shapers, and similar machines, 12 percent; milling machines, 10 percent; drilling machines, 9 percent; grinding machines, 5 percent; and boring machines, 2 percent. Other machine tool exports consisted of metal-forming machines and included presses, 26 percent of total machine tool exports; and guillotine shears, pneumatic hammers, and universal shearing and punching machines, constituting the remaining 6 percent. 1/

By year end 1982, exports as a share of production stood at 5.3 percent (based on value), representing a decrease from 6.8 percent in 1981. Prior to 1981, the share of exports to production grew from 2.8 percent in 1977 to 6.7 percent in 1980. Imports as a share of consumption stood at approximately 23 percent in 1982, which was a decrease from 26 percent in 1980. During 1977-80, the ratio of imports to consumption was approximately 13 percent.

By 1981, China had developed the technical capacity to produce 1,400 types of machine tools. 2/ During 1977-82, the production ratio of metal-cutting to metal-forming machine tools (based on value) was approximately 3 to 1.

Government involvement.--Two State organizations handle imports and exports of machine tools: the China National Machinery and Equipment Import and Export Corporation (EQUIMPEX), established in February 1980 by the First Ministry of Machine Building; and the China National Machinery Import and Export Corporation (MACHIMPEX), under the Ministry of Foreign Trade. EQUIMPEX frequently appoints foreign agents to conduct business on its behalf. Machine tool purchases, though, are generated by local governments upon request from end users. 3/

In acquiring machine tools and machine tool technology and know-how, China is seeking coproduction arrangements between foreign manufacturers and its industry rather than through the direct purchase of machinery, countertrade, licensing, or joint ventures. 4/ Licensing arrangements have a disadvantage in that foreign currency is paid for licenses, whereas the Chinese would prefer foreign firms to bear some investment and marketing costs. In coproduction arrangements, the product is made in China with some output going to the foreign company. The foreign company either supplies parts for the product or engineering drawings of the product.

1/ Liang Xunxian, op. cit., p. 32.
2/ Liang Xunxian, op. cit., p. 30.
3/ Warren Storey, "China Pressing for Co-Production In Machine Tool, Heavy Equipment," American Metal Market, May 5, 1983, p. 26.
4/ Ibid.

Spain

Industry.--In mid-1983, there were 131 machine tool builders represented in the Association of Spanish Machine Tool Manufacturers (AFM). AFM's membership consisted of 129 members representing about 95 percent of Spain's machine tool production in 1982. 1/ In 1981, according to estimates from CECIMO, there were approximately 145 firms producing machine tools. During 1977-80, the number of firms decreased: in 1977, there were 158 firms, increasingly to 165 firms in 1978, but decreasing to 160 firms in 1979 and 155 firms in 1980. 2/ The majority of machine tool firms in Spain are concentrated in the Basque region, the industrial northwest, around the cities of Eibar and Bilbao.

In mid-1983, according to one estimate, Spain's machine tool industry employed 4,500 workers. 3/ At the end of 1982, the industry employed 8,500 workers, a decrease from the 8,800 workers in the industry in 1981. 4/ In 1981, Spain's machine tool industry employed an estimated 60 workers per firm. In 1977, Spain's machine tool industry employed 10,500 workers.

In mid-1983, approximately 12 percent of AFM's membership was cooperatives, which have the designation Societe Cooperative (S. Coop.). The cooperatives are businesses with at least 51 percent of the firm owned by the workers. 5/ The remainder of AFM's membership is either privately- or investor-held firms, which have the designation Societe Anonymous (S.A.). In a cooperative, the workers who are shareholders elect a board of directors, which, in turn, hires the firm's management staff for conducting operations. When joining a cooperative, workers are required to make an initial capital investment. In 1980, this was about $1,000, but by mid-1983, the amount had risen to about $4,900. 6/ Many of the cooperatives, such as the Mondragon Workers Co-operative and Danobat (both of which are leading machine tool manufacturers in Spain), provide banks, housing, training, employment, and sometimes an education through their own technical college to their members. Workers employed by cooperatives are considered self-employed by the Central Government of Spain and, therefore, are ineligible for welfare from the State. Cooperatives have schemes for welfare, housing, pensions, and medical care. However, in the area of wages, workers in cooperatives are restricted by cooperative rules, which generally state that the top person in the organization can earn only three times as much as the lowest paid employee. 7/

1/ Repertorio de Fabricantes Espanoles 1980-82 Maquines Herramienta, Direccion General De Exportacion, Ministerio de Comercio, 1982, p. 1.

2/ CECIMO.

3/ Bruce Vernyi, "Huge Machine Tool Conglomerate Planned In Spain," American Metal Market, June 13, 1983, p. 11.

4/ Association of Spanish Machine-Tool Manufacturers, 1983.

5/ Ibid.

6/ "An Industry Built by Two Schools," American Machinist, March 1980, p. 142.

7/ Ibid., p. 144, and Max Commander, "Small is Beautiful for the Basques," Financial Times, May 12, 1983, p. 28.

The Caja Lamboral Bank (CLB), established in 1959, provides banking services to cooperatives and has financed the establishment of new cooperatives, including those in the machine tool industry such as Danobat. CLB is, in fact, a credit cooperative.

The cooperatives in the Spanish machine tool industry are involved in research activities. In 1977, several cooperatives, in particular Danobat, established a research center, called Ikerlan, to develop electronic controls for machine tools. Ikerlan, which is attached to a technical college, employed 36 full-time scientists in 1983.

Recently, a number of corporate restructurings have started to occur in the industry. In mid-1983, four major Spanish machine tool cooperatives were planning to merge into Spain's largest machine-tool-manufacturing conglomeration. The new conglomerate, under the name "Devaco Group," would be made up of Danobat S. Coop., Txurtxill S. Coop., Soraluce S. Coop., and Goiti S. Coop. The four companies which would form the Devaco Group are not competitors, since they produce different product lines. Danobat manufactures horizontal and vertical lathes, grinding machines, assembly lines and material-handling machinery; Txurtxill produces small grinding machines; Soraluce manufactures boring machines; and Gorti produces presses and metal-forming machines. Although the companies will operate as autonomous divisions, they will bear the profits and losses of other members and share supplies. Under the plan, the companies will draw workers from a central labor pool. 1/ It appears that one of the reasons for forming the conglomerate is to minimize the economic impacts of the cyclical nature of the machine tool business. 2/ In addition to this restructuring, other machine tool groups are considering the formation of conglomerates. 3/

By year end 1982, Spanish machine tool production totaled $299.6 million, a decline from the high point of $352.9 million achieved in 1980. In 1977, production was valued at $190.9 million. 4/

In 1982, Spanish machine tool imports totaled $169.8 million and had increased steadily from $91.4 million in 1977. Exports were valued at $191.6 million in 1982, a decrease from $228.3 million in 1980. In 1977, exports totaled $102.5 million. Consumption of machine tools had increased to $277.8 million in 1982 from $178.5 million in 1977.

During 1977-82, exports as a share of production had grown to 63.9 percent in 1982, a decline from 66.7 percent in 1981. Exports constituted 53.7 percent of production in 1977. Imports as a share of consumption had increased to 61.1 percent in 1982 from a low of 45.3 percent in 1981. However, imports were 51.2 percent of consumption in 1977. Since 1978, Spanish machine tool builders have had to rely on increasing exports because of a flat market. The two basic reasons that account for the flat market are

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1/ Bruce Vernyi, "Huge Machine Tool Conglomerate Planned in Spain," American Metal Market, June 13, 1983, p. 11.

2/ Ibid.

3/ Ibid.

4/ Figures of production, imports, exports, and production are from American Machinist, February issues, 1979-83.

(1) lack of investment in the Basque region of Spain because of political instability and (2) the depreciation of the peseta, the deutsche mark, and the French franc. In 1981, the domestic machinery market was stablized by only one factor--the $600 million investment by General Motors-Espana for a new automobile plant at Zaragoza. 1/

In late 1981, the Spanish machine tool builders' association established a trade office in the Chicago area. The office promotes the Spanish industry's products by emphasizing the level of quality of Spanish machines. This can be seen as part of a trend to increase exports to the United States. In early 1983, Spanish machine tool builders began changing their distribution structures in the U.S. market by either establishing direct-sales subsidiaries or acquiring and integrating established distributors into marketing networks. Spanish machine tool builders are looking toward the U.S. market because of (1) an anticipated influx of machine tools into their domestic market when Spain joins the EC in 1984 and (2) declining sales in 1982 to Mexico, West Germany, and the Republic of South Africa. 2/ Another factor in this distribution structure change appears to be the amount of expertise required on the part of selling organizations because of the increasingly sophisticated nature of machine tools. 3/

Government involvement.--Spain's planned entry into the EC will give Spanish machine tool firms access to CNC and other components at lower costs because of the removal of tariffs on those components. 4/ Spain currently maintains protective tariffs on a number of machine tools, such as CNC lathes (maximum 24 percent), presses and metal-forming machines (maximum 18 percent), and milling and boring machines (maximum 14 percent).

Taiwan

Industry.--In 1981, there were 88 firms producing machine tools, each of which had exports of at least NT$10 million (US $272,500) for that year. 5/ Approximately 60 percent of Taiwan's machine tool builders are located in the Taichung province. 6/

Employment in the industry in 1982 totaled 10,770 workers, representing an increase from 9,069 workers in 1980 and 5,693 workers in 1977. In 1982, blue collar workers constituted 85 percent of the industry's employment, and

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1/ "Show Highlights Spain's Exportables," American Machinist, December 1982, p. 25.

2/ Bruce Vernyi, "Spain Tool Builders Bolster Their U.S. Sales Arrangements," American Metal Market, June 6, 1983, p. 5.

3/ Ibid., p. 21.

4/ Ibid., p. 5.

5/ U.S. Department of State Telegram, American Institute in Taiwan Taipei, Taiwan, Mar. 17, 1983.

6/ Shoji Imai, "'Latent trends' In the Taiwan's Machinery Industry," Metalworking Engineering & Marketing, November 1981, p. 81.

white collar workers, the remaining 15 percent. 1/ The average monthly earnings of a worker in 1982 totaled $303, after reaching a high point in 1981 of $343 from $151 in 1977.

In 1982, machine tool production was valued at $199.9 million, decreasing from $249.4 million in the previous year. 2/ During 1977-80, production increased dramatically, to $245.1 million in 1980 from $58.3 million in 1977. In terms of machine tool units, Taiwan's production in 1981 totaled 556,571 increasing from 181,701 in 1977. 3/ Similarly, during 1977-82, machine tool exports peaked in 1981 at $182.6 million, but decreased to $149.2 million in 1982. Exports totaled $49.8 million in 1977. Imports were valued at $80.9 million in 1982, but had peaked at $125.1 million in 1980. Imports increased steadily to $91.4 million in 1979 from $35.7 million in 1977. Consumption was valued at $131.6 million in 1982, declining from $191.9 million in 1980. Consumption was valued at $44.2 million in 1977.

Exports as a share of production amounted to about 75 percent in 1982. During 1978-82, exports ranged from 72 to 74 percent of production. In 1977, however, exports constituted 85 percent of production. Imports as a share of consumption were 61 percent in 1982, and ranged from 59 to 65 percent during 1978-82.

Taiwan machine tool production appears to be concentrated in metal-cutting machine tools. In 1982, the ratio of metal-cutting to metal-forming machine tool production (based on value) was 18:1 and in 1981 was 19:1, but in 1980, it was 31:1, and in 1979, about 27:1. However, in 1977, the ratio was 6:1.

In 1981, domestic manufacturers of machine tools accounted for 63.3 percent of the total value of exports, trading companies accounted for 32.4 percent, and the remainder, 4.4 percent, was accounted for by other manufacturers. 4/ In 1981, imported machine tools were sold through several distribution channels--"indenting agents," actually sales representives, accounted for about 55 percent of imported machine tool sales; distributors, for 25 percent; end users, purchasing directly from foreign manufacturers, about 15 percent; and the remaining 5 percent comprised sales to contractors. 5/ Engineers and contractors are occasional suppliers of machine tools, in that they are responsible for specifications and recommendations in

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1/ U.S. Department of State Telegram, American Institute in Taiwan, Taipei, Taiwan, Mar. 17, 1983.

2/ Figures for production, exports, imports, and consumption are from American Machinist, February issues, 1979-83.

3/ U.S. Department of State Telegram, American Institute in Taiwan, Taipei, Taiwan, Mar. 17, 1983.

4/ Industrial Technology Research Institute, Brief Information on Machine Tools, Taiwan, (in Chinese), Apr. 1, 1982, p. 33.

5/ Frost & Sullivan, Inc., Machine Tools & Accessories Market in Far East, New York, N.Y., March 1981, p. 161.

the acquisition of machine tools for new plants of user industries. 1/ At least in 1981, the quality and durability of machine tools were more important to domestic purchasers than were price and payment terms. 2/ Another important factor in the sales decision was the quality and type of services offered by agents and distributors, who normally provide a full range of application engineering services. 3/ The "distribution cost over and above the landed cost of the equipment" varies depending upon the distribution channel--usually 5 percent from indenting agents, about 30 percent from a distributor, and approximately 15 percent if the end user purchases direct from a foreign supplier. 4/ Machine tool sales are promoted through advertisements in local newspapers and trade exhibitions. Advertisements typically appear in the major trade journal, Taiwan Machinery and Hardware Monthly, and the newspaper Economic Daily News. 5/ The annual trade fair, "Taiwan Machinery Show," is held in April or May. The show, organized by the China External Trade Development Council, has been exclusively for domestically manufactured products. However, the 1983 Taiwan Machinery Show, which generated $27 million in on-the-spot orders, was open to foreign machinery displays for the first time. 6/

Government involvement.--Over the past few years, the Government of Taiwan has realized the importance of the metalworking machine tool industry. The Government has used a number of avenues to promote the industry, including loans for capital investment, support and funding for research and development, promoting cooperation among Taiwan machine tool builders, nontariff barriers, and tax incentives.

In January 1979, the Government of Taiwan initiated loans totaling $600 million to accelerate the rate of investment by machinery manufacturers. 7/

In 1982, the Government encouraged 14 major machine tool manufacturers to form the Taiwan Machinery Association, the aim of which was to raise the technical quality of the member firms' output. The association, also called the Precision Machinery Development Association of the Republic of China, expects the Government to assist in publicizing the symbol "CMD" ("Chinese Machinery Development"), appearing on Taiwan machine tools. The "CMD" symbol signifies the product has met the standards set by the association and the Japan Machinery Institute. 8/

In July 1977, the Metal Industry Research Laboratory of the Industrial Technology Research Institute established the Machine Tools Center as a division of the laboratory with the objective of upgrading the technology of

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1/ Ibid., pp. 161-162.
2/ Ibid., p. 161.
3/ Ibid.
4/ Ibid., p. 162.
5/ Ibid.
6/ "FMS's Displayed at Taiwan Show," American Machinist, June 1983, p. 33.
7/ Kazushima Takahashi, "Brisk Taiwan Machine Tool Industry-NC-Oriented Segment Initiating A New Epoch," Metalworking Engineering and Marketing, September 1979, p. 97.
8/ "Taiwan's Builders Seek Japanese Technical Aid," American Machinist, April 1983, p. 31.

the country's machine tool industry, including the establishment of a gear technology program. The Metal Industry Research Laboratory receives Government support. In March 1981, the total value of the facility was $120 million, with another plant of 4,500 square meters to be completed in 1983. 1/ In mid-1982, the laboratory was seeking to license production know-how for its milling- and drilling-machine controllers to domestic manufacturers. 2/ In June 1983, the Government-supported Mechanical Industry Research Laboratories (MIRL) was planning to license to local manufacturers for commercial production its know-how for an FMS station which can accomodate 10 machines and up to 24 loading/unloading stations. The Lian Feng Machine Industries has been producing a horizontal machining center, which was developed by MIRL. 3/

The Government of Taiwan is also involved in protecting domestic manufacturers through mechanisms such as the mandatory condoning of joint ventures with foreign manufacturers. However, in June 1982, the Government of Taiwan rejected a proposal from the Japanese firm Fujitsu to establish a joint manufacturing venture in Taiwan in order to encourage the newly formed, local controller industry. Taiwan authorities stated that Fujitsu failed to "give sufficient guarantees of technology transfer to the local partner." 4/

The Government of Taiwan exercises some of the more traditional nontariff barriers to trade in the area of machine tools. Although no import bans or import quotas are imposed on metalworking machine tools, import licenses are required. The licensing fee is 0.15 percent of the import value, as stated on the import permit. 5/ The Bureau of Foreign Trade initially tries to direct buyers who may seek to import to contact local metalworking machine tool manufacturers first. If the buyer can not obtain the machine desired, the local manufacturer referred to by the Bureau will issue an "unable-to-make" certificate. With this certificate, the buyer can obtain an import license, but will not be eligible for the privilege of taking low-interest loans from public banks to finance the purchase. 6/ A qualified investor may take a 10-percent tax deduction on an investment in machinery if it is imported, and a 15-percent deduction on the investment if the machinery is manufactured locally.

Republic of Korea

Industry.--By the end of 1982, there were approximately 70 firms in the Republic of Korea (Korea) manufacturing metalworking machine tools, employing about 15,000 factory workers. 7/ Korean machine tool production increased steadily during 1977-82, and by 1982, production totaled $200 million. In

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1/ Shoji Imai, "'Latent trends' in the Taiwan's Machinery Industry," Metalworking Engineering & Marketing, November 1981, p. 82.

2/ "Toward Home-Grown CNC for Taiwan," American Machinist, June 1982, p. 49.

3/ "FMS Displayed at Taiwan Show," American Machinist, June 1983, p. 33.

4/ "Toward Home-Grown CNC for Taiwan," American Machinist, June 1982, p. 49.

5/ U.S. Department of State Telegram, American Institute in Taiwan, Taipei, Taiwan, Mar. 17, 1983.

6/ Ibid.

7/ U.S. Department of State Telegram, U.S. Embassy, Seoul, Korea, Mar. 11, 1983.

1977, Korean production of machine tools was valued at $57 million. 1/ In 1979, production totaled $163.7 million, a 72.3-percent increase over the previous year's production of $95.0 million.

During 1977-82, Korea had a negative balance of trade in metalworking machine tools. By 1982, imports were valued at $250 million, or $50 million more than domestic production; exports were valued at $65 million. In 1979, imports reached a peak of $397.6 million, or $233.9 million greater than domestic production. Exports in 1979 were valued at $14.9 million, a 198-percent increase over the previous year's exports of $5 million. In comparison, in 1977, imports of machine tools totaled approximately $130 million, or $73 million more than domestic production. Exports were valued at $2 million. Exports as a share of domestic production increased to 32.5 percent in 1982 from 19.6 percent in 1980 and 3.5 percent in 1977.

By 1982, Korean consumption of machine tools was valued at $385 million; Korean consumption reached a peak of $546 million in 1979. In 1977, consumption totaled only $185 million. Imports as a share of consumption amounted to 64.9 percent in 1982, after reaching a peak of 76 percent in 1980, and were 70.3 percent in 1977.

By the end of 1982, according to the Korea Machine Tool Industry Association, more than 50 types of machine tools, including parts, were being domestically produced. 2/ The types of metal-cutting machine tools produced include NC lathes, CNC lathes, machining centers, automatic deburring and tapping machines, grinding machines, horizontal boring and milling machines, shapers, auto cycle gear hobbing machines, and precision electrical discharge machines. The types of metal-forming machine tools produced locally include power and hydraulic presses, drop forging hammers, and a variety of shearing and bending machines such as press brakes and shearing machines, continuous shearing lines, and cold shearing and up-cut shearing machines. 3/ By the end of 1982, 23 firms were producing lathes, a major type of machine tool manufactured locally. Only one firm, Jin Young Precision Machine Co., Ltd., manufactured precision EDM's.

In 1979, a number of Korean machine tool builders had technical affiliations with foreign manufacturers, as seen in the following tabulation:

1/ Figures for total production, consumption, imports, and exports are from American Machinist, February issues, 1979-83.

2/ U.S. Department of State Telegram, U.S. Embassy, Seoul, Korea, Mar. 11, 1983.

3/ Ibid.

Korean Firm	Product	Foreign Firm
Hyundai International, Inc.	NC lathe; cylindrical grinding machine.	Osaka Kiko Co., Ltd., (Japan) Cincinnati Milacron, Inc. (USA).
Kia Machine Tool Co., Ltd.	Special-purpose machine-cylindrical blocks.	Toyo Kogyo Co., Ltd., (Japan).
Dong Yang Machinery Co	Engine lathes	Okuma Machinery Works, Ltd. (Japan).
Chung Kong Sa Co., Ltd	Milling machines	Howa Sangyo Co., Ltd. (Japan).
Dae Young Industrial Co., Ltd.	Centerless grinding machines.	Ohmiya Machinery Co., Ltd. (Japan).

In 1979, Daewoo was demonstrating an unmanned NC lathe which was combined with a Fuijitsu Fanuc industrial robot. 1/ By early 1981, most domestic firms had licensing agreements with foreign manufacturers. There were 16 licensing agreements for metal-cutting machine tools and two licensing agreements for metal-forming machine tool manufacture. 2/ In 1982, Daewoo International was marketing a CNC lathe with controls built by Fanuc Ltd. and which could be combined with a dedicated Fanuc robot for loading and unloading. 3/

In 1981, machine tools imported into Korea generally took the following distribution channels: sales offices of foreign companies, local "offering agents," Japanese trading companies, or Korean trading companies. 4/ The Korean Traders Association (KOTRA) and the Korea Society for the Advancement of Machinery Industry (KOSAMI) are major organizations for the promotion of machine tools for trade shows. For foreign manufacturers, experienced local agents are scarce. However, in 1982, the development of general trading companies was being promoted by the Korean Government. 5/

Government involvement.--In 1967, the Korean Government enacted the Machinery Industry Promotion Law. Then, in the 1970's, with the establishment of the Changwon Machinery Complex, large Korean firms such as Daewoo Heavy Industries, Ltd., and Lia Machine Tool Co. were founded and began manufacturing machine tools.

In mid-1980, the Korean Government provided funds to promote the purchase of domestically produced machines. The Government's program was designed to

1/ Shoji Imai, "Korea International Exhibition of Machine Tools: KIMAT '79," Metalworking Engineering and Marketing, September 1979, p. 106.

2/ Frost & Sullivan, Inc., Machine Tools & Accessories Market in Far East, New York, N.Y., March 1981, p. 100.

3/ Stuart Brown, "Daewoo Pushes for Share of US CNC Lathe Market," American Metal Market, Sept. 6, 1982, p. 10.

4/ Ibid.

5/ Ibid.

spur investment in plant and equipment on the part of the machinery industry. The Government initially allocated $88.9 million for national investment funds, $49.3 million for small- and medium-sized enterprises, and $65.8 million for industrial bank machinery industry funds. Another $164.6 million was later added to the program. It is not known how much of these funds were received by the machine tool industry.

In 1981, the Korean Government was providing a number of incentives to spur investment in machinery including tax credits, research and development assistance, grants, and preferential, low-cost financing. 1/

In 1981, foreign machine tools were required to receive a recommendation by the Fine Instruments Center (FIC) before being imported. The Fine Instruments Section of the Korean Ministry of Commerce and Industry established technical standards for certain types of precision machinery. The Korea Standards Association established certain other standards. 2/ Although not a standard, the metric system is universally used in Korea, and those machine tools with metric standards have an advantage in penetrating the Korean market. 3/ The Korean Government does require licenses for imports of foreign-made metalworking machine tools. In 1981, the granting of an import license was dependent on priority for defense-related products, products embodying high technology, a preference for U.S. or European products instead of those from Japan, and a preference for products manufactured for current or future licensing agreements and joint ventures. 4/ An import license was granted once the local agent presented the sales contract to the FIC and the contract was subsequently approved. A valid import license was required before letters of credit could be opened. 5/

In 1981, tariffs on machine tools ranged from zero to 20 percent, with no preferential import duties imposed for country of origin. 6/ Machine tools which were not produced locally in sufficient quantity, quality, and price were allowed to be imported duty free by major capital goods manufacturers. 7/ In 1982, the Korean Government designated the metalworking machine tool industry as a strategic export industry. The current Korean Trade Plan, covering the period July 1, 1982, to June 30, 1983, specifies that most imports of metalworking machine tools are subject to recommendation of the Korea Machine Tool Industry Association. 8/ The imports covered consist of 69 subitems of the Customs Cooperation Council Nomenclature 84.45 category.

The Korean Government's targets for the metalworking machine tool industry in 1986 include production valued at $950 million and exports

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1/ Frost & Sullivan, Inc., Machine Tools & Accessories Market in Far East, March 1981, p. 104.

2/ Frost & Sullivan, Inc., Machine Tools & Accessories Market in Far East, New York, N.Y., March 1981, pp. 97, 105.

3/ Ibid, p. 98.

4/ Ibid., p. 97.

5/ Ibid.

6/ Ibid.

7/ Ibid.

8/ U.S. Department of State Telegram, U.S. Embassy, Seoul, Korea, Mar. 11, 1983.

(including metal-forming machinery) totaling $550 million, or 57.9 percent of production. Sixty percent of the machine tools in use by Korean industry are to be domestically produced. 1/ Planned exports (by value) for 1986 include 150 million dollars' worth of lathes, 60 million dollars' worth of milling machines, 20 million dollars' worth of drilling machines, and 170 million dollars' worth of other machine tools. 2/

Factors of Competition

Inventories

Respondents to the Commission's survey of machine tool purchasers in the U.S. marketplace revealed that shorter delivery time was less important in the purchase of a U.S.-made machine tool vis-a-vis the purchase of a foreign-made machine tool.

The large inventories of foreign-made, especially Japanese, machine tools has had an impact on the entire U.S. machine tool market. When U.S. demand for machines tools became severely depressed in late 1981 and throughout 1982, the large inventories of foreign-made machine tools led to price-cutting, with manufacturers' discounts of 15 percent being commonplace. 3/ As a result, the profitability of U.S. manufacturers suffered.

Markets in Singapore, Taiwan, and Western Europe also suffered from price cutting due to large Japanese inventories. The presence of larger inventories of new, foreign-made, machine tools in the U.S. market also disrupted the market for used machine tools. Although it had never been significant, this market grew during 1980-82 because of the large number of repossessions of machine tools due to the heavy impact of the recession on job shops and general manufacturing. Both the market value and the collateral value of these repossessed machine tools declined in light of the increased inventories of foreign-made machine tools. 4/

In late 1979 and early 1980, Japanese machine tool builders and trading companies established a number of centers for stockpiling machine tools in both the United States and Europe. 5/ These centers were built, in part, to reduce the delivery time of Japanese machine tools. In June 1980, for instance, a Japanese trading company had in its stockyard center in Chicago inventories worth some $3 million, or about a 2-month supply. 6/

The buildup in the United States of Japanese machine tools paralleled the growing inventories in Japan of the same products. In 1980, Japanese machine

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1/ Ibid, citing the Korean Ministry of Commerce and Industry.
2/ Ibid.
3/ J.D. Kidd and Minoru Inaba, "Japan Machine Tool Inventories In U.S. Growing, Discounts Offered," American Metal Market, July 19, 1982, p. 22.
4/ "Creditors Are Loaded with Machine Tools," Business Week, Oct. 18, 1982, p. 47.
5/ "European Machine Tool Stocking Center is Eyed," Japan Economic Journal, June 17, 1980, p. 8.
6/ Ibid.

tool builders had inventories in Japan of 1,191 NC lathes and machining centers, which were valued at approximately $78 million. This was a 32.5-percent increase in value over 1979 inventories for NC lathes and a 38.1-percent increase for machining centers. 1/ In 1980, approximately 90 percent of all machine tool inventories in Japan were NC lathes and machining centers. 2/

According to a 1982 survey by the Japan Machine Tool Builders' Association, of the 3,878 NC lathes and 2,180 machining centers shipped to the United States in 1980, 2,500 and 1,000, respectively, were considered to be in inventory. 3/ By the end of 1982, estimates of unsold Japanese machine tools in the United States ranged from 5,000 to 10,000 units, worth up to $500 million. 4/

The Commission's survey of U.S. importers of metalworking machine tools indicated that as of December 1982, there were 5,246 machine tools in inventory in the United States, 409 of which were NC lathes and 305 of which were machining centers. 5/ Responses to the Commission's survey accounted for 43 percent of imports, by value. If the ratio of machine tools in inventory to imports (by value) were applied to 100 percent of imports, the number of machine tools in inventory would be 12,223. 6/

Raw Materials, Capital, and Labor Availability and Cost

The bulk of raw materials consumed in the manufacture of machine tools are iron, steel, aluminum, and copper. Ferrous metals are being slowly replaced by composites, 7/ which will be increasingly used as a cost-saving measure in the future. Other materials include paint, oil, and rubber. The 1977 Census of Manufactures reported the cost of materials to the metalworking machine tool industry to be about 38 percent of the value of shipments reported by the Bureau of the Census for 1977. Although little information is available on the cost of these raw materials to foreign producers, U.S. producers who have studied foreign machine tool industries are of the opinion that raw-material costs are relatively equal throughout the world. However, there are other costs, such as wages, fixed overhead, and financing, all of which vary significantly between countries.

1/ "Market Trends of Machine Tool Inudstries," Digest of Japanese Industry & Technology (DJIT), Japan Trade & Industry Publicity, Inc., Tokyo, Japan, No. 164, 1981, p. 28.

2/ J.D. Kidd and Minoru Inaba, op. cit., p. 22.

3/ Minoru Inaba, "Japan's Massive Tool Stocks," American Metal Market, June 28, 1982, p. 1.

4/ John A. Byrne, "Industrial Equipment and Serives," Forbes, Jan. 3, 1983, p. 130.

5/ Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

6/ Estimated by the staff of the U.S. International Trade Commission, based on questionnaire responses.

7/ Composites are blends of different types of materials that tend to be stronger, lighter, and more resistant to temperature extremes than any of their component materials alone.

Wages, including supplementary benefits, paid to production workers are estimated to be higher in West Germany and Switzerland than in the United States; wages in all other major producing countries are estimated to be lower than those earned in the United States. 1/ Wages paid to production workers in France, Italy, Japan, and the United Kingdom are, on average, two-thirds of those paid to production workers in the United States. The difference in wages paid to white collar workers is even greater. Engineers in the United States with 1 year of experience earn approximately twice that of their Japanese counterparts and four times that of Taiwan and Korean engineers. 2/ The higher wages in West Germany, Switzerland, and the United States, as compared to other machine-tool-producing countries, generally contribute to higher costs of production, which may have a significant effect on the competitiveness of these countries in the world market for metalworking machine tools.

Historically, it has been difficult for the U.S. machine tool industry to generate capital. The cyclical nature of the industry due to the instability of the market has made it difficult for machine tool producers to attract external equity or debt financing. Since machine tool companies' profits are generally on par with those of other manufacturing industries during upswings and much worse during downturns, and since the majority of U.S. companies are small and privately held, few financial institutions are willing to assume the risk for such a low return on their investment. Debt-to-equity ratios in the U.S. industry are typically below 50 percent. Profits earned in good years are generally held as a buffer for the downside of the cycle, when capital is needed to retain as many skilled workers as possible and so companies may undertake whatever capital improvements are deemed necessary.

The ability to generate capital in foreign industries does not appear to be so burdensome. Japanese debt-to-equity ratios have been reported to range from 150 to 560 percent. 3/ Thus, the typical Japanese machine tool company has much easier access to capital than its American counterpart and the risks associated with capital expansion and investments are, in effect, assumed by the lending agency. The relative ease of capital investments also gives Japanese machine tool companies the ability to maintain a highly skilled workforce even in times of weak demand. In comparison, debt-to-equity ratios in the EC range from 30 to 120 percent, thus allowing some EC countries the advantages over the typical U.S. manufacturer that are also enjoyed by Japanese companies (see country profiles section for further discussions of Government involvement in the machine tool industry).

Technology Level

Manufacturing technology

Manufacturing technology in the machine tool industry is constantly changing. The advent of NC and CNC and constant advances in cutting tool materials, machine tool design, measurement and sensing devices, tool

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1/ U.S. Department of Labor, Bureau of Labor Statistics.

2/ Asian Wall Street Journal Weekly, Jan. 10, 1983, p. 11.

3/ George P. Sutton, "Trip Report on the Technology of Machine Tools in Japan," Machine Tool Task Force, Lawrence Livermore, National Laboratory, February 1980.

changing, workpiece handling, and workpiece materials have made it difficult for even the most modern, sophisticated machine tool company to keep abreast of technology developments. 1/ The emerging technologies of computer-aided-design and computer-aided-manufacture are beginning to play an important role in the competitiveness of machine tool companies. Machine tool builders who now utilize CAD/CAM techniques in their own manufacturing operations are obviously in a more favorable competitive position than those who do not. 2/

Much of the technology used today in the machine tool industry (i.e., numerical control, measurement and inspection technology, CAD/CAM, laser technology, and similar high-technology features) was developed outside the industry. In order to keep pace with technological advances of primary importance in both the manufacturing process and the end product, some machine tool companies have been acquiring interests in high-technology firms which provide expertise in these areas. 3/ However, the diffusion of new technology in the machine tool industry has generally been slow. 4/ One reason for this may be the relative lack of capital of U.S. machine tool builders, compared with that of foreign machine tool builders.

One barometer of the diffusion of manufacturing technology in the U.S. machine tool industry is the number of NC machine tools in use in machine tool plants. A study by the U.S. Army in 1978 revealed that of a sample of 25 percent of all U.S. manufacturing companies with 20 or more production workers, only 4 percent of the machine tools in use were numerically controlled. Data submitted in response to the Commission's questionnaire to U.S. producers of machine tools indicate that in 1982, NC machine tools accounted for 10 percent of all machine tools currently in use in machine-tool-manufacturing facilities. Of these, 39 percent are 4 years old or less; 26 percent are 5 to 9 years old; 31 percent are 10 to 19 years old; and 4 percent are 20 years old or more. The number and ages of machines in use by U.S. producer respondents as of December 1982 are shown in table 28.

Table 28.--Metalworking machine tools: Machines in use by U.S. producers of machine tools, by ages, as of Dec. 31, 1982

(In units)

Age	Numerically controlled	All other	Total
0 to 4 years	660	1,104	1,764
5 to 9 years	442	1,528	1,970
10 to 14 years	518	4,051	4,569
20 years and over	66	8,706	8,772
Total	1,686	15,389	17,075

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

1/ Commission staff interviews with industry executives.
2/ Ibid.
3/ American Metal Market/Metalworking News, Jan. 31, 1983, p. 1.
4/ The Competitive Status of the Machine Tool Industry, National Academy Press, Washington, D.C., 1983, p. 25.

Of the conventional-type machine tools in use in U.S. machine tool plants in 1982, 7 percent were 4 years old or less, 10 percent were 5 to 9 years old, 26 percent were 10 to 19 years old; and 57 percent were 20 years old or more, according to 140 domestic producers responding to the Commission's survey.

A recent innovation which is already of benefit to machine tool producers is CAD/CAM, which eliminates the need to define every point along the path of a cutting tool as is necessary with standard NC and CNC programming. The part is designed through a cathode ray tube (CRT) by entering information through a keyboard. The computer performs the complex mathematical operations and produces graphics, which eliminates the need for conventional engineering drawings. The computer retains all data for each part designed, and the graphics for each part may be recalled and redesigned at will. The programmer keys in data for tool selection, speed, feed rates, and similar information. The computer then generates the tool path, which is checked by the operator and, if acceptable, the computer generates the NC tape for producing that particular part.

A more recent development which holds promise for the industry is distributed numerical control. This process electronically links the CAD/CAM system directly to the NC machine tool, which eliminates the need for punched paper tapes and allows for easier and faster editing of machinery operations. Distributed numerical control is a further step toward automated manufacturing. With a CAD/CAM system electronically linked to NC machine tools, robots for loading and off-loading, automated conveyors for workpieces, and automated inventory control, repetitive machining operations can be carried out with limited worker intervention.

CAD/CAM systems are integral to Flexible Manufacturing Systems. FMS's consist of one or more computer-controlled machine tools, other machinery for testing and inspection, automated material-handling systems, and a central computer for controlling this equipment. FMS's are designed to produce a family of diverse parts in batches. Although significant cost benefits are realized with flexible manufacturing systems, there is a large initial investment that has precluded its widespread use.

In the United States, only the largest machine tool manufacturers use CAD/CAM. 1/ However, Commission staff interviews with machine tool company executives in connection with this study revealed that intermediate-sized firms are beginning to realize the value of CAD/CAM to their operations. Most industry representatives expressed a desire to acquire CAD/CAM capability not only for in-house use in producing machine tools, but also for the experience with such a system that will help them market more effectively to sophisticated users of total manufacturing systems. Two producers had recently installed CAD/CAM and were still learning its uses. There are approximately 30 FMS's operating in the United States, but only a few of these are in use in the machine tool industry. 2/

1/ U.S. Department of Labor, Technology and Labor in Four Industries, Jan. 1982, p. 22.

2/ U.S. Industrial Outlook, 1983, p. 20-5, and the NMTBA.

In Japan, there are approximately 250 FMS's currently in operation, with about 10 of these in use in the machine tool industry. 1/ 2/ In addition, one Japanese machine tool producer has established a flexible manufacturing factory in the United States. The average number of machine tools in a typical Japanese FMS is seven, most of which are machining centers. The number of different parts produced varies from 4 to 3,000, and lot sizes vary from 3 to 300. FMS's range in cost from $2 million to $8 million. 3/

At a recent American Products Fair in Sapporo, Japan, staged by the American Consulate, U.S. CAD/CAM and Office Automation companies received $2 million in orders from Japanese companies. In addition, four sales agreements were concluded, and five were under negotiation. Funds for the fair were provided by the exhibiting U.S. companies, a subsidy from the Manufactured Imports Promotion Organization, which is under MITI, and from advertisements. In addition, the space for the show was provided rent free by the Keio Plaza Hotel. No U.S. Government funds were expended to put on this show. 4/

In Western Europe, the total number of flexible manufacturing systems in current use is estimated at 25. 5/ Machine tool companies that utilize FMS are believed to be fewer than 10. West Germany has a Government-financed project for CAD/CAM research, development, and implementation. In most other countries, research and development on FMS is coordinated by commercial interests supported by government funding. 6/ A report by the United States Machine Tool Task Force in 1980 stated that the West German machine tool builders may be ahead of U.S. machine tool builders in some areas of FMS. 7/ The Western European market for CAD/CAM is expected to reach $1.6 billion by 1987. 8/ The number of machine tool producers using CAD/CAM can be expected to increase as applications for its use increase and the cost of installing such systems decreases.

In Eastern Europe and the Soviet Union, CAD/CAM development was not begun until the 1970's. There are approximately 25 FMS's in operation in these areas. 9/ The Governments of these countries have backed considerable efforts toward CAD/CAM research, with the impetus for these efforts based on rapid industrial expansion and a chronic labor shortage. 10/

According to industry sources, the Japanese and U.S. machine tool producers are on equal ground when considering the technology of flexible manufacturing systems. Where the Japanese have an advantage is in practical experience in using FMS's, because there are so many more in operation in Japan than in the United States. This gives the Japanese firms an advantage in terms of the application of FMS, which could prove to be a significant

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1/ American Metal Market/Metalworking News, Nov. 15, 1982, p. 7.
2/ Industrial Review of Japan/1982, March 1982, p. 97.
3/ American Machinist, Nov. 1981, p. 212.
4/ Department of State Airgram, Mar. 5, 1983.
5/ American Machinist, Nov. 1981, p. 213.
6/ Ibid.
7/ Iron Age, Nov. 24, 1980, p. 119.
8/ American Machinist, Apr. 1983, p. 43.
9/ American Machinist, Nov. 1981, p. 218.
10/ Ibid., p. 215.

advantage in terms of market penetration. West Germany, however, may be ahead of the United States in terms of automatic tool control and actual cutting time of the tool in the FMS field. 1/

Product technology

The product technology of U.S. machine tool producers is generally held to be internationally competitive. 2/ For certain products the United States has superior technology, simply because U.S. producers have concentrated on the development of these products. These include large, sophisticated NC machine tools for use in the production of aircraft, military equipment, and other specialized products. Foreign producers, for the most part, are not competitive in these markets.

The market for small- and medium-sized NC machine tools is a different matter. The Japanese producers, in particular, have concentrated production efforts in the area of standard NC machine tools. 3/ The markets for these types of machine tools consist of appliance and machinery manufacturers, along with small job shops that supply parts to these and other industries. The competition among Japanese producers of NC machine tools in the mid-1970's and the decreasing cost of NC control units led to significant price reductions for these machines. 4/ The resulting attainment of economies of scale in the production of standard NC machine tools such as turning machines and machining centers and thus, the low selling price, coincided with a significant surge in demand for these machine tools in the United States in the late 1970's. Retooling in the automobile and aerospace industries, along with oilfield goods producers, was expanding, and the job shops which supply these industries were demanding standard NC machine tools. At the same time, U.S. producers were showing little interest in this market and continued to produce the large, sophisticated machine tools for specialized use. 5/ Since that time, however, a few U.S. producers have started producing competitive machine tools to serve this market. 6/

In certain categories of machine tools, different countries have the leading technology because they have concentrated on the development of these products. In a 1982 survey, U.S. purchasers of both U.S.-made and foreign-made machine tools were asked to rate producers regarding the engineering of their products. 7/ Purchasers rated U.S. producers only slightly higher than Japanese and West German producers. 8/ Other producing countries rating much lower than the top three included the United Kingdom, Italy, France, and Taiwan. It appears from this survey that U.S. producers

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1/ Iron Age, Nov. 24, 1980, pp. 119 and 120.
2/ The Competitive Status of the U.S. Machine Tool Industry, National Academy Press, Washington, D.C., 1983, p. 67.
3/ Industrial Review of Japan/1982, March 1982, p. 91.
4/ Ibid.
5/ American Machinist, September 1979, p. 116.
6/ Industry Week, Aug. 9, 1982, pp. 46 and 48.
7/ Hitchcock Marketing and Research Services, Three Views of Machine Tool Marketing, Dec. 1982.
8/ Ibid.

have a slight overall edge in product technology over their foreign competitors, at least in the U.S. market. However, when the machine tool categories were broken down into types of machine tools used, U.S. products were rated first and Japanese products second in the metal-cutting category, and vice versa in the metal-forming category. When U.S.-made machine tools and foreign-made machine tools were compared by industries using these products, U.S.-made machine tools were rated first among SIC's 34 (fabricated metal products), 35 (machinery, except electrical), and 36 (electrical machinery), and Japanese-made machine tools were rated first among SIC's 30 (rubber and miscellaneous plastics products), 38 (instruments and related products), and 39 (all other durable goods). German-made machine tools were rated first in SIC 37 (transportation equipment), and Taiwan machine tools were rated first in SIC 33 (primary metals).

Product Quality

In the Commission's survey of U.S. purchasers of both domestic and foreign-made machine tools, respondents indicated that performance features were less significant factors in the purchase of a U.S.-made machine tool vis-a-vis the purchase of a foreign-made machine tool. Table 29 lists the factors considered in the Commission's survey and ranks them in order of their importance to domestic purchasers.

Table 29.--U.S.- and foreign-made machine tools: U.S. purchasers' reasons for purchases, 1980-82

Reason for purchase	U.S.-made machine tools	Foreign-made machine tools
Availability of spare parts	1	8
Compatibility with existing systems	2	7
Servicing/training	3	6
Availability	4	5
Lower purchase price (delivered)	5	1
Supplier relationship	6	10
Shorter delivery time	7	2
Superior design	8	3
More durable	9	10
Higher productivity (man-hour output ratio)	10	4
Ability to add to or upgrade machine tool capability	11	8
Favorable warranties	12	9
Less maintenance	13	7
Changeover time (for different production runs)	14	11
Energy efficiency	15	15
Favorable financing terms	16	12
Lower installation costs	16	14
A 11 other	17	13

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Purchasers responded that overall, in their opinion, foreign-made machine tools are better designed than U.S.-made machine tools, have higher productivity, and require less maintenance. U.S.-made machine tools were rated as slightly more durable than foreign-made products.

U.S. machine tool builders have generally concentrated on production of specialized types of machine tools for the machinery and fabricated-metal products industries, as well as the transportation industry. As a result, purchasers in these industries have indicated that U.S.-made machine tools are superior to foreign-made machine tools. 1/

Product Price

Domestic purchasers indicated in Commission questionnaires that a lower delivered purchase price was the most important reason for buying a foreign-made machine tool and of somewhat less importance when buying a domestically made machine tool. U.S. producers and importers submitted information in Commission questionnaires on shipments (by value and quantity) of numerically controlled lathes and machining centers. Included in the responses was information on horizontal spindle NC lathes with a rated horsepower of less than 25 and over 50; vertical spindle NC lathes and vertical spindle machining centers with a Y-axis travel of less than 20 inches and over 26 inches; and horizontal spindle machining centers with a Y-axis travel over 40 inches. 2/

Tables 30-33 show the average prices of these machines for U.S. domestic and export shipments and U.S. imports and importers' shipments.

Table 30.--Numerically controlled lathes: Average price of U.S. domestic shipments, by types, 1977-82

Year	Horizontal spindle		Vertical spindle
	Rated less than 25 horsepower	Rated over 50 horsepower	
1977	$64,596	$190,332	$224,390
1978	72,192	185,457	274,290
1979	55,790	192,872	271,437
1980	90,514	239,612	263,948
1981	130,890	276,226	342,504
1982	110,020	343,111	386,488

Source: Compiled from data submited in response to questionnaires of the U.S. International Trade Commission.

1/ Industry Week, Aug. 9, 1982, p. 47, and American Machinist, September 1979, p. 117.

2/ It should be noted that information was provided for specific categories of metalworking machine tools and the reported values of shipments for U.S. producers and importers do not necessarily represent comparable products. Product variation may occur from one year to the next for one producer or importer.

Table 31.--Numerically controlled lathes: Average price of U.S. export shipments, by types, 1977-82

Year	Horizontal spindle		Vertical spindle
	Rated less than 25 horsepower	Rated over 50 horsepower	
1977	$46,211	$238,667	$256,231
1978	49,808	204,250	134,678
1979	59,792	203,071	347,313
1980	79,879	259,647	400,200
1981	102,970	280,690	252,143
1982	85,200	368,278	483,900

Source: Compiled from data submited in response to questionnaires of the U.S. International Trade Commission.

Table 32.--Numerically controlled lathes: Average price of U.S. imports, by types, 1977-82

Year	Horizontal spindle		Vertical spindle
	Rated less than 25 horsepower	Rated over 50 horsepower	
1977	$49,201	$100,633	$67,071
1978	61,837	113,410	98,767
1979	67,141	140,291	72,615
1980	66,739	142,977	195,379
1981	73,573	156,475	159,528
1982	65,480	151,755	209,396

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table 33.--Numerically controlled lathes: Average price of U.S. importers' shipments, by types, 1977-82

Year	Horizontal spindle		Vertical spindle
	Rated less than 25 horsepower	Rated over 50 horsepower	
1977	$62,249	$134,747	$93,125
1978	72,516	147,442	127,292
1979	80,579	172,387	72,000
1980	86,364	174,240	136,875
1981	97,962	199,604	224,146
1982	89,019	209,644	202,814

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

U.S. producers' average prices of domestic shipments of horizontal spindle NC lathes rated less than 25 horsepower increased from $64,596 in 1977 to $72,192 in 1978, decreased to $55,790 in 1979, increased to $130,890 in 1981, and decreased to $110,020 in 1982. The 1981 average price increased 103 percent over the 1977 average price and the 1982 average price was 16 percent below the 1981 average price. The average price of U.S. producers' export shipments of horizontal spindle NC lathes rated less than 25 horsepower increased from $46,211 in 1977 to $102,970 in 1981, or by 123 percent, and decreased to $85,200 in 1982, or by 17 percent. The average price of U.S. imports of horizontal spindle NC lathes rated less than 25 horsepower increased from $49,201 in 1977 to $67,141 in 1979, decreased to $66,739 in 1980, increased to $73,573 in 1981, and decreased to $65,480 in 1981. The 1981 average price was 50 percent higher than the 1977 average price and 11 percent higher than the 1982 average price. The average price of U.S. importers' shipments of horizontal spindle NC lathes rated less than 25 horsepower increased from $62,249 in 1977 to $97,962 in 1981, or by 57 percent, and decreased to $80,019 in 1981, or by 9 percent.

The average price of U.S. producers' domestic shipments of horizontal spindle NC lathes rated over 50 horsepower increased erratically from $190,332 in 1977 to $343,111 in 1982 (80 percent) and the average price of export shipments increased 54 percent from $238,667 in 1977 to $368,298 in 1982. The average price of U.S. imports of horizontal spindle NC lathes rated over 50 horsepower increased from $100,633 in 1977 to $156,475 (55 percent) and decreased to $151,755 in 1982 (3 percent). U.S. importers' shipments increased in average price from $134,747 in 1977 to $209,644 in 1982, a 56 percent increase.

The average price of U.S. domestic shipments of vertical spindle NC lathes increased erratically from $243,390 in 1977 to $386,488 in 1982 (72 percent) and the average price of export shipments increased from $256,231 in 1977 to $483,900 in 1982 (89 percent). The average price of U.S. imports of vertical spindle NC lathes increased from $67,071 in 1977 to $209,396 in 1982 (212 percent) and the average price of U.S. importers' shipments increased from $93,125 in 1977 to $262,814 in 1982 (182 percent).

Tables 34-37 show the average prices of U.S. domestic and export shipments and the average prices of U.S. imports and importers' shipments of certain machining centers during the period 1977-82, as reported by questionnaire respondents.

Table 34.--Machining centers: Average price of U.S. domestic shipments, by types, 1977-82

Year	Vertical spindle		Horizontal spindle, Y-axis travel over 40 inches
	Y-axis travel less than 20 inches	Y-axis travel over 26 inches	
1977	$57,244	$140,295	$336,894
1978	59,674	142,623	459,067
1979	65,927	150,953	539,347
1980	73,761	163,200	522,887
1981	80,857	178,211	619,238
1982	85,263	197,743	706,670

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table 35.--Machining centers: Average price of U.S. export shipments, by types, 1977-82

Year	Vertical spindle		Horizontal spindle, Y-axis travel over 40 inches
	Y-axis travel less than 20 inches	Y-axis travel over 26 inches	
1977	$29,667	$156,667	$390,333
1978	59,292	287,091	399,875
1979	72,239	182,933	555,833
1980	76,288	182,483	810,500
1981	71,161	203,333	637,000
1982	103,289	203,000	741,000

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table 36.--Machining centers: Average price of U.S. imports, by types, 1977-82

Year	Vertical spindle		Horizontal spindle, Y-axis travel over 40 inches
	Y-axis travel less than 20 inches	Y-axis travel over 26 inches	
1977	$60,010	$116,000	1/
1978	75,405	121,857	$158,000
1979	77,301	120,800	162,750
1980	75,800	114,667	307,438
1981	77,390	198,253	320,828
1982	74,059	194,123	306,091

1/ Respondents to the Commission's survey reported no imports of this machine tool in 1977.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table 37.--Machining centers: Average price of U.S. importers' shipments, by types, 1977-82

Year	Vertical spindle		Horizontal spindle, Y-axis travel over 40 inches
	Y-axis travel less than 20 inches	Y-axis travel over 26 inches	
1977	$53,368	$138,000	1/
1978	88,649	144,857	$193,000
1979	88,928	140,100	197,667
1980	86,993	135,667	362,272
1981	91,329	224,697	313,389
1982	91,146	232,783	398,833

1/ Respondents to the Commission's survey reported no imports of this machine tool in 1977.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

The average price of U.S. domestic shipments of vertical spindle machining centers with Y-axis travel of less than 20 inches increased 49 percent from $57,244 in 1977 to $85,263 in 1982. The average price of U.S. export shipments increased, except in 1981 when there was a slight decrease, from $29,667 in 1977 to $103,289 in 1982, or by 248 percent. The average price of U.S. imports of vertical spindle machining centers with Y-axis travel of less than 20 inches increased erratically from $60,010 in 1977 to $77,390 in 1981 and decreased to $74,059 in 1982. The average price of U.S. importers' shipments followed the same pattern, increasing erratically from $53,368 in 1977 to $91,329 in 1981, and decreased slightly to $91,146 in 1982.

The average price of U.S. producers' domestic shipments of vertical spindle machining centers with Y-axis travel over 26 inches increased 41 percent during 1977-82 while the average price of export shipments increased 30 percent. The average prices of imports and importers' shipments, during the same period, increased 67 percent and 69 percent, respectively.

The average price of U.S. domestic shipments of horizontal spindle machining centers with Y-axis travel over 40 inches increased erratically from $336,894 in 1977 to $706,670 in 1982. The average price of U.S. exports of this type machine tool increased from $390,333 in 1977 to $810,500 in 1980, decreased to $637,000 in 1981, and increased to $741,000 in 1982. U.S. importers responding to the Commission's survey reported no imports or shipments of horizontal spindle machining centers with Y-axis travel over 40 inches in 1977. During 1978-81, the average price of imports of these types of machines increased from $158,000 to $320,828, and decreased to $306,091 in 1982. The average price of U.S. importers' shipments increased from $193,000 in 1978 to $362,272 in 1980, decreased to $313,389 in 1981, and increased to $398,833 in 1982.

For specific types of machine tools, U.S. producers took immediate steps in reducing the price of their products once they realized that imported machine tools were capturing an increasing share of the market. 1/ Additional steps taken include standardization of parts, assembly line production, increased versatility of the machine tool, and the elimination of special accessories as standard equipment. The results have been better quality machine tools at competitive prices. 2/

In addition, some U.S. producers are starting production of certain machine tools for markets they had previously neglected. These machine tools are standard, instead of custom products, and are designed to be price competitive with foreign-made products. Some U.S. producers have even begun producing some standard machine tools for stock. The high-volume production may not only lower the price of these tools, but may also shorten delivery times. 3/ Despite these recent developments, U.S. machine tool producers are still claiming that sales have been lost to foreign competitors due to price. For example, one prominent U.S. manufacturer allegedly lost a bid to a distributor of foreign made machine tools for a 15-inch, CNC, universal lathe for the U.S. Naval Regional Contracting Center. The U.S. producer's bid was 2.5 times over that of the foreign competitor's. In another instance, a United States firm allegedly lost sales of over $6.5 million over a period of a few years to foreign competition due to price; the majority of this business was lost to a single foreign producer. 4/

One major Japanese machine tool producer has established a show place in California, complete with a lobby, bar, amphitheatre (100 seats), Japanese garden and pool (with retractable roof), restaurant, showroom demonstration floor, conference room, and 36-hole golf course. 5/ This company allegedly

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1/ Industry Week, Aug. 9, 1982, p. 46.
2/ Ibid, and Business Week, Oct. 5, 1981, p. 27.
3/ Commission staff interviews with machine tool manufacturers.
4/ Information submitted by U.S. producers in response to questions about lost sales.
5/ Iron Age, Nov. 1, 1982.

has one pricing strategy for first-time buyers and another for repeat buyers. Reportedly, first-time buyers are offered progressively lower prices until they place an order, whereas repeat orders are accepted at full list price. 1/ The Japanese company is also reportedly setting up a program to place NC lathes into U.S. companies on a no-charge consignment basis. 2/

Marketing

The manner in which a machine tool reaches the end user depends typically on the degree to which it is designed to the end user's specifications. Highly specialized machines are sold primarily direct to the end user, whereas the more standard production machine tools are sold mainly through a distributor network. Approximately two-thirds of the value of U.S. machine tool sales were accounted for by independent distributors, and the remainder, by direct sales. 3/ According to responses to the Commission's questionnaires, the share of U.S. producers' domestic shipments through distributors decreased from 40 percent in 1977 to 32 percent in 1982 and distribution to end users increased from 39 percent in 1977 to 54 percent in 1982. Distribution by other means, mainly through manufacturers' representatives and agents, decreased from 21 percent in 1977 to 14 percent in 1982, as shown in table 38.

Table 38.--Metalworking machine tools: Percentage distribution of U.S. producers' domestic shipments, by market channels, 1977-82

Year	Distributors	End users	All other	Total
1977	40.0	39.0	21.0	100.0
1978	37.4	43.2	19.4	100.0
1979	37.0	43.1	19.9	100.0
1980	37.1	44.7	18.2	100.0
1981	36.9	45.4	17.7	100.0
1982	32.3	54.0	13.7	100.0

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

In contrast, the distribution of U.S. imports of metalworking machine tools through distributors increased from 68 percent in 1977 to 72 percent in 1982; distribution of imported metalworking machine tools to end users decreased from 30 percent in 1977 to 25 percent in 1982. Distribution through manufacturers' representatives and agents increased slightly, from 2 percent in 1977 to 3 percent in 1982, as shown in table 39.

1/ Commission staff interviews with U.S. machine tool company executives and industry analysts.

2/ Ibid.

3/ American Machine Tool Distributors' Association.

Table 39.--Metalworking machine tools: Percentage distribution of U.S. importers' shipments, by market channels, 1977 and 1982

(In percent)

Market channel	1977	1982
Distributors	68.0	72.3
End users	29.6	24.7
Other	2.4	3.0
Total	100.0	100.0

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

According to industry sources, the volume of sales through distributors fluctuates from year to year. In periods of increasing sales, many builders switch to direct sales in order to reduce sales commissions paid to distributors. Conversely, when sales are declining, there is a tendency for machine tool builders to reduce full-time sales staff and turn to independent distributors, who are paid commissions only for the products they sell.

Several basic steps in successful sales are qualifying the immediate sales prospects, demonstrating the product, providing a competitive price and delivery, assuring the customer of effective machine installation, startup and maintenance, and ensuring the availability of parts and service. 1/

Most machine tool builders utilize a combination of direct-sales offices and independent distributors. Direct sales are more likely to take place in areas of high customer concentration, whereas independent distributors are more likely to be used in areas of low-volume sales.

A typical distributor employs about four salespersons and sells about $4 million a year in machine tools, parts, and accessories. 2/ Distributors generally serve specific geographic areas. Independent distributors will typically represent several manufacturers' product lines, both imported and domestic. A distributor will attempt to offer a balanced line (a line from several manufacturers that includes machines to handle a wide variety of machining functions) in a given territory. Often, the sales territory covered will vary with different machines.

The success of a distributor in any given product area depends on the training and ability of the salespersons and on the operations of the machines they handle. 3/ Another important factor is the salesperson's knowledge of the clients in the area. Distributor salespersons must know which companies are using which machines, which companies are expanding current operations or adding new production capacity, which companies are growing, and which companies are not competitive. Often, manufacturers choose a distributor based upon the distributor's knowledge of his local market.

1/ Frost & Sullivan, Inc., The United States Market For Foreign Machine Tools and Parts, New York, N.Y., June 1980, p 32.

2/ American Machine Tool Distributors' Association.

3/ Commission staff interviews with industry executives.

Distributors must have service and spare parts capabilities; therefore, the relationship between the manufacturers and distributors is very important. The manufacturers typically provide product training to distributors' sales and service staff. 1/ They also provide product brochures and other marketing tools, such as video tapes of machine tools in operation. Other key functions provided by the manufacturer are the development of advertising strategy, advertising copy, and other promotional material. The manufacturer will often supplement the distributor's advertisements with its own advertisements in various trade publications.

A recent survey of the machine tool industry showed that the most important marketing device, as viewed by machine tool builders, is trade shows. 2/ Personal calls by sales representatives were rated second, followed closely by product literature. 3/ Of less importance was business publication advertising. Machine tool distributors, however, rated personal visits by sales representatives as the most important marketing tool. 4/ This difference is understandable, considering the distributors' more direct relationship with the end users. Distributors in the Commission's survey placed trade shows third, following product literature, as important marketing tools. 5/ Recently, U.S. distributors have started to diversify both their product lines and services in order to survive in the market. Some machine tool distributors are increasing the competence and size of their technical staffs in order to take on lines of industrial robots, which are increasingly being used in automation in smaller firms. 6/ Other distributors are offering such services as machine tool rentals on short-term contracts, as well as machining seminars and programming courses. 7/

There appear to be four marketing channels through which foreign machine tool manufacturers are penetrating the U.S. market. These are selling through U.S. importers, U.S. dealers, or through the foreign manufacturer's plant salesmen traveling in the United States, and creating a foreign-owned subsidiary in the United States and then sell through U.S. dealers or through the subsidiary's own sales force. 8/ One estimate of the distribution channels of imported machine tools in 1978 is as follows: independent importers, 35 percent; affiliated or subsidiary companies, 46 percent; and direct factory sales, 19 percent. 9/

1/ Ibid.

2/ Water J. Reed, "Three Views of Machine Tool Marketing," Machine Tool Blue Book.

3/ Ibid.

4/ Ibid.

5/ Ibid.

6/ Stuart F. Brown, "Adapting to Robot Markets," American Metal Market-Machine Tool Distributor Section, Apr. 11, 1983, p. 20.

7/ Bruce Vernyi, "Hard Times Spur Market Changes," American Metal Market-Machine Tool Distribution Section, Apr. 11, 1983, p. 22.

8/ Frost & Sullivan, Inc., The United States Market For Foreign Machine Tools and Parts, New York, N.Y. June 1980, pp. 32-35.

9/ Ibid., p. 11.

The importer usually handles a large number of machine tool lines, several of which are produced by different manufacturers which may be in direct competition with each other. The importer usually provides a number of services for the customer such as business functions (quotation preparation, invoicing, and customer service and so forth); machine installation, field service and handling the warranty; and inventory of parts.

The importer also arranges foreign exchange transactions and financing through both U.S. and foreign banking contacts. Financing is arranged for the foreign machine tool manufacturer by the importer, which usually saves the manufacturer financing costs. However, as in 1980, when there were high interest rates, importers faced risks in the areas of foreign exchange, forward exchange contracts, and financing. 1/ Forward exchange contracts cover the dollar price of machines which are to be delivered in the future. When the contract comes due, the importer must purchase the machine or else pay penalties. Several reasons why an importer may incur losses on forward exchange contracts are late delivery, delayed installation, and withheld or delinquent payment by the customer. 2/ Importers, however, offer to foreign manufacturers the benefit of easy access to the U.S. market through the importer's sales force, dealers, and distributors. 3/ By selling different lines, the importer has a wide variety of contacts both with suppliers and in the marketplace, thus allowing a manufacturer easy access to a market without having to build a distribution channel.

Some foreign manufacturers have expressed the view that importers do not provide satisfactory sales coverage and that business functions, such as invoicing and foreign exchange, are duplications which can be handled at the foreign manufacturer's headquarters. 4/ Some foreign manufacturers have established their own U.S. sales companies for direct sales. These companies are usually staffed by a resident manager (generally from the foreign builder's plant) and a number of service engineers, sometimes U.S. nationals. 5/ Since sales volume is frequently insufficient to justify the existance of a sales office which would cover all major market locations, the foreign manufacturer might also decide to establish a dealer network.

Several trends appearing in the U.S. metalworking machine tool industry that probably affect the marketing structure in the United States are the use of foreign-built components and subassemblies in U.S.-made machine tools, licensing agreements which lead to the building of foreign-designed and specified machine tools in the United States, and foreign manufacturers building their own machines in the United States. 6/ Currently, a growing number of foreign firms are manufacturing, or at least assembling, machine tools in the United States. In September 1982, for example, the West German machine tool builder Scharmann GmbH & Co. set up an assembly plant for its line of horizontal machining centers in Carol Stream, Ill. Scharmann's U.S.

1/ Ibid., pp. 230 and 231.
2/ Ibid.
3/ Ibid., p. 83.
4/ Frost & Sullivan, Inc., The United States Market For Foreign Machine Tools and Parts, New York, N.Y., June 1980, p. 232.
5/ Ibid., p. 85.
6/ Robert A. Gale, "Distributors Are Prepared for Era of Global Tools," American Metal Market, June 27, 1983, p. 30.

sales are handled through the same distributor networks the company used before setting up assembly operations in the United States. 1/ Also, in late summer of 1982, three other West German machine tool builders established operations, including assembly, in the United States--Gebr. Heller Maschinenfabrik GmbH, Schiess AG, and Nuertingen. 2/ Currently, at least five West German manufacturers have production operations in the United States, and about eight have assembly operations. 3/ In February 1983, five Swiss machine tool builders established a cooperative and servicing center in Rhode Island, with possible assembly operations at a later date. 4/ Japanese metalworking machine tool builders are also establishing production and assembly operations in the United States. Yamazaki Machinery Works Ltd. owns Mazak Corp. in Kentucky and will produce up to 60 units a month in 1984. Yamazaki started production in the United States as part of its long-range planning, expecting current lower Japanese labor costs to someday equal U.S. labor costs. 5/ Makino Milling Machine Co. Ltd. established U.S. production in 1981 by acquiring majority ownership of the U.S. firm, LeBlond. Hitachi Seiki Co. Ltd. assembles NC lathes in New York. Mitsubishi Heavy Industries Ltd., and Toyoda Machine Works Ltd. are producing in the United States through license agreements with U.S. machine tool manufacturers. The idea of producing in the United States is viewed in Japan as an alternative to confronting U.S. protectionist moods. 6/

Another recent development is the trend toward the establishment in the United States of sales offices for a group of companies. For example, MFL Machine Tool Inc. was established in Connecticut for sales and servicing for four French firms: Forest, Line, Saint-Etienne, and Berthiez. Both the Spanish Machine Tool Builders' Association and the Italian Machine Tool Builders Association have established offices in the United States in order to promote their members' machine tools.

The U.S. metalworking machine tool industry has not traditionally oriented its marketing efforts toward exporting its products. After World War II, the U.S. machine tool industry typically produced the most technologically advanced machine tools of any producing country. Foreign purchasers sought out U.S. machine tools to fill their needs, and there was no need for U.S. producers to aggressively market their products overseas. In addition, the U.S. market was large enough to accomodate almost all U.S. production. However, in 1945, a group of U.S. machine tool manufacturers formed American Machine Tool Export Associates (AMTEA) to promote the sale of their products throughout Latin America. AMTEA was initially organized to comply with the Webb-Pomerene Act, which permits associations of manufacturers

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1/ "Germany's Scharmann Sets Ill. Base for Operations," American Metal Market, Sept. 27, 1982, p. 12.

2/ Ibid.

3/ Commission staff interviews with corporate officials.

4/ "Swiss Builders Plan Office in Rhode Island," American Machinist, February 1983, p. 31.

5/ Mutsuki Murakami, "Voluntary Curbs Likely," American Metal Market-Japanese Machine Tools Supplement, July 11, 1983, p. 3A.

6/ Ibid.

or producers to be formed for export trading activities. 1/ However, the organization withdrew from incorporation under the Act in 1958. AMTEA originally promoted the sale of member company products through local representatives in Latin American countries. Currently, the corporation maintains a network of branch offices in Argentina, Brazil, Chile, and Mexico. The branch offices have fully qualified service personnel for installation and servicing of equipment. AMTEA is made up of 11 stockholding companies and 11 affiliated companies. 2/

THE U.S. MARKET

Description of the Market

The United States is the largest single market for metalworking machine tools in the world. The market grew during 1977-81, before declining in 1982. A significant portion of the market was taken by imports as backlogs of orders in U.S. production facilities increased. U.S. manufacturers have recently taken action to counteract increased import penetration, especially in the area of small, standard NC machine tools.

Consumption

In 1977, the United States was the second largest consumer of machine tools in the world, with consumption valued at $2.4 billion. The Soviet Union was the world leader, with consumption at $2.8 billion. 3/ In 1978, the United States became the leading consumer of metalworking machine tools in the world and has since maintained that position. U.S. consumption increased from $3.2 billion in 1978 to $5.6 billion in 1981, and decreased to $4.4 billion in 1982. 4/

Major factors influencing the dramatic increase in metalworking machine tool consumption in the United States between 1977 and 1981 were the retooling of the U.S. automobile industry and the aircraft industry and heavy demand from producers of oil and gas equipment. As indicated in table 40, capital expenditures in these industries increased significantly from 1977 to 1981, placing heavy demand on machine tool manufacturers. The automobile and aerospace industries were developing new, fuel-efficient motor vehicles and aircraft, and the oilfield machinery industry was meeting worldwide demand for threaded oil well casings and related products.

1/ 15 U.S.C. 61-66.
2/ American Machine Tool Export Associates.
3/ American Machinist, February issues, 1978-83.
4/ Ibid.

Table 40.--Capital expenditures in the U.S. aerospace, automobile, and oil field machinery industries, 1977-82

(In billions of dollars)

Year	Aerospace industry	Automobile industry	Oil field machinery	Total
1977	2.01	5.82	0.26	8.09
1978	3.22	7.22	.30	10.74
1979	5.27	8.30	0.38	13.95
1980	7.03	9.06	0.46	16.55
1981	6.43	10.08	1/ 0.35	1/ 16.86
1982	6.04	1/ 8.22	1/ 0.25	1/ 14.51

1/ Bureau of Economic Analysis projection, U.S. Department of Commerce.

Source: Aerospace Industries Association, Motor Vehicle Manufacturers Association, and the U.S. Department of Commerce.

U.S. purchasers of metalworking machine tools responding to the Commission's survey were basically in those industries that purchase the specialized machine tools in which U.S. producers have a competitive advantage. They indicated an overwhelming preference for U.S.-made machine tools, as is evidenced by comparing data in table 41 with those in table 42. During 1977-82, respondents purchased 4.7 billion dollars' worth of U.S.-made machine tools and 178 million dollars' worth of imported machine tools.

The major purchasers of foreign-made "off-the-shelf" machine tools, such as lathes and machining centers, are the thousands of job shops, which, because of their number, were not contacted for this study. These small businesses account for the bulk of foreign machine tool purchases in the United States.

The machine tool market grew during 1977-81 by 243 percent, and the ratio of U.S. imports to apparent consumption rose from 17 to 27 percent. In 1982, U.S. imports constituted 29 percent of apparent U.S. consumption. Domestic producers' U.S. market share decreased from 83 percent in 1977 to 73 percent in 1981, and decreased further in 1982 to 70 percent.

Analysis of Interaction of Domestic and Foreign Products in the U.S. Market

U.S. machine tool producers have historically relied on backlogs of orders to get them through periods of weak demand. The size of the U.S. market and import levels of the period up through the mid-1970's allowed U.S. producers to become accustomed to this buffer of backlogged orders. At the end of 1976, the net new-order backlog of the U.S. industry was valued at $1.5

billion. 1/ This backlog increased dramatically during the next 4 years and peaked at $5.9 billion in April-June 1980. 1/ The demand represented by this significant backlog was equivalent to approximately 111 percent of the value of total U.S. consumption in 1980 and was more than 2 times that of total consumption of machine tools in Japan in the same year. 2/

During the 1970's, competition among Japanese NC machine tool builders intensified as industries purchased more and more NC machine tools to offset energy and labor cost increases. This intense competition led to lower prices for machine tools, and innovations in electronics led to lower prices for NC control units. The result was low-priced, competitive NC machine tools.

With order backlogs in the United States increasing in the late 1970's, there was ample opportunity for foreign-made machine tools to gain a greater share of the U.S. market. This was particularly true in the area of small, standard NC machine tools, a product line that American manufacturers had tended to neglect. 3/ As a result, these Japanese-made machine tools, which were (and still are today) technologically comparable with U.S.-made machine tools, gained a significant share of the U.S. market.

There is indication, however, that U.S. machine tool manufacturers are beginning to reenter this large market for small NC machine tools. Some U.S. producers have taken their high-priced, over engineered machine tools that were not competitive and reengineered them and have succeeded in placing good quality, price-competitive machine tools on the market. 4/ U.S. builders recently displayed small- and medium-sized NC lathes at a show in Hanover, West Germany, some of which were priced lower than the comparable Japanese lathes. 5/ The increase in imports, as described earlier, seems to have stimulated some U.S. producers into intense competitive efforts. 6/ In fact, in response to the Commission's survey, U.S. machine tool builders stated that cost reduction and improved quality of the product were the top two actions taken in response to foreign competition in both the U.S. and foreign markets. Other actions taken by producers included reducing or stopping production of noncompetitive products, shifting production to more advanced types of machine tools, and eliminating plans to increase production capacity. A few producers responded by importing the competitive products or opening overseas production facilities.

1/ NMBTA.
2/ American Machinist, February 1981, p. 96.
3/ Ibid., September 1979, p. 117.
4/ Industry Week, Aug. 9, 1982, p. 46.
5/ The Japan Economic Journal, Industrial Review of Japan/1982, March 1982, p. 91.
6/ Anderson Ashburn, American Machinist, November 1980, p. 5.

Table 41.--Metalworking machine tools: U.S. purchasers' consumption of U.S.-produced articles, by major types, 1977-82

Item	1977	1978	1979	1980	1981	1982
	Quantity (units)					
Metal-removing machine tools	4,481	5,182	4,830	5,041	4,097	2,952
Metal-forming machine tools	818	869	971	1,060	841	720
Total	5,299	6,051	5,801	6,101	4,938	3,672
	Value (1,000 dollars)					
Metal-removing machine tools	522,988	673,413	617,653	625,356	773,656	805,082
Metal-forming machine tools	79,427	101,649	133,872	120,747	143,622	151,059
Total	602,415	775,062	751,525	746,103	917,278	956,141

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table 42.--Metalworking machine tools: U.S. purchasers' consumption of imported articles, by major types, 1977-82

Item	1977	1978	1979	1980	1981	1982
	Quantity (units)					
Metal-removing machine tools	129	126	152	240	190	182
Metal-forming machine tools	21	24	36	26	28	59
Total	150	150	188	266	218	241
	Value (1,000 dollars)					
Metal-removing machine tools	12,714	12,259	22,507	37,180	20,397	28,942
Metal-forming machine tools	8,880	4,643	4,470	3,965	19,525	2,521
Total	21,594	16,902	26,977	41,144	39,922	31,463

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Future Trends

Next-Generation Products

Flexible manufacturing systems are becoming increasingly important as a means of production in manufacturing industries. The ability of the machine tool industry to compete in world markets will depend to a great extent on the ability of the industry to provide FMS to those purchasers who demand it. The efficient use of CAD/CAM in conjunction with FMS will enable an engineer to design a part on a CRT and initiate production of the part almost immediately, without setting foot on the shop floor. The Japanese are already very close to having such a system in operation. 1/ Only the largest machine tool manufacturers with high-volume production and the necessary capital will adopt FMS to their own use. Smaller machine tool builders will increase their use of machining cells and NC machine tools.

A very important part of these types of systems are the units that control the motion of the machine tools. Some U.S. industry observers believe that the United States has fallen behind in control technology. 2/ Others, however, believe that U.S. producers have an advantage in this area, because U.S.-made controllers are more flexible due to their modular design. 3/

In response to the Commission's survey, U.S. purchasers of metalworking machine tools provided the information shown in table 43 regarding future purchases of both domestic and foreign-made metalworking machine tools.

Table 43.--Metalworking machine tools: U.S. purchasers' estimated future consumption, 1983-90

Year	Number of units	Value	Number of reponses
		1,000 dollars	
1983	2,872	752,645	87
1984	2,457	634,168	84
1985	2,627	909,215	71
1986	1,500	485,234	56
1987	1,620	534,905	43
1988	1,115	433,383	36
1989	1,099	427,007	33
1990	983	405,530	32

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

As reported in the Commission's questionnaire, both the number and value of future purchases decline markedly after 1985 (the peak year), and the projected values of future purchases are well below the actual value of

1/ Metalworking Engineering and Marketing, January 1983, p. 31.

2/ The Competitive Status of the U.S. Machine Tool Industry, National Academy Press, 1983, p. 52.

3/ Commission staff interviews with U.S. machine tool company executives.

reported purchases in 1982. However, when the units and value are stated as a ratio of the number of responses, units per response vary between 27 and 38 during 1983-90, and the value per response varies between $7.6 million and $12.9 million, with values of over $12 million in every year after 1986. Although table 43 appears to confirm industry and U.S. Department of Commerce forecasts of a decrease of approximately 30 percent in shipments in 1983 (and shows an even further decline in 1984), respondents indicate that consumption will increase significantly in 1985 and remain at a high level through 1990, with the exception of 1986. Most purchasers revealed that capital expenditures beyond a 3-year projection were difficult to ascertain because of company policy. Some also stated that the state of the economy would play a significant role in determining future purchases.

The increasing use of new materials, such as composites and ceramics, will have an impact on both machine tool technology and demand for machine tools. The use of ceramics, for instance, "could eliminate the need for some of the metal drilling, bending, and welding that robots and so-called flexible manufacturing systems are designed for." 1/

1/ John W. Dizard, "The Amazing Ceramic Engine Draws Closer," Fortune, Jul. 25, 1983, p. 79.

APPENDIX A

NOTICES OF INSTITUTION AND TERMINATION OF PREVIOUS MACHINE TOOL INVESTIGATION NO. 332-138 AND NOTICES OF INSTITUTION AND MODIFICATION OF INVESTIGATION NO. 332-149

study, written statements should be submitted at the earliest practicable date, but no later than June 30, 1982. All submissions should be addressed to the Secretary, United States International Trade Commission, 701 E Street NW., Washington, D.C. 20436.

By order of the Commission.

Issued: February 11, 1982.

Kenneth R. Mason,

Secretary.

[FR Doc. 82-4405 Filed 2-17-82; 8:45 am]

BILLING CODE 7020-02-M

[332-138]

Competitive Assessment of the U.S. Metalworking Machine Tool Industry

AGENCY: International Trade Commission.

ACTION: The Commission, on its own motion, instituted investigation No. 332-138, under section 332(b) of the Tariff Act of 1930 (19 U.S.C. 1332(b)), for the purpose of gathering and presenting information on the competitive position of the U.S. metalworking machine tool industry. This study will assess the impact of the growing competition from imports on the U.S. metalworking machine tool industry, explore the related development of further competition in the industry's overseas markets, and examine the steps that have been taken and may be taken to counteract these developments.

EFFECTIVE DATE: February 5, 1982.

FOR FURTHER INFORMATION CONTACT: Mr. Donald M. Terry, Machinery and Equipment Division, U.S. International Trade Commission, Washington, D.C. 20436 (telephone 202-523-0262 or 202-523-0169).

WRITTEN SUBMISSIONS: While there is no public hearing scheduled for this study, written submissions from interested parties are invited. Commercial or financial information which a party desires the Commission to treat as confidential must be submitted on separate sheets of paper, each clearly marked "Confidential Business Information" at the top. All submissions requesting confidential treatment must conform with the requirements of § 201.6 of the Commission's rules of practice and procedure (19 CFR 201.6). All written submissions, except for confidential business information, will be made available for inspection by interested persons. To be assured of consideration by the Commission in this

INTERNATIONAL TRADE COMMISSION

[Investigation No. 332-138]

Competitive Assessment of the U.S. Metalworking Machine Tool Industry; Termination of Investigation

AGENCY: International Trade Commission.

ACTION: Termination of investigation.

EFFECTIVE DATE: April 7, 1982.

BACKGROUND: The Commission, on its own motion, instituted, effective February 5, 1982, investigation No. 332-138, under section 332(b) of the Tariff Act of 1930 (19 U.S.C. 1332(b)), for the purpose of gathering and presenting information on the competitive position of the U.S. metalworking machine tool industry. This study was to assess the impact of the growing competition from imports on the U.S. metalworking machine tool industry, explore the related development of further competition in the industry's overseas market, and examine the steps that have been taken and may be taken to counteract these developments.

Because of changes in workload and staffing limitations, it is not feasible for the Commission to continue the subject investigation at this time. Therefore, the Commission, on its own motion, has hereby terminated the subject investigation.

Notice of the institution of the investigation was published in the **Federal Register** of February 18, 1982 (47 FR 7350).

Issued: April 8, 1982.

By order of the Commission.

Kenneth R. Mason,

Secretary.

[FR Doc. 82-10246 Filed 4-13-82; 8:45 am]

BILLING CODE 7020-02-M

Written Submissions: While there is no public hearing scheduled for this study, written submissions from interested parties are invited. Commercial or financial information which a party desires the Commission to treat as confidential must be submitted on separate sheets of paper, each clearly marked "Confidential Business Information" at the top. All submissions requesting confidential treatment must conform with the requirements of § 201.6 of the Commission's *Rules of Practice and Procedure* (19 CFR 201.6). All written submissions, except for confidential business information, will be made available for inspection by interested persons. To be ensured of consideration by the Commission, written statements should be received by the close of business on February 1, 1983. All submissions should be addressed to the Secretary, United States International Trade Commission, 701 E Street NW., Washington, D.C. 20436.

Issued: December 3, 1982.

By order of the Commission.

Kenneth R. Mason,

Secretary.

[FR Doc. 82-33471 Filed 12-7-82; 8:45 am]

BILLING CODE 7020-02-M

[332-149]

Competitive Assessment of the U.S. Metalworking Machine Tool Industry

AGENCY: United States International Trade Commission.

ACTION: The Commission, on its own motion, instituted investigation No. 332-149, under section 332(b) of the Tariff Act of 1930 (19 U.S.C. 1332(b)), for the purpose of gathering and presenting information on the competitive position of the U.S. metalworking machine tool industry. This study will examine the factors affecting the present and future international competitive position of U.S. metalworking machine tool producers. It will assess the impact of the growing competition from imports on the U.S. metalworking machine tool industry, explore the related development of further competition in the industry's overseas markets, and examine the steps that have been taken and may be taken to counteract these developments.

SUMMARY:

Background

A previous investigation of the same scope and subject matter was instituted on February 5, 1982, and notice of institution was published in the Federal Register of February 18, 1982 (47 FR 7350). However, because of changes in workload and staffing limitations, that investigation was terminated on April 7, 1982, and notice of termination was published in the Federal Register of April 14, 1982 (47 FR 16125).

EFFECTIVE DATE: December 1, 1982.

FOR FURTHER INFORMATION CONTACT: Mr. Charles M. West or Mr. Ronald DeMarines, Machinery and Equipment Division, U.S. International Trade Commission, Washington, D.C. 20436 (telephone 202-523-0299 or 202-523-0259).

INTERNATIONAL TRADE COMMISSION

[332-149]

Competitive Assessment of the U.S. Metalworking Machine Tool Industry

AGENCY: United States International Trade Commission.

ACTION: The Commission is extending the deadline for the filing of written submissions from interested parties in the subject investigation from February 1, 1983 to March 1, 1983. Supplemental submissions from parties having already filed written briefs will be accepted. The initial notice of investigation indicating the scope of the study, contact persons, and other related information was published in the Federal Register of December 8, 1982 (47 FR 55343).

By order of the Commission.

Issued: February 7, 1983.

Kenneth R. Mason,

Secretary.

[FR Doc. 83-4075 Filed 2-14-83; 8:45 am]

BILLING CODE 7020-02-M

Issued: April 11, 1983.

Kenneth R. Mason,

Secretary.

[FR Doc. 83-10469 Filed 4-19-83; 8:45 am]

BILLING CODE 7020-02-M

[332-149]

Competitive Assessment of the U.S. Metalworking Machine Tool Industry.

AGENCY: International Trade Commission.

ACTION: The Commission will hold a public hearing for the purpose of affording all interested parties an opportunity to present views on the competitive position of the U.S. metalworking machine tool industry. The initial notice of the investigation indicating the scope of the study, contact persons, and other related information was published in the Federal Register of December 8, 1982 (47 FR 55343); notice of the Commission's extension of the deadline for the filing of written submissions from interested parties was published in the Federal Register of February 15, 1983 (48 FR 6793).

Public Hearing: A public hearing in connection with the investigation will be held in the Commission Hearing Room, 701 E Street NW., Washington, D.C. 20436, beginning at 10:00 a.m., e.d.t., on June 28, 1983, to be continued on June 29, 1983, if required. All persons shall have the right to appear by counsel or in person, to present information and to be heard. Requests to appear at the public hearing should be filed with the Secretary, United States International Trade Commission, 701 E Street NW., Washington, D.C. 20436, not later than June 21, 1983.

Written Submissions: In lieu of or in addition to appearance at the public hearing, interested persons are invited to submit written statements concerning the investigation by June 25, 1983. Commercial or financial information which a submitter desires the Commission to treat as confidential must be submitted on separate sheets of paper, each clearly marked "Confidential Business Information" at the top. All submissions requesting confidential treatment must conform with the requirements of § 201.6 of the Commission's *Rules of Practice and Procedure* (19 CFR 201.6). All written submissions, except for confidential business information, will be made available for inspection by interested persons. All submissions should be addressed to the Secretary at the Commission's office in Washington, D.C.

By order of the Commission.

APPENDIX B

CALENDAR OF PUBLIC HEARING

CALENDAR OF PUBLIC HEARING

Those listed below appeared as witnesses at the United States International Trade Commission's hearing:

Subject : Competitive Assessment of the U.S. Metalworking Machine Tool Industry

Inv. No. : 332-149

Date and time: June 28, 1983 - 10:00 a.m.

Sessions were held in the Hearing Room of the United States International Trade Commission, 701 E Street, N.W., in Washington.

Domestic:

Covington & Burling--Counsel
Washington, D.C.
on behalf of

The National Machine Tool Builders' Association

FIRST PANEL:

W. Paul Cooper, Chairman of the Board, Acme-Cleveland Corporation

Charles E. Gilbert, Jr., President, The Cincinnati Gilbert Machine Tool Co.

James A. Gray, President, National Machine Tool Builders' Association

SECOND PANEL:

Nathaniel S. Howe, Senior Vice President and Group Executive, Machine Tool Systems Group, Litton Industries, Inc.

Richard T. Lindgren, President and Chief Executive Officer, Cross & Trecker Corporation

Michael W. Davis, President, White-Sundstrand Machine Tool Company

John T. Smith, II)
Harvey M. Appelbaum)--OF COUNSEL
Lawrence T. MacNamara, Jr.)

- more -

Cravath, Swaine & Moore--Counsel
New York, N.Y
on behalf of

Cincinnati Milacron

Jack J. Earl, General Counsel and Secretary

Joseph R. Sahid--OF COUNSEL

Covington & Burling--Counsel
Washington, D.C.
on behalf of

Houdaille Industries, Inc.

John Latona, Vice President-Law

Richard D. Copaken)
Michael P. Richman)--OF COUNSEL
Oscar Garibaldi)

Blodgett & Blodgett--Counsel
Worcester, Massachusetts
on behalf of

New England Butt Company

Norman S. Blodgett--OF COUNSEL

Importers:

Rode & Qualey--Counsel
New York, N.Y.
Opton, Handler, Gottlieb & Feiler--Counsel
New York, N.Y.
on behalf of

Agietron Corporation

James A. Miller, National Sales Manager

Rode & Qualey

Patrick D. Gill-- OF COUNSEL

Opton, Handler, Gottlieb & Feiler

Lloyd B. Gottlieb--OF COUNSEL

Wender, Murase & White--Counsel
Washington, D.C.
on behalf of

The Japan Machine Tool Builders' Association
The Japan Metal Forming Machine Builders' Association
The Japan Machinery Exporters' Association

Dr. Harald B. Malmgren, Economic Consultant

Dr. Sarvel Rosenblatt

Carl J. Green--OF COUNSEL

Barnes, Richardson & Colburn--Counsel
Washington, D.C.
on behalf of

The German Machine Tool Builders' Association
(Verein Deutscher Werkzeugmachinenfabriken e.V.) of
Frankfurt, West Germany

Dr. Fred Steiner, Counsel

Edward E. Martin, Economic Consultant,
E. E. Martin Associates

Gunter von Conrad--OF COUNSEL

H. Henning Vent--Counsel
Bethesda, Maryland
on behalf of

European Committee for Cooperation of the
Machine Tool Industries (CECIMO)

Lucien Rama, Secretary General

H. Henning Vent--OF COUNSEL

Arnold & Porter--Counsel
Washington, D.C.
on behalf of

The Machine Tool Importers Association of America (MTIAA)

Stephen A. Lazinsky, President

Mark J. Spooner--OF COUNSEL

APPENDIX C

PORTIONS OF THE TARIFF SCHEDULES OF THE UNITED STATES ANNOTATED (1983) RELATING TO U.S. IMPORT CLASSIFICATIONS OF METALWORKING MACHINE TOOLS

Explanation of the rates of duty applicable to metalworking machine tools and parts

The rates of duty in column 1 are most-favored-nation (MFN) rates, and are applicable to imported products from all countries except those Communist countries and areas enumerated in general headnote 3(f) of the TSUSA. 1/ However, such rates do not apply to products of developing countries which are granted preferential tariff treatment under the Generalized System of Preferences (GSP) or under the "LDDC" column.

The rates of duty in the "LDDC" column are preferential rates (reflecting the full U.S. MTN concession rate for a particular item without staging of duty reductions) and are applicable to products of the least developed developing countries designated in general headnote 3(d) of the TSUSA which are not granted duty-free treatment under the GSP. If no rate of duty is provided in the "LDDC" column for a particular item, the column 1 rate applies.

The rates of duty in column 2 apply to imported products from those Communist countries and areas enumerated in general headnote 3(f) of the TSUSA.

The GSP is a program of nonreciprocal tariff preferences granted by the United States to developing countries to aid their economic development by encouraging greater diversification and expansion of their production and exports. The GSP, implemented by Executive Order No. 11888, of November 24, 1975, applies to merchandise imported on or after January 1, 1976, and is scheduled to remain in effect until January 4, 1985. It provides for duty-free treatment of eligible articles imported directly from designated beneficiary developing countries. Eligible articles are identified in the column marked "GSP" with an "A" or "A*." The designation "A" means that all beneficiary developing countries are eligible for the GSP, and "A*" indicates that certain developing countries, specified in general headnote 3(c) of the TSUSA, are not eligible.

1/ The only Communist countries currently eligible for MFN treatment are the People's Republic of China, Hungary, Romania, and Yugoslavia.

GSP	Item	Stat. Suffix	Articles	Units of Quantity	Rates of Duty		
					1	LDDC	2
			Subpart F. - Machines for Working Metal, Stone, and Other Materials				
			Subpart F headnotes: 1. For the purposes of this subpart -- (a) the term "machine tool" means any machine used for shaping or surface-working -- (i) metals (including metallic carbides); (ii) stone, ceramics, concrete, asbestos-cement and like mineral materials, or glass in the cold; or (iii) wood, cork, bone, hard rubber or plastics, or other hard materials, whether by cutting away or otherwise removing the material or by changing its shape or form without removing any of it, but does not include rolling mills (item 674.20) or the hand-directed or -controlled tools provided for in items 674.60 and 674.70 of this subpart and in item 683.20 of part 5 of this schedule; and (b) the term "metal-working" includes metallic-carbide-working.				
			Subpart F statistical notes: 1. For the purposes of this subpart -- (a) "Metal-removing (metal-cutting) machine tools" are metal-working machine tools which shape or surface-work metal by removing metal either in the form of chips, dust, swarf or similar forms or by spark-erosion, ultrasonic, electrolytic, or other chipless methods; and (b) "Metal-forming machine tools" are metal-working machine tools other than metal-removing (metal-cutting) machine tools. 2. In the provisions for machining centers, report machine tools for working metal which can carry out different types of machining operations by automatic tool change whether or not from an indexing turret. 3. In the provisions for single-station machines and multistation transfer machines, report machine tools for working metal, classifiable in item 674.32, which can carry out different types of machining operations by automatic use, simultaneously or sequentially, of different unit heads working on a fixed-position workpiece (single-station machines) or on a workpiece which is automatically transferred to different unit heads (multistation transfer machines).				

GSP	Item	Stat. Suffix	Articles	Units of Quantity	Rates of Duty 1	LDDC	2
A	674.10		Converters, ingot molds, and casting machines, all the foregoing of types used in metallurgy and in metal foundries, and parts thereof	.....	2.3% ad val.	Free	35% ad val.
			Casting machines:				
		10	Die-casting machines	No.			
		15	Other	No.			
		40	Other	X			
A	674.20	00	Metal rolling mills and parts thereof	X.....	6.2% ad val.	4.9% ad val.	30% ad val.
			Machine tools:				
			Metal-working machine tools:				
A	674.30		Machine tools for cutting or hobbing gears	.....	7.9% ad val.	5.8% ad val.	40% ad val.
		15	Used or rebuilt	No.			
			Other:				
		25	Gear hobbers	No.			
		35	Gear shapers	No.			
		45	Other	No.			
A	674.32		Boring, drilling, and milling machines, including vertical turret lathes	.....	5.1% ad val.	4.2% ad val.	30% ad val.
			Machining centers:				
			Without indexing turret or automatic head-changing capability:				
			Vertical-spindle machines with a Y-axis travel of:				
		04	Not over 26 inches (660 mm)	No.			
		06	Over 26 inches (660 mm)	No.			
		09	Other	No.			
		11	Other	No.			
		12	Single-station machines and multistation transfer machines	No.			
		13	Way-type machines	No.			
			Combination boring, drilling, and milling machines:				
		15	Used or rebuilt	No.			
			Other:				
			With numerical controls or facings for numerical controls:				
			Horizontal spindle:				
		17	Table type, excluding planer type	No.			
		18	Other	No.			
		19	Other	No.			
			Other:				
		22	Horizontal spindle	No.			
		23	Other	No.			

Note: For explanation of the symbol "A" or "A*" in the column entitled "GSP", see general headnote 3(c).

GSP	Item	Stat. Suffix	Articles	Units of Quantity	Rates of Duty 1	LDDC	2
			Machine tools (con.):				
			Metal-working machine tools (con.):				
A	674.32 (con.)		Boring, drilling, and milling machines, including vertical turret lathes (con.):				
			Drilling machines:				
		26	Used or rebuilt.....	No.			
		27	Other, valued under $2,500 each.....	No.			
			Other:				
		28	With numerical controls or facings for numerical controls.....	No.			
			Other:				
		29	Multiple spindle.....	No.			
			Other:				
		34	Radial.....	No.			
		36	Upright, excluding sensitive (hand-directed), turret, and deep-hole machines.....	No.			
		42	Other.....	No.			
			Milling machines:				
		61	Used or rebuilt.....	No.			
		62	Other, valued under $2,500 each.....	No.			
			Other:				
		64	With numerical controls or facings for numerical controls.....	No.			
			Other:				
		66	Profile, duplicating, and die sinking.....	No.			
		67	Knee type.....	No.			
		68	Bed type.....	No.			
		69	Other.....	No.			
			Boring machines, including vertical turret lathes:				
		72	Used or rebuilt.....	No.			
		73	Other, valued under $2,500 each.....	No.			
			Other:				
			Vertical machines:				
		76	With numerical controls or facings for numerical controls.....	No.			
		77	Other.....	No.			
			Other:				
		81	With numerical controls or facings for numerical controls.....	No.			
		83	Other.....	No.			

Note: For explanation of the symbol "A" or "A*" in the column entitled "GSP", see general headnote 3(c).

GSP	Item	Stat. Suffix	Articles	Units of Quantity	Rates of Duty		
					1	LDDC	2
			Machine tools (con.):				
			Metal-working machine tools (con.):				
A*	674.35		Other.....	.....	6% ad val.	4.4% ad val.	30% ad val.
			Metal-removing (metal-cutting) machine tools:				
			Lathes:				
		02	Used or rebuilt.....	No.			
		03	Other, valued under $2,500 each.....	No.			
			Other:				
			Horizontal:				
			With numerical controls or facings for numerical controls and with a rated horsepower of:				
		07	Less than 25.....	No.			
		09	25 to 50.....	No.			
		11	Over 50.....	No.			
			Other:				
		12	Engine or toolroom.....	No.			
			Automatic chucking machines:				
		13	Single spindle....	No.			
		14	Multiple spindle....	No.			
			Automatic bar machines:				
		15	Single spindle....	No.			
		16	Multiple spindle....	No.			
		18	Other.....	No.			
			Other lathes:				
		21	With numerical controls or facings for numerical controls.....	No.			
		22	Other.....	No.			

Note: For explanation of the symbol "A" or "A*" in the column entitled "GSP", see general headnote 3(c).

GSP	Item	Stat. Suffix	Articles	Units of Quantity	Rates of Duty 1	Rates of Duty LDDC	Rates of Duty 2
			Machine tools (con.):				
			Metal-working machine tools (con.):				
A*	674.35 (con.)		Other (con.):				
			Metal-removing (metal-cutting) machine tools (con.):				
			Machine tools for deburring, sharpening, grinding, honing, lapping, polishing, or otherwise finishing metal by means of grinding stones, wheels, abrasives or polishing products:				
		24	Used or rebuilt.....	No.			
		26	Other, valued under $2,500 each.....	No.			
			Other:				
		27	Gear-tooth grinding and finishing machines.....	No.			
			Sharpening (tool or cutter grinding) machines:				
		28	With numerical controls or facings for numerical controls.....	No.			
		29	Other.....	No.			
		33	Honing or lapping machines.....	No.			
			Flat-surface grinding machines, in which the positioning of any one axis can be set up to an accuracy of at least 0.01 mm (0.0004 in.):				
		39	With numerical controls or facings for numerical controls.....	No.			
			Other:				
		41	Reciprocating-table type.....	No.			
		43	Other.....	No.			
			Other machines, in which the positioning of any one axis can be set up to an accuracy of at least 0.01 mm (0.0004 in.).....	No.			
		46	With numerical controls or facings for numerical controls.....	No.			
			Other:				
		54	External cylindrical, including universal.....	No.			
		56	Internal cylindrical.....	No.			
		58	Other.....	No.			
		59	Other.....	No.			

Note: For explanation of the symbol "A" or "A*" in the column entitled "GSP", see general headnote 3(c).

GSP	Item	Stat. Suffix	Articles	Units of Quantity	Rates of Duty 1	Rates of Duty LDDC	Rates of Duty 2
			Machine tools (con.):				
			Metal-working machine tools (con.):				
A*	674.35 (con.)		Other (con.):				
			Metal-removing (metal-cutting) machine tools (con.):				
			Spark-erosion, ultrasonic, electrolytic or other metal-removing (metal-cutting) machine tools using chipless methods:				
			Electrical discharge machines:				
		62	Traveling wire.....	No.			
		64	Other.....	No.			
			Other:				
		67	With numerical controls or facings for numerical controls.....	No.			
		71	Other.....	No.			
			Other metal-removing (metal-cutting) machine tools:				
		73	Used or rebuilt.....	No.			
		74	Other, valued under $2,500 each.....	No.			
			Other:				
		76	With numerical controls or facings for numerical controls.....	No.			
			Other:				
		77	Sawing or cutting-off machines.....	No.			
		78	Broaching machines...	No.			
		79	Other.....	No.			
			Metal-forming machine tools:				
		82	Used or rebuilt.....	No.			
		83	Other, valued under $2,500 each.....	No.			
			Other:				
			Shearing machines, punching machines, and combination shearing and punching machines:				
		84	With numerical controls or facings for numerical controls.....	No.			
			Other:				
		86	Shearing machines....	No.			
		87	Other.....	No.			
			Bending, folding, straightening, or flattening machines:				
		88	With numerical controls or facings for numerical controls.....	No.			
			Other:				
		89	Press brakes.....	No.			
		91	Bending rolls.....	No.			
		92	Other.....	No.			

Note: For explanation of the symbol "A" or "A*" in the column entitled "GSP", see general headnote 3(c).

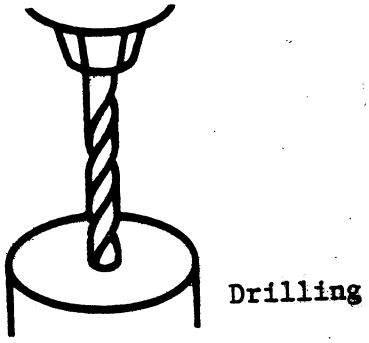
GSP	Item	Stat. Suffix	Articles	Units of Quantity	Rates of Duty 1	Rates of Duty LDDC	Rates of Duty 2
			Machine tools (con.):				
			Metal-working machine tools (con.):				
A*	674.35 (con.)		Other (con.):				
			Metal-forming machine tools (con.):				
			Other (con.):				
			Other metal-forming machine tools:				
		93	With numerical controls or facings for numerical controls	No.			
			Other:				
			Presses:				
		94	Mechanical	No.			
			Other:				
		95	Vertical (single action), except gap or C-frame, hydraulic	No.			
		96	Other	No.			
			Forging machines:				
		97	Headers and upsetters, including cold headers	No.			
		98	Other	No.			
		99	Other	No.			
			Other machine tools:				
A	674.40	00	Reciprocating gang-saw machines	No.	4.7% ad val.	3.9% ad val.	35% ad val.
	674.41	00	Copying lathes used for making rough or finished shoe lasts from models of shoe lasts and, in addition, capable of producing more than one size shoe last from a single size model of a shoe last	No.	Free		Free
A	674.42		Other	.....	4% ad val.	3% ad val.	35% ad val.
			Machines designed primarily as:				
			Woodworking machines:				
		10	Sawmill machines	No.			
		30	Plywood and veneer-making machines	No.			
			Other woodworking machines valued under $2,500 each:				
		32	Lathes	No.			
		34	Multipurpose machines	No.			
			Saws:				
		36	Radial arm	No.			
		38	Table	No.			
		42	Other	No.			
		46 (2)	Other	No.			
		48	Other	No.			
		50	Glass-working machines	No.			
		60	Other machines	No.			
	674.48	00	Work and tool holders and other parts of, and accessories used principally with, copying lathes provided for in item 674.41	X	Free		Free

Note: For explanation of the symbol "A" or "A*" in the column entitled "GSP", see general headnote 3(c).

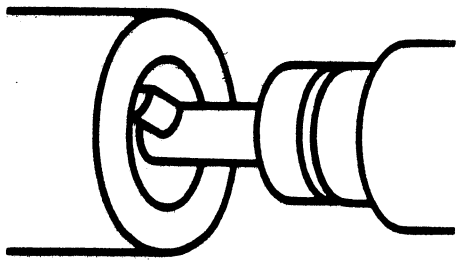
APPENDIX D

BASIC MACHINE TOOL OPERATIONS USED IN U.S. INDUSTRY

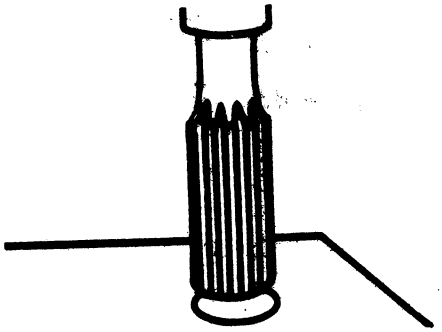
drilling and boring



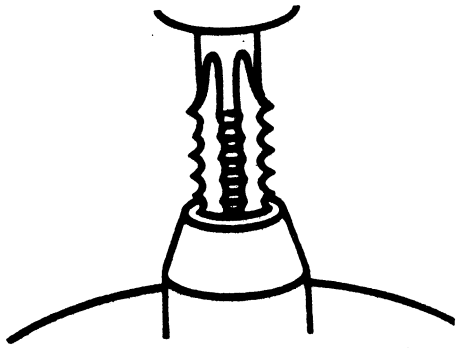
Drilling



Boring

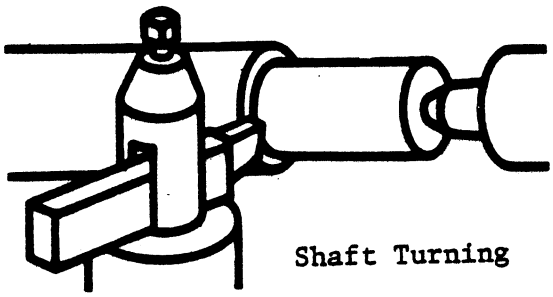


Reaming

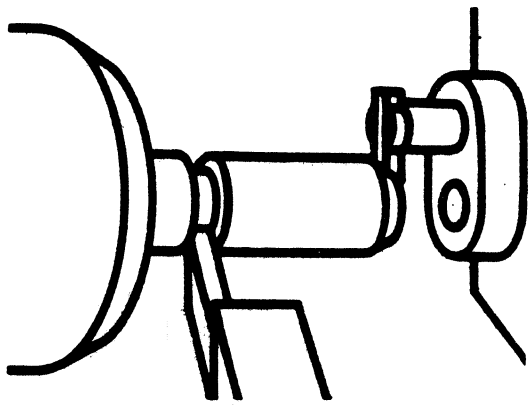


Tapping

turning



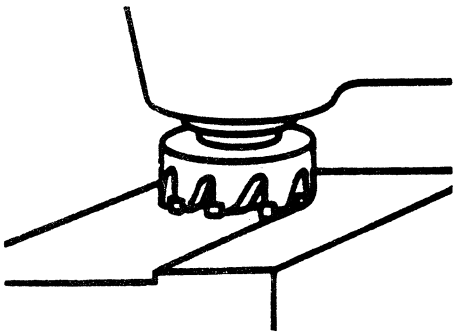
Shaft Turning



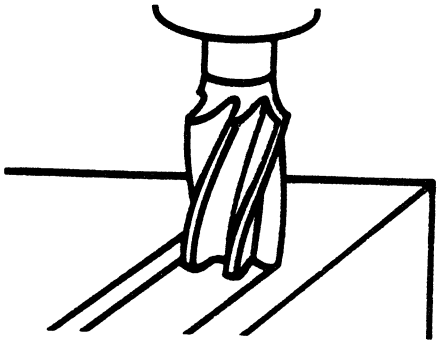
Necking and
Chamfering

milling

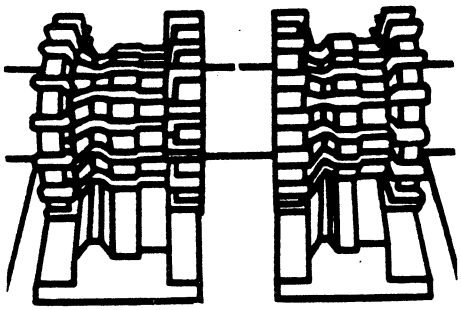
Face Milling



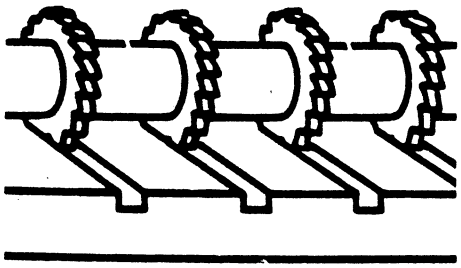
End Milling



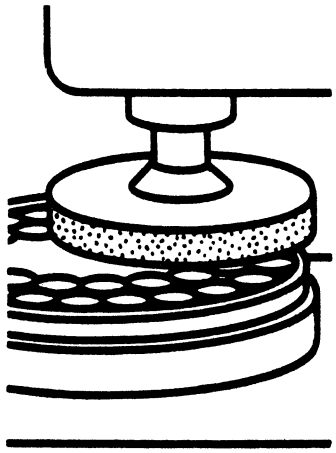
Gang Milling



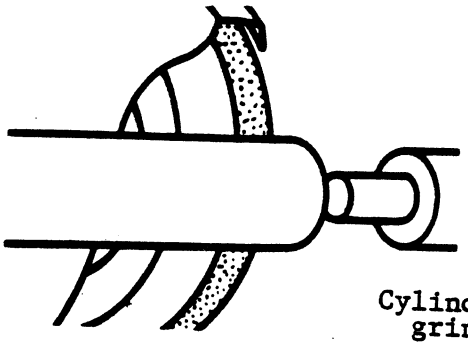
Multiple slotting



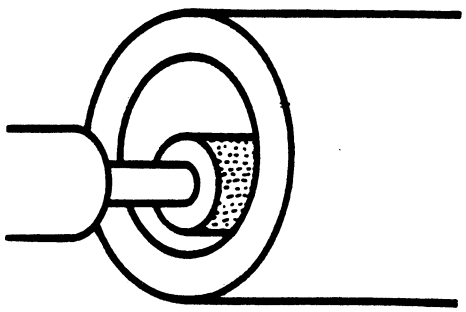
grinding



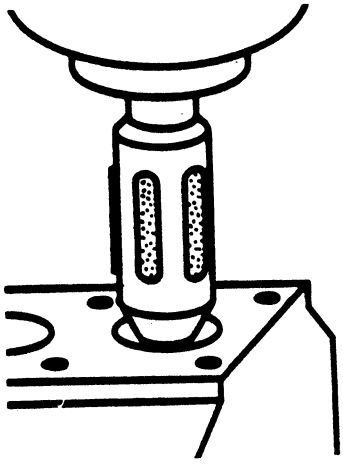
Surface grinding



Cylindrical grinding



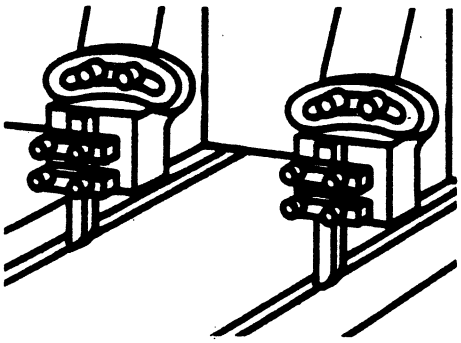
Internal grinding



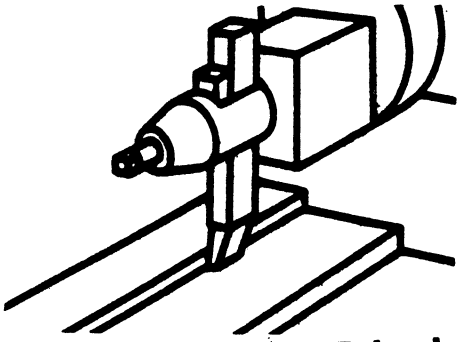
Honing

planing and shaping

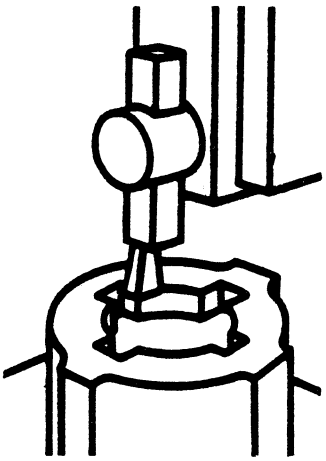
Planing



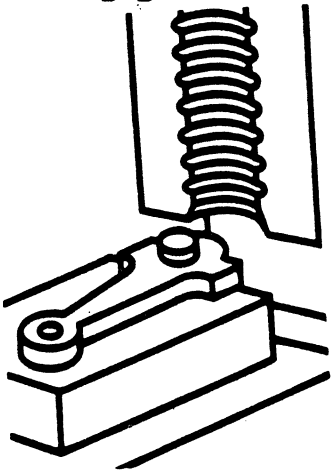
Shaping



Slotting

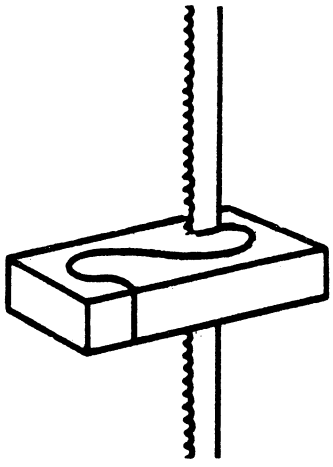


Broaching

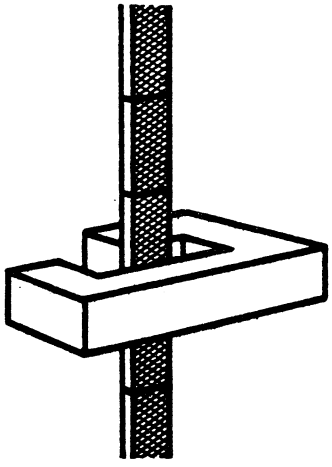


sawing

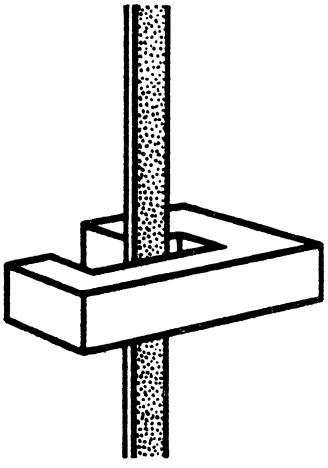
Contour Sawing



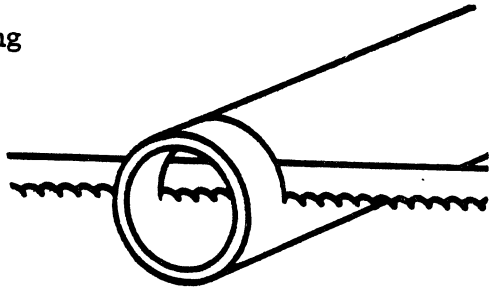
Filing



Polishing

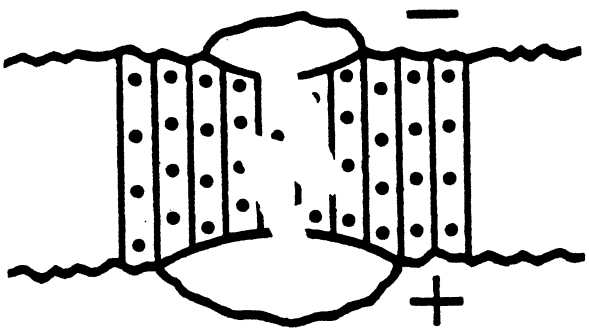


Cutoff Sawing

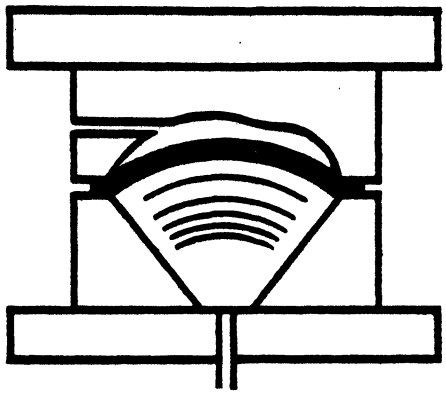


advanced techniques

Electrical Discharge Machining

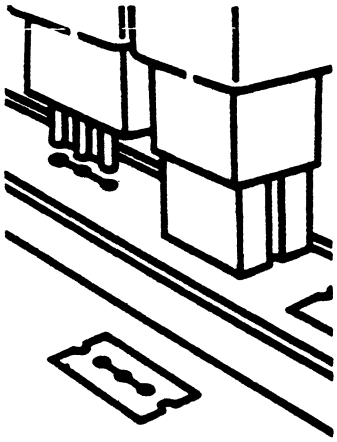


Electrospark Forming

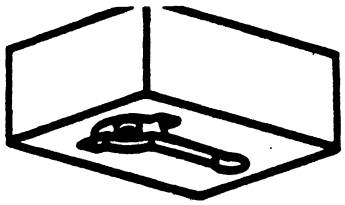


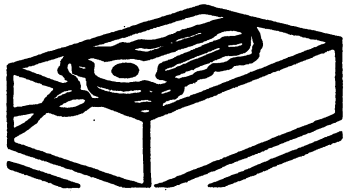
forming

Punching



Forging





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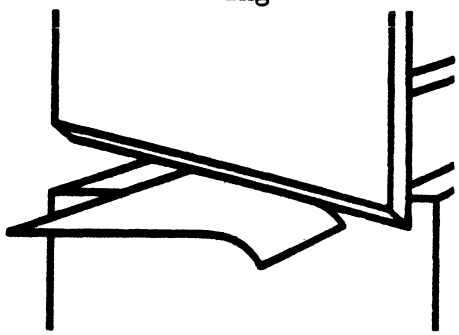

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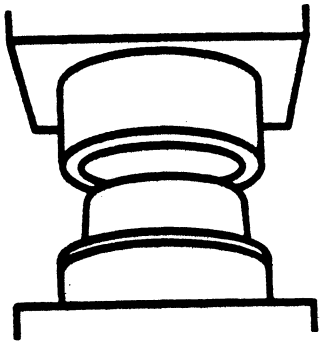

APPENDIX E

A DISCUSSION OF THE EFFECTS OF EXCHANGE-RATE CHANGES AMONG MAJOR U.S. TRADING PARTNERS ON THE COMPETITIVENESS OF U.S. PRODUCTS

EXCHANGE RATES

General

Unless offset by differences in relative inflation rates, changes in the value of the U.S. dollar vis-a-vis foreign currency can alter the competitiveness of imports in the United States. For example, a strong dollar and a relatively high rate of U.S. inflation can cause the dollar to become overvalued, increasing the competitiveness of imports in the United States.

To determine if changes in exchange rates have offset changes in inflation rates, real exchange rate indexes are often used. These indexes deflate changes in nominal exchange rates by changes in relative price levels. They show the change in competitiveness between the products of two countries since a base period. Real exchange rates for the U.S. dollar are determined by the following formula:

$$\text{Real exchange rate index} = \frac{\text{Nominal exchange rate index} \times \text{U.S. price index}}{\text{Foreign price index}}$$

If the real exchange rate index equals 100, the real value of the U.S. dollar has not changed since the base year. If the real exchange rate index is less than 100, the dollar is undervalued compared with the base year, and U.S. goods in general have become more competitive with foreign goods. The index would be less than 100 if either the U.S. price level has fallen relative to the foreign price level with no change in nominal exchange rates or the value of the dollar has risen in foreign exchange markets with no offsetting movement in relative price levels. If the real exchange rate index is greater than 100, the dollar is overvalued compared with the base year, and U.S. goods in general have become less competitive with foreign goods.

The following tabulation shows the real exchange rate indexes for the U.S. dollar against the currencies of several countries for the base year 1976:

Country	Producer price index (1976=100)	Nominal exchange rate index (1976=100)	Real exchange rate index (1976=100)
United States	163.6	-	-
Canada	178.6	125.1	114.6
Italy	232.6	162.5	114.3
Japan	129.5	84.0	106.1
Korea	253.1	151.1	97.7
Spain	257.6	164.2	104.3
Sweden	189.4	144.2	124.6
Switzerland	114.7	81.2	115.8
Taiwan	157.4	103.9	108.2
United Kingdom	204.8	103.2	82.4
West Germany	133.4	96.4	118.2

Source: Compiled from statistics of the International Monetary Fund.

As shown by the real exchange rate indexes in the tabulation, U.S. goods have become less competitive with goods from most foreign countries since 1976. The average real exchange rate index for the U.S. dollar against the foreign currencies is 108.6. This means that the price of imports has gone up by about 8.6 percent less since 1976 than the price of U.S. goods. Goods from Sweden, West Germany, and Switzerland have enjoyed an especially sharp increase in competitiveness since 1976. Only goods from Korea and the United Kingdom have lost competitiveness to U.S. goods since 1976. 1/

1/ A recent study done by the U.S. International Trade Commission (The Effect of Changes in the Value of the U.S. Dollar on Trade in Selected Commoditites, Investigation No. 332-150, USITC Pub. No. 1423 (August 1983)) found that although changes in exchange rates influence trade, other factors such as competitors' prices, product demand, and manufacturing costs are often equally important.

APPENDIX F

STATISTICAL TABLES

Table F-1.--Metalworking machine tools: 1/ U.S. Air Force acquisitions, by sources, fiscal years 1978-82 2/

Source	Fiscal year ended Sept. 30--				
	1978	1979	1980	1981	1982
	Quantity (units)				
United States	76	62	61	68	93
Foreign	2	3/ 4	0	8	12
Total	78	66	61	76	105
	Value (1,000 dollars)				
United States	8,326	8,996	3,879	5,271	10,564
Foreign	408	3/ 325	-	2,688	1,991
Total	8,644	9,321	3,879	7,959	12,555

1/ As defined in the Federal Supply Classification for categories 3408-3460.

2/ Figures cover only direct U.S. Air Force purchases and not those of U.S. contractors with Defense Department funding.

3/ Includes 1 award for machine tool accessories.

Source: U.S. Department of Defense, Office of the Under Secretary of Defense, Research and Engineering, Acquisition Management.

Table F-2.--Metalworking machine tools: 1/ U.S. Navy acquisitions, by sources, fiscal years 1978-82 2/

Source	Fiscal year ended Sept. 30--				
	1978	1979	1980	1981	1982
	Quantity (units)				
United States	244	454	171	214	263
Foreign	12	17	27	30	15
Total	256	471	198	244	278
	Value (1,000 dollars)				
United States	18,641	18,178	22,353	24,634	16,276
Foreign	1,345	791	2,488	4,723	3,484
Total	19,986	18,969	24,841	29,357	19,760

1/ As defined in the Federal Supply Classification for categories 3408-3460.
2/ Figures covers primarily U.S. Navy purchases and not those of U.S. contractors with Defense Department funding.

Source: U.S. Department of Defense, Office of the Under Secretary of Defense, Research and Engineering, Acquisition Management.

Table F-3.--Metalworking machine tools: 1/ U.S. Army acquisitions, by sources, 1978-82 2/

Source	1978	1979	1980	1981	1982 3/
	Quantity (units)				
United States	265	553	229	267	147
Foreign 4/	11	38	20	22	8
Total	276	591	249	289	155
	Value (1,000 dollars)				
United States	30,111	91,185	30,778	41,455	32,784
Foreign 4/	1,694	10,916	3,409	2,021	1,186
Total	31,805	102,101	34,187	43,476	33,970

1/ As defined in the Federal Supply Classification: 3408--machining centers and way-type machines; 3410--electrical and ultrasonic erosion machines; 3411--boring machines; 312--broaching machines; 3413--drilling and tapping machines; 3414--gear-cutting and gear-finishing machines; 3415--grinding machines; 3416--lathes; 3417--milling machines; 3418--planers and shapers; 3419--miscellaneous machine tools; 3426--metal-finishing equipment; 3433--gas welding, heat-cutting, and metalizing equipment; 3441--bending and forming machines; 3442--hydraulic and pneumatic presses, power-driven; 3443--mechanical presses, power-driven; 3446--forging machinery and hammers; 3448--riveting machines; and 3449--miscellaneous secondary metal-forming and metal-cutting machines.

2/ Recorded year of machine manufacture.

3/ Data are incomplete.

4/ Includes Mainz Army Depot (West Germany) purchases of foreign-made machine tools, although the U.S. Army considers these to be domestic purchases. Includes French-built lathes mated with U.S.-made controls and assembled in the United States, which in the U.S. Army's view qualifies them as domestic purchases.

Source: U.S. Department of Defense, Office of the Under Secretary of Defense, Research and Engineering, Acquisition Management.

Table F-4.--Metalworking machine tools: 1/ U.S. Air Force acquisition of foreign-made machine tools, by sources, fiscal years 1978-82 2/

Country	Fiscal year ended Sept 30--							
	1978		1979		1981		1982	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	Number	1,000 dollars	Number	1,000 dollars	Number	1,000 dollars	Number	1,000 dollars
United Kingdom	2	408	3	311	6	2,315	9	1,835
Spain	0	-	0	-	0	-	1	100
France	0	-	0	-	0	-	1	45
Portugal	0	-	0	-	0	-	1	11
Japan	0	-	0	-	2	373	0	-
West Germany	0	-	3/ 1	3/ 14	0	-	0	-
Total	2	408	4	325	8	2,688	12	1,991

1/ Metalworking machine tools covering Federal Supply Classifications 3413--drilling and tapping machines; 3415--grinding machines; 3416--lathes; 3417--milling machines; and 3460--machine tool accessories.

2/ Figures cover only direct U.S. Air Force purchases and not those of U.S. contractors with Defense Department funding. There were no purchases in 1980.

3/ Machine tool accessories.

Source: Office of the Under Secretary of Defense, Research & Engineering, Acquistion Management, Department of Defense.

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Table F-5.-- Metalworking machine tools: 1/ U.S. Navy acquisition of foreign-made machine tools by sources, fiscal years 1978-82 2/

Source	Fiscal year ended Sept 30--									
	1978		1979		1980		1981		1982	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	Number	1,000 dollars	Number	1,000 dollars	Number	1,000 dollars	Number	1,000 dollars	Number	1,000 dollars
Switzerland	5	498	2	2	3	701	3	1,563	4	1,079
United Kingdom	4	224	6	329	13	1,270	20	2,339	5	1,043
West Germany	1	492	8	457	4	187	2	570	4	1,033
Spain	0	-	0	-	1	192	2	82	1	297
Italy	1	32	0	-	0	-	0	-	1	32
Austria	0	-	0	-	1	6	1	8	0	-
Japan	0	-	1	3	2	50	0	-	0	-
Netherlands	0	-	0	-	0	-	1	1	0	-
Poland	1	99	0	-	0	-	0	-	0	-
Singapore	0	-	0	-	3	82	0	-	0	-
Sweden	0	-	0	-	0	-	1	160	0	-
Total	12	1,345	17	791	27	2,488	30	4,723	15	3,484

1/ Metalworking machine tools covering Federal Supply Classifications 3408--machining centers and way-type machines; 3410--electrical and ultrasonic erosion machines; 3411--boring machines; 3413--drilling and tapping machines; 3414--gear cutting and finishing machines; 3415--grinding machines; 3416--lathes; 3417--milling machines; 3419--miscellaneous machine tools; and 3460--machine tool accessories.

2/ Figures cover primarily U.S. Navy purchases and not those of U.S. contractors with Defense Department funding.

Source: Office of the Under Secretary of Defense, Research & Engineering, Acquistion Management, Department of Defense.

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Table F-6.--Metalworking machine tools: 1/ U.S. Army acquisition of foreign-made machine tools, by sources, 1977-82 2/ 3/

Source	1978		1979		1980		1981		1982 4/	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	Number	1,000 dollars	Number	1,000 dollars	Number	1,000 dollars	Number	1,000 dollars	Number	1,000 dollars
Switzerland	4	973	16	6,178	2	562	2	78	2	494
West Germany	2	27	5	194	4	904	3	175	5/ 2	5/ 457
United Kingdom	0	-	5	85	5	82	11	212	3	84
France	0	-	8	1,625	0	-	4	1,545	0	-
Italy	0	-	2	556	1	103	0	-	0	-
Japan	5	694	2	2,278	5	1,554	0	-	0	-
Spain	0	-	0	-	1	93	0	-	0	-
Taiwan	0	-	0	-	0	-	2	11	0	-
Sweden	0	-	0	-	0	-	1	10	0	-
Total	11	1,694	38	10,916	6/ 20	6/ 3,409	22	2,021	6/ 8	6/ 1,186

1/ Metalworking machine tools covers Federal Supply Classifications: 3408--machining centers and way-type machines; 3411--boring machines; 3415--grinding machines; 3416--lathes; 3417--milling machines; 3419--miscellaneous machine tools; 3443--mechanical presses, power driven; and 3460--machine tool accessories.

2/ Includes Mainz Army Depot. U.S. Army considers machine tool purchases at Mainz to be domestic. Includes 8 machine tools of French make, assembled in United States, mated with U.S.-made NC controls. Value $654,700.

3/ Recorded year of machine manufacture.

4/ Data for 1982 incomplete.

5/ Includes 1 machine tool purchase from West German subsidiary of a U.S. machine tool builder.

6/ Country of manufacture not given for 1 machine tool purchase in that year.

Source: Office of the Under Secretary of Defense, Research & Engineering, Acquistion Management, Department of Defense.

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Table F-7.--Metalworking machinery and machine tools: Eximbank authorizations, by fiscal years, 1977-82 1/

Type of assistance	1977			1978			1979		
	New authorizations	Export value	Authorization amount	New authorizations	Export value	Authorization amount	New authorizations	Export value	Authorization amount
	Number	1,000 dollars	1,000 dollars	Number	1,000 dollars	1,000 dollars	Number	1,000 dollars	1,000 dollars
Cooperative Financing Facility (CFF) and relending loans	16	4,801	3,458	16	3,956	1,969	13	4,266	2,716
Financial and other guarantees	1	-	8	3	-	299	4	-	189
Bank and preship	15	14,724	9,908	13	7,055	5,215	12	12,404	9,395
Medium-term insurance policies	1	368	288	1	6,400	4,896	5	1,635	1,251
Short-term insurance	4	2,375	2,375	4	11,175	11,175	5	10,650	10,650
Discount loans	14	7,105	8,656	6	132	1,928	12	6,659	10,887
CFF loans	2/	2/	2/	2/	2/	2/	2/	2/	2/
CFF guarantees and Certificate of Loan Participation	2/	2/	2/	2/	2/	2/	2/	2/	2/
Total	51	29,373	24,692	43	28,718	25,482	51	35,614	35,087

Type of assistance	1980			1981			1982		
	New authorizations	Export value	Authorization amount	New authorizations	Export value	Authorization amount	New authorizations	Export value	Authorization amount
	Number	1,000 dollars	1,000 dollars	Number	1,000 dollars	1,000 dollars	Number	1,000 dollars	1,000 dollars
Cooperative Financing Facility (CFF) and relending loans	8	1,997	849	2/	2/	2/	3/	3/	3/
Financial and other guarantees	4	-	501	2/	2/	2/	3/	3/	3/
Bank and preship	11	6,955	6,704	12	4,508	3,837	14	6,314	5,419
Medium-term insurance policies	7	4,367	3,758	4	989	894	0	68	60
Short-term insurance	4	230	230	3	2,140	2,140	5	1,590	1,590
Discount loans	15	658	5,042	4		1,024	30	8,942	13,753
CFF loans	2/	2/	2/	7	1,458	812	3/	3/	3/
CFF guarantees and Certificate of Loan Participation	2/	2/	2/	2	-	191	3/	3/	3/
Total	49	14,208	17,083	32	9,093	8,698	49	16,914	20,822

1/ Does not include all financing for metalworking machine tools because of Eximbank classification scheme; therefore, financing for machine tools may be hidden in categories such as manufacturing equipment or automobile or aircraft plants.

2/ CFF broken into different categories in 1981.

3/ CFF program discontinued at close of fiscal year 1981.

Source: Export-Import Bank of the United States, Authorizations Report, MA090, 1977-82.

Table F-8.--Metalworking machine tools: Number of U.S. patents granted in the U.S. Patent System, by selected countries, 1977-82 1/

Country	1977	1978	1979	1980	1981	1982	Total
Total	1,501	1,472	1,047	1,352	1,399	1,116	7,887
U.S. origin	929	906	660	804	853	675	4,827
Foreign origin	572	566	387	548	546	441	3,060
West Germany	163	168	111	149	171	133	895
Japan	107	118	92	107	129	103	656
United Kingdom	65	68	29	47	32	32	273
France	45	31	17	43	33	24	193
Switzerland	34	22	28	43	28	24	179
Sweden	28	35	20	26	27	23	159
Canada	25	31	21	27	29	24	157
Italy	14	20	18	18	22	21	113
U.S.S.R	22	19	17	21	15	9	103
Austria	10	9	4	15	13	9	60
Netherlands	11	12	8	7	8	9	55
Australia	12	7	4	11	4	7	45
South Africa	4	3	1	7	3	0	18
Belgium	3	2	0	1	4	5	15
Finland	2	3	3	6	8	1	23
Denmark	2	1	3	2	0	3	11
Spain	6	1	0	0	3	0	10
Bulgaria	4	2	0	0	1	1	8
East Germany	1	0	0	1	3	1	6
Romania	0	1	0	0	0	0	1
All other	14	13	11	17	13	12	80

1/ Figures include U.S. Patent Classifications 29 (subclasses 26-30); 33, 34, 35.5, 36-47, 48.5, 49-57, 64, 65, 560, 564-566, 568, 650, and 225 (subclasses 93-106); and 10, 51, 76, 82, 83, 234, 279, 407, 407, and 409 (all subclasses).

Source: U.S. Department of Commerce, U.S. Patent and Trademark Office, Office of Technology Assessment and Forecast.

Table F-9.--Controls for machine tools: 1/ Number of patents granted in the U.S. Patent System, by selected countries, 1977-82

Country	1977	1978	1979	1980	1981	1982	Total
Total	116	123	88	105	111	106	649
U.S. origin	64	69	52	50	55	54	344
Foreign origin	52	54	36	55	56	52	305
Japan	21	24	12	32	31	33	153
West Germany	8	12	3	8	10	7	48
United Kingdom	6	7	2	5	3	1	24
France	7	2	2	4	2	4	21
Switzerland	3	2	2	1	2	1	11
Italy	1	2	3	0	3	1	10
Canada	0	0	4	1	2	2	9
U.S.S.R	3	3	1	1	1	0	9
Sweden	1	1	2	2	1	1	8
Netherlands	0	1	3	1	0	0	6
Austria	0	0	0	0	1	0	1
Belgium	0	0	1	0	0	0	1
Hungary	0	0	1	0	0	0	1
East Germany	1	0	0	0	0	0	1
Finland	0	0	0	0	0	1	1
All other	1	0	0	0	0	0	1

1/ Figures include U.S. Patent Classifications 318 (subclass 162); 560-579, and 364 (subclasses 472, 474, 478, and 513). Includes controls for metalworking and woodworking machinery as well as some controls for robots.

Source: U.S. Department of Commerce, and U.S., Patent and Trademark Office, Office of Technology Assessment and Forecast.

Table F-10.--Numerically controlled lathes: U.S. purchasers' consumption of domestically produced and imported products, 1977-82

Year	Domestically produced 1/		Imports 2/		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
	Units	Million dollars	Units	Million dollars	Units	Million dollars
1977	290	41.66	12	2.15	302	43.81
1978	354	55.94	7	0.64	361	56.58
1979	266	42.26	51	18.61	317	60.87
1980	122	25.32	12	2.37	134	27.69
1981	203	54.20	23	4.71	226	58.91
1982	112	26.51	18	3.71	130	30.22
Total	1,347	245.89	123	32.19	1,470	278.08

1/ Based on data from 61 respondents.
2/ Based on data from 6 respondents.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table F-11.--Machining centers: U.S. purchasers' consumption of domestically produced and imported products, 1977-82

Year	Domestically produced 1/		Imports 2/		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
	Units	Million dollars	Units	Million dollars	Units	Million dollars
1977	29	8.20	0	-	29	8.20
1978	72	20.27	1	0.60	73	20.87
1979	59	20.61	0	-	59	20.61
1980	49	10.09	9	1.72	58	11.81
1981	51	14.67	16	2.85	67	17.52
1982	31	9.29	25	9.98	56	19.27
Total	291	83.13	51	15.15	342	98.28

1/ Based on data from 45 respondents.
2/ Based on data from 16 respondents.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table F-12.--Imported metalworking machine tools: Principal foreign sources, by number of responses, 1977-82

Source	All metalworking machine tools	All metal-removing machine tools	Gear hobbers	Machining centers, ATC, vertical, Y-axis 20 inches	Machining centers, ATC, vertical, Y-axis 26 inches	Machining centers, ATC, horizontal, Y-axis 40 inches	Combination B-D-M machines, horizontal, NC	Combination B-D-M machines, horizontal, not NC	Radial drilling machines, not NC, $2,500 or more	Multiple spindle drilling machines, not NC, $2,500 or more	Drilling machines, not NC, under $2,500	Milling machines, knee or bed type, NC	Horizontal lathes, NC, less than 25 horsepower (small)
Far East:													
China (PRC)	3	3	-	-	-	-	-	-	1	-	-	-	-
Taiwan	34	32	-	-	-	-	-	2	1	-	8	2	-
India	1	1	-	-	-	-	-	-	-	-	-	-	-
Japan	73	69	2	10	8	6	1	4	3	1	-	3	9
Republic of Korea	5	5	-	-	-	-	-	-	-	-	-	-	-
Singapore	1	1	-	-	-	-	-	-	-	-	-	-	-
Western Europe:													
Belgium	2	-	-	-	-	-	-	-	-	-	-	-	-
West Germany	29	26	2	-	1	-	2	1	1	1	-	-	3
France	10	9	-	-	-	-	-	-	-	-	-	1	2
Italy	16	14	-	-	-	1	-	1	2	-	-	1	2
Netherlands	2	2	-	-	-	-	-	-	-	-	-	-	-
Spain	8	7	-	-	-	-	-	-	1	-	-	1	1
United Kingdom	17	15	-	-	-	-	-	-	1	-	-	1	1
Switzerland	11	9	1	-	-	-	-	-	-	-	-	-	-
Sweden	8	8	-	-	-	-	-	1	1	-	2	-	-
Denmark	1	1	-	-	-	-	-	-	-	-	-	-	-
Other	1	-	-	-	-	-	-	-	-	-	-	-	-
Eastern Europe:													
East Germany	1	-	-	-	-	-	-	-	-	-	-	-	-
Romania	2	2	-	-	-	-	-	1	-	-	-	-	-
Poland	10	9	-	-	-	-	-	1	1	-	-	1	-
Czechoslovakia	6	6	1	-	-	-	-	1	1	-	-	-	-
Yugoslavia	2	2	-	-	-	-	-	-	-	-	-	-	1

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Table F-12.--Imported metalworking machine tools: Principal foreign sources, by number of responses, 1977-82--Continued

Source	Horizontal lathes, NC, over 50 horsepower (large)	Vertical lathes, NC	Engine or toolroom lathes, not NC, $2,500 or more	Automatic bar machines, not NC, $2,500 or more	Sharpening machines, not NC, $2,500 or more	External cylindrical machines, not NC, $2,500 or more	Grinding machines, not NC, under $2,500	Sawing (cutting-off) machines, not NC, $2,500 or more	Electrical discharge machines	All metal-forming machine tools	Punching machines, fixed position, etc., $2,500 or more	Mechanical press, automatic, strip/coil field, $2,500 or more	Hydraulic press, horizontal, $2,500 or more
Far East:													
China (PRC)	-	-	1	-	-	1	-	-	-	-	-	-	-
Taiwan	-	-	5	-	4	1	6	3	-	2	-	1	-
India	-	-	-	-	-	-	-	-	-	-	-	-	-
Japan	4	2	5	-	4	1	1	3	2	4	1	2	-
Republic of Korea	-	-	2	-	1	-	1	-	-	-	-	-	-
Singapore	-	-	1	-	-	-	-	-	-	-	-	-	-
Western Europe:													
Belgium	-	-	-	-	-	-	-	-	-	2	-	1	-
West Germany	1	-	1	1	4	1	1	5	-	3	1	-	-
France	1	1	1	-	1	-	1	-	-	1	-	-	1
Italy	1	1	1	-	-	1	-	2	-	2	-	1	1
Netherlands	-	-	1	-	-	-	-	-	-	-	-	-	-
Spain	-	-	2	-	2	-	-	-	-	1	-	1	-
United Kingdom	-	1	2	2	2	1	1	-	1	2	-	2	-
Switzerland	-	-	1	1	3	1	-	-	-	2	1	-	-
Sweden	1	-	-	-	-	1	1	-	-	-	-	-	-
Denmark	-	-	1	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	1	-	-	-
Eastern Europe:													
East Germany	-	-	-	-	-	-	-	-	-	1	-	1	-
Romania	-	-	1	-	-	-	-	-	-	-	-	-	-
Poland	-	2	1	1	1	1	-	-	-	1	-	1	-
Czechoslovakia	-	-	1	-	1	1	-	-	-	-	-	-	-
Yugoslavia	-	-	1	-	-	-	-	-	-	-	-	-	-

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table F-13.--Metalworking machine tools: Nontariff barriers experienced by U.S. producers in foreign markets, by number of responses, 1977-82

Source	Licensing requirements	Quotas	Embargoes	Export restraints	Exchange/monetary/financial controls	Minimum/maximum price regulations	Local content/mixing requirements	Discriminatory bilateral agreements	Restrictive business practices	Discriminatory sourcing	Other	Border taxes	Port/statistical taxes	Nondiscriminatory use/excise taxes/registration fees	Discriminatory excise taxes, government taxes, controlled insurance, film taxes, use/commodity taxes	Nondiscriminatory sales taxes
Far East:																
Australia	-	1	-	-	2	-	2	1	2	1	1	-	-	-	-	-
China (P.R.C.)	4	1	-	2	-	-	1	-	1	-	-	-	2	-	-	-
Taiwan	1	-	-	-	1	-	-	-	1	-	1	-	-	-	-	-
India	16	1	1	-	12	-	5	1	7	4	-	2	-	-	-	-
Japan	5	-	-	2	10	1	-	-	14	6	2	1	-	1	2	-
Republic of Korea	4	1	-	-	4	-	1	1	2	1	-	-	-	-	-	-
Singapore	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Central and South America (excluding Mexico):																
Argentina	10	-	1	3	9	-	6	1	2	-	-	1	-	4	2	1
Brazil	23	3	3	8	23	1	17	3	10	7	-	6	-	3	3	2
South Africa	2	-	2	1	-	-	-	-	1	-	1	-	-	?	-	-
Western Europe:																
Austria	1	-	-	-	-	-	-	-	1	-	-	-	-	1	1	1
Belgium	2	-	-	-	1	-	-	-	1	3	-	-	-	-	-	-
West Germany	1	-	-	-	-	1	1	1	4	5	-	2	-	2	2	1
France	-	-	-	-	2	1	3	1	5	1	-	2	-	1	1	1
Italy	1	-	-	-	2	-	1	-	3	-	-	-	-	1	1	-
Netherlands	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Portugal	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-
Spain	-	-	-	1	1	-	2	-	1	-	-	1	-	-	-	-
United Kingdom	2	-	-	-	3	-	2	-	1	1	-	-	-	-	-	-
Switzerland	1	-	-	-	-	-	-	-	1	1	-	1	-	-	1	-
Sweden	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-
Denmark	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Eastern Europe:																
East Germany	4	-	1	3	2	-	-	-	3	-	-	-	-	-	1	-
Romania	3	-	1	2	1	-	-	-	3	-	-	-	-	-	1	-
Poland	3	-	1	2	2	-	-	-	2	-	-	-	-	-	1	-
Czechoslovakia	2	-	2	2	2	-	-	-	3	-	-	-	-	-	1	-
Hungary	3	-	1	2	1	-	-	-	2	-	-	-	-	-	1	-
Bulgaria	4	-	1	3	1	-	-	-	2	-	-	-	-	-	1	-
Yugoslavia	4	-	1	2	3	-	-	-	2	-	-	-	-	-	1	-
North America and Mexico:																
Canada	-	-	-	1	3	-	1	-	1	1	-	4	-	1	-	-
Mexico	15	-	-	6	22	-	6	1	7	3	-	4	-	1	2	-
U.S.S.R	6	-	2	9	2	-	-	-	4	1	-	-	-	-	2	-

Table F-13.--Metalworking machine tools: Nontariff barriers experienced by U.S. producers in foreign markets, by number of responses, 1977-82--Continued

Source	Discriminatory sales taxes	Prior import deposits	Consular fees	Variable levies	Stamp taxes	Government subsidies and other aids	State training, government monopolies, exclusive franchises	Laws/practices which discourage imports	General government policy problems	Government procurement	Other government participation in trade problems	Health and safety standards	Processing standards	Requirements on weights and measures	Labeling and container requirements	Product content requirements
Far East:																
Australia	-	-	-	1	-	-	-	-	-	2	1	-	-	-	1	2
China (P.R.C.)	-	-	-	1	-	1	9	3	3	3	1	-	-	-	-	1
Taiwan	-	-	-	1	-	-	-	1	-	2	1	-	-	-	-	1
India	-	1	1	2	1	2	2	10	4	3	1	-	-	-	2	1
Japan	-	1	-	3	-	24	7	22	8	-	1	1	-	-	1	2
Republic of Korea	-	1	-	1	-	1	2	2	2	1	2	-	-	-	-	1
Singapore	-	-	-	1	-	-	3	-	-	-	1	-	-	-	-	1
Central and South America (excluding Mexico):																
Argentina	-	2	5	4	-	2	2	6	5	-	1	-	-	-	-	1
Brazil	1	12	-	7	-	8	6	17	12	1		-	-	2	1	2
South Africa	-	-	-	2	-	-	-	1	-	-	1	-	-	-	-	1
Western Europe:																
Austria	-	-	-	1	1	-	-	1	-	1	1	1	-	-	-	1
Belgium	-	-	-	1	-	-	-	1	-	1	1	1	-	-	-	1
West Germany	-	-	-	2	1	9	3	4	1	1	1	4	-	-	1	1
France	-	-	-	3	1	5	2	9	6	5	2	4	-	1	4	1
Italy	-	1	-	2	1	6	-	1	1	1	1	-	-	-	-	1
Netherlands	-	-	-	-	-	-	-	1	-	1	1	1	-	-	-	1
Portugal	-	1	-	-	-	1	-	1	-	1	1	-	-	-	-	1
Spain	-	1	-	2	-	1	-	3	-	1	1	-	-	-	-	1
United Kingdom	1	-	-	2	-	9	-	4	-	2	1	5	-	-	-	2
Switzerland	1	-	-	1	1	-	-	1	1	1	1	2	-	-	-	1
Sweden	-	-	-	1	-	-	-	1	-	1	1	2	-	-	-	1
Denmark	-	-	-	1	-	-	-	1	-	1	-	-	-	-	-	-
Eastern Europe:																
East Germany	-	-	-	1	-	3	4	4	4	3	1	-	-	-	-	1
Romania	-	-	-	1	-	3	6	3	3	2	1	-	-	-	-	2
Poland	-	-	-	1	-	4	7	3	3	4	1	-	-	-	-	2
Czechoslovakia	-	-	-	1	-	4	6	4	4	3	1	-	-	-	-	2
Hungary	-	-	-	1	-	3	5	3	3	2	1	-	-	-	-	2
Bulgaria	-	-	-	1	-	3	4	3	3	2	1	-	-	-	-	2
Yugoslavia	-	-	-	1	-	3	6	3	3	2	1	1	-	-	-	2
North America and Mexico:																
Canada	-	-	-	1	-	5	-	4	2	1	1	1	-	1	1	1
Mexico	-	-	-	3	-	3	3	7	10	1	1	-	-	1	1	3
U.S.S.R	-	1	-	1	-	5	8	7	4	4	1	-	-	-	1	-

Table F-13.--Metalworking machine tools: Nontariff barriers experienced by U.S. producers in foreign markets, by number of responses, 1977-82--Continued

Source	Industrial standards	Marking requirements	Trademark problems	Antidumping practices	Consular formalities	Packaging requirements	Customs valuation	Documentation requirements	Administrative difficulties	Merchandise classification problems	Regulations on samples, returned goods, reexports	Countervailing duties	Emergency action	Other customs procedures and administrative practices	Discriminatory ocean freights
Far East:															
Australia	1	-	-	-	-	2	2	1	1	-	-	-	-	-	-
China (P.R.C.)	1	-	-	-	-	2	1	4	3	-	1	-	-	-	-
Taiwan	1	-	-	-	-	1	2	3	3	-	-	-	-	-	-
India	1	1	-	1	-	2	5	5	4	-	-	1	-	-	-
Japan	2	-	2	-	-	1	5	4	4	1	1	2	-	-	-
Republic of Korea	1	-	-	-	-	1	1	1	1	-	-	-	-	-	-
Singapore	1	-	-	-	-	1	1	1	1	-	-	-	-	-	-
Central and South America (excluding Mexico):															
Argentina	2	-	-	-	-	1	1	4	2	3	2	-	-	-	-
Brazil	2	1	-	1	3	1	7	5	7	3	2	1	1	-	-
South Africa	1	-	-	-	-	1	-	2	1	-	-	-	-	-	-
Western Europe:															
Austria	2	-	-	-	-	1	1	2	1	-	-	-	-	-	-
Belgium	2	-	-	-	-	1	1	1	1	-	-	-	-	-	-
West Germany	8	-	-	-	-	1	3	2	1	-	-	2	-	-	-
France	7	6	1	-	-	2	4	8	-	-	-	-	-	-	-
Italy	2	-	-	-	-	1	3	1	3	-	1	-	-	-	-
Netherlands	2	-	-	-	-	1	1	1	1	-	-	-	-	-	-
Portugal	2	-	-	-	-	1	1	1	1	-	-	-	-	-	-
Spain	2	-	-	-	-	1	2	1	2	-	-	-	-	-	-
United Kingdom	5	-	-	-	-	1	2	1	1	-	1	-	-	-	-
Switzerland	2	-	-	-	-	1	1	2	1	-	-	-	-	-	-
Sweden	4	-	-	-	-	1	1	1	1	-	-	-	-	-	-
Denmark	2	-	-	-	-	1	1	1	1	-	-	-	-	-	-
Eastern Europe:															
East Germany	2	-	-	-	-	1	2	2	1	-	1	-	-	-	-
Romania	2	-	-	-	-	1	2	3	1	-	1	-	-	-	-
Poland	2	-	-	-	-	1	2	-	1	-	1	-	-	-	-
Czechoslovakia	2	-	-	-	-	1	2	3	1	-	1	-	-	-	-
Hungary	2	-	-	-	-	1	2	2	1	-	1	-	-	-	-
Bulgaria	2	-	-	-	-	1	2	2	1	-	1	-	-	-	-
Yugoslavia	2	-	-	-	-	1	2	2	1	-	1	-	-	-	-
North America and Mexico:															
Canada	2	-	-	1	-	1	2	4	1	-	1	1	-	-	-
Mexico	2	-	-	-	1	1	4	3	7	2	1	-	-	-	-
U.S.S.R	2	1	-	-	1	3	1	5	2	-	-	-	-	-	-

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

APPENDIX G

NATIONAL SCIENCE FOUNDATION, PRODUCTION RESEARCH PROGRAM, FISCAL YEAR 1983

NSF Production Research Program, FY 1983

Design

University of Massachusetts
University of Illinois
University of Pennsylvania
Texas A & M University
University of Rochester 1/

Casting

University of Michigan
Georgia Institute of Technology

Forging

Battelle Columbus
University of Texas 1/
University of California (Los Angeles)
University of California (Berkeley)
University of Massachusetts
Michigan Technological University
Dyna East Corp.

Machining

Battelle Northwestern
University of Michigan
University of California (Berkeley)
Carnegie-Mellon University
University of Wisconsin (Madison)
Hahn Associates - grinding
(funded by the Small Business Program)
Michigan Technological University - EDM

Bin Picking

University of Rhode Island

Methods

Cornell University
University of Iowa

Engineering Economy

Carnegie-Mellon University

Human Productivity

SRI International

Management Effectiveness

Northwestern University
Purdue University

Assembling

C. S. Draper Laboratory, Inc.
University of Massachusetts
Stanford University
University of Michigan
Ohio State University

Joining

Adaptive Technologies, Inc.
CRC Welding Systems, Inc.
University of California (Berkeley)
Greenbriar Systems, Inc.
Magnasonics, Inc.
Bethesda Corp.

Inspecting

Raycon Corp.
SRI International

1/ Completed.

Source: W. M. Spurgeon, "Production Research Program, National Science Foundation," Tenth NSF Conference on Production Research and Technology, Detroit, Mich., March 1983, pp. 10-23.

NSF Production Research Program, Robot-Related Projects, FY 1983

Inspection

SRI International
L.N.K. Corp.
Sparta, Inc.

Assembly

Charles Stark Draper Lab., Inc.
University of Massachusetts
Stanford University
University of Michigan

Arc Welding, Sealant or Adhesive Application

Adaptive Technologies, Inc.
CRC Welding Systems, Inc.
University of California (Berkeley)
General Electric/ Rensselaer Polytechnic Institute
Greenbriar, Inc.

Material Handling

University of Rhode Island

Programming in English

Machine Intelligence Corp.

General Capability

Purdue University
University of Rhode Island, Robotics Center

Economic Feasibility

Carnegie-Mellon University

Source: W. M. Spurgeon, "Production Research Program, National Science Foundation," Tenth NSF Conference on Production Research and Technology, Detroit, Mich., March 1983, pp. 10-23.

APPENDIX H

THE EUROPEAN COMMUNITY'S PROGRAM FOR ITS MACHINE TOOL INDUSTRY

II. COMMUNITY ACTION: AN OPERATIONAL PROGRAMME OF WORK

Actions which the Commission has decided to undertake can be grouped under six headings:

1. Revival of investment: an essential framework

Although the situation varies considerably between Member States, the general trend over the past few years has been for Community production facilities - the capital equipment of European firms - to age in comparison with that of Japanese and American competitors. (1)

This trend is disturbing all round, but particularly so in the case of the machine tool stock, which, on all the available evidence, is becoming rapidly obsolescent in relation to that of Japan and the United States. The level of numerically controlled machine tools is symptomatic of the situation: in 1980, Japan was using almost as many of these as France, the Federal Republic of Germany and Italy put together, although in terms of production by the mechanical and electrical engineering industries Japan's output in that year was barely 65% of the combined output of those three Member States.

If the decline in investment which is at the root of this phenomenon became a permanent feature, there would be reason to fear a gradual erosion of the Community's industrial base and an increasing loss of competitiveness by its manufacturing industry.

In March 1982, the European Council expressed concern at the weakness of productive investment in Europe. Action to revive industrial investment is justified both by the need to react to the depressed state of the economy and by the grave risk of deterioration in the capital goods-producing industries which are caught between weaker demand and keener international competition and can no longer muster the resources needed for technical and structural adaptation.

The Commission has already sent the Council two communications with a set of proposal and guidelines on the action needed to promote investment. (2)

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(1) Commission working paper II/III(82) 387 "The competitiveness of the Community industries".

(2) COM(82) 365: Commission Communication to the Council on the problem of investment; and
COM(82) 641: Commission Communication to the Council on initiatives for promoting investment.

It takes the view that the machine tool industry should be recognized as having strategic importance. Its general approach as outlined in its communications is therefore that the methods of support and the type of action to be taken must be designed in a manner that is consistent throughout the Community. This is an essential requirement for success, firstly because measures adopted nationally exert a decisive influence, secondly because the overall and sectoral approach should complement each other.

With a view to showing how the existing measures can be improved and coordinated, the Commission, in collaboration with representatives of the industry, has completed an initial study on the effectiveness of the schemes already in operation, as perceived by those they are designed to help. The Commission is to carry out more detailed analyses on this subject, after which it may propose to the Member States that they harmonize their procedures, by adopting appropriate legal instruments, in order to achieve maximum efficiency and compatibility.

The Commission has of now approved the following actions and guidelines on the objectives to be pursued, the methods to be employed and the beneficiaries:

- as regards the objectives, it is essential to remove short-term disincentives to investment and to promote the development and the rapid diffusion of new technologies throughout production processes, in the context of boosting the demand for industrial equipment;

- as to the methods:

  . as far as national mechanisms for promoting investment are concerned (of which the weakness is due to the difficulties being experienced by the users of production equipment because of high interest rates, the lack of capital and cash flow of a number of firms and sluggishness in demand) it will be proposed to the Member States that they harmonize their laws on lines that favour the most effective procedures, i.e., according to the operators concerned, systems such as tax allowances for investment and the more novel mechanisms introduced in some of the Member States (e.g. the MECA system in France, the Sabatini Law in Italy, and the United Kingdom's aid scheme for flexible manufacturing processes).

  . The Commission for its part will endeavour to ensure that companies have adequate access to the resources that can be mobilized by the Community's financial instruments. Even now productive investments by small and medium-scale undertakings

can be financed by loans from NCI funds or from the EIB itself. Recently, moreover, (1) the Commission suggested that projects eligible for NCI aid should include those that help to strengthen the Community's economy, e.g. by the diffusion of new technologies and innovations. Thus the machine tool industry has a twofold claim to loans from Community financial instruments: (a) it is largely composed of small or medium-sized firms and (b) it is a vehicle for advanced technologies. The Commission therefore intends to draw the attention of the financial intermediaries who distribute EIB or NCI global loans to the importance it attaches to this sector.

. Beneficiaries: Simultaneous action must be taken to assist both the producers and the users of machine tools in order to promote the best possible correlativity between supply and demand so that the manufacturers' ability to use their own products is maintained (it is particularly important for the manufacturers themselves to be able to use the most advanced equipment).

2. Matching supply to demand

The efficiency of the Community's industrial production system is closely dependent upon the quality of its production equipment. The process of automating manufacturing industries which started a few years ago is rapidly gaining momentum and will have a major impact on the future composition of demand for machine tools. It adds to the uncertainty of any assumptions that might be made by industrial undertakings and could entail far-reaching changes in the organization of production and in relations between the parties concerned.

In commenting on the situation, the European machine tool industry has called for an exploratory study of the market with a view to analysing the future composition of demand for machine tools and determining how the supply can be matched to it.

Clearly the industry itself will have to accept full responsibility for any such study. In view of the paramount importance of the market side of the problem and of the constraints imposed by the structure of the sector (many small and medium-sized firms), the Commission has:

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(1) COM(82) 601 final: Proposal for a Council decision on the New Community Instrument.

- agreed to the principle of providing logistic and financial support for this exploratory survey of the market, provided that the industry takes over the actual running of it - including its implementation;

- undertaken a methodological study, the results of which will be known by the end of 1982: its purpose is to define the scope of the survey, the terms of reference and the operational methods and work patterns to ensure that the means fit the ends. In view of the scale of the project it will be impossible to come to a decision on all points until thought has been given to shaping the terms of reference;

- requested the Council and the European Parliament to take account of the special budgetary requirements which the decision will entail. Since they share the Commission's view of the importance of the matter, the Council and Parliament have made a token entry against the budget item requested for 1983. In order to carry out its responsibilities, the Commission will undertake the required actions to the extent that the necessary funds may become available in the course of implementing the budget as adopted. (Estimated amount: 1.2 Million EUA).

3. Compatibility of the structural adjustments

The technological evolution now under way will bring structural changes with it. Along with questions relating to the size and organization of firms, problems will arise increasingly in connection with their financial structure, a factor that crucially affects their ability to adapt and grow. In these fields - amalgamations and government aids - the Commission has special responsibilities resulting from its powers in relation to competition, in the exercise of which it will be guided by the outcome of the exploratory survey mentioned above.

Some of the Member States have introduced sector schemes concerned with the restructuring of the machine tool industry; incentives are offered for inter-company cooperation, usually with support from public funds.

In view of the need to strengthen the competitiveness of the European machine tool industry, which is an objective common to all the Member States despite the industry's very disparate performance and level of development in them, the Commission will endeavour to create conditions under which an adjustment of the productive apparatus can take place by carrying out its responsibilities along the following lines:

- With regard to state aid, in the present situation the machine tool industry is receiving assistance from public funds under various headings. The Commission will satisfy itself, when

assessing measures to aid the machine tool industry notified pursuant to Article 93, that they provide a compensating Community interest in that they respect in principle the prohibition in regard to operating aids as provided for in the Treaty. It will re-assess the effects and transparency of general or regional systems, which may also have considerable impact on industries such as machine tools, in order to avoid disparities resulting from support procedures rather than the nature of actual aid.

- As regards measures to meet the need for closer cooperation upstream and downstream of the sector owing to technological evolution and the constraints of the competitive situation, * there are likely to be major adjustments which only the most competitive and best adapted undertakings will be able to cope with.

For these the changes now under way will mostly entail an increase in scale - economic, industrial and financial - for reasons that are partly technical (products becoming more complex in design and costlier to produce) and partly commercial (expansion of the sale of production systems and standardization of products). The Commission will not oppose the resultant structural changes. It will assess measures affecting the structure of the sector according to their conformity with Articles 85 and 86 of the EEC Treaty. The machine tool industry comprising over 2.800 firms within the Community is confronted with the adaptation of its structures to the conditions required by the research of competitiveness within a Community market which must of necessity be kept open. In this respect the Commission stresses its positive attitude towards small and medium size firms in regard to certain forms of co-operation and/or specialization which give favourable results in research, production or distribution (1).

On the third point - improvement of the financial structure of the undertakings - it should be noted that most machine tool builders in the Community are small or medium-sized firms with two pronounced weaknesses: inadequate capital resources and a disproportionate amount of short-term debt in their balance-sheets.

These weaknesses testify to one of the characteristic shortcomings of the financial environment of European firms compared with that of their Japanese competitors: the difficulty the Community financial systems have in procuring long-term, high-risk capital for a sector

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* See sections I/A/3 and II.C.1 of the attached document.

(1) Commission notice of 27.5.1970 concerning agreements of minor importance, modified by notice of 19.12.1977, O.J. C 313 of 29.12.1977, p, 3. Commission notice of 1968 concerning cooperation between firms, O.J. C 75 of 29.7.1968 p. 3 corrigendum: O.J. C 84 of 28.8.1968, p. 14. Regulation (EEC) No 2779/72 concerning the application of Article 85, paragraph 3 of the Treaty on specialization agreements, modified by Regulation No ...../82 O.J. L ... of ..... (to be published shortly).

whose current profitability does not permit it to generate sufficient funds of its own, while the small scale of the undertakings limits their ability to come to the stock market.

To help find a solution to these problems, the Commission is giving thought to the kind of framework within which the whole problem of finance for industry could be dealt with, since clearly it is one that far exceeds the immediate financing capacity of the Community institutions. Only by broad reflection on all the available mechanisms for financing businesses in the Community will it be possible to define schemes to counterbalance the advantage apparently enjoyed by foreign companies in this respect.

At this juncture, the Commission can say that:

- it is preparing a set of proposals on the means of easing the approach to the financing of innovation in small and medium-sized undertakings. The Commission plans to submit to the Council a Communication and draft Decision in the spring of 1983.
  A pilot scheme for cooperation between European venture capital companies is already available and proposals designed to encourage the establishment of an association of these specialized financial institutions are now being presented to the Council; (1)

- companies will find it easier to organize themselves on the required economic scale if the European Cooperation Grouping comes into being: it is to be hoped that a decision will emerge from the Council's examination of this Commission proposal (2) before the end of 1983.

4. Social aspects of the industrial transformation

The impact of automated production on employment and working conditions will, of course, extend far beyond the machine tool sector: it belongs to a set of wider social problems raised by the introduction of new technologies, and should be examined in that context.

Whether or not the automation of production is a success is obviously directly dependent on its social acceptability and on the willingness of all the industrial operators concerned to carry it further. It will, however, largely determine the future competitive ability of the European economy and thus the level of employment which the Community will be able to maintain in the years ahead, not only in industry itself but also in the services linked with, or dependent on, industrial production.

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(1) COM(82)251 final, 15.6.1982.
(2) Amended proposal for a Council Regulation (EEC) on the European Cooperation Grouping, OJ No C 103 of 28 April 1978.

As well as the initiatives it has already taken in matters relating to the introduction of new technologies, (1) (on which the Council is urged to decide without delay), the Commission, noting that "automated production systems" seem to diffuse and develop more easily where dialogue between the two sides of industry is most effectively organized, will lend support to efforts to improve it. The EMF and CECIMO will shortly be consulted on the expediency of organizing contacts on the subject.

It will give special attention to solving training problems in certain areas of the machine tool industry clearly defined by the industry itself.

In the more general context of assistance from the Social Fund: the Commission's proposals for the reorientation of the Fund provide in particular for the grant of assistance to persons employed in small and medium-sized firms who need training in new skills as a result of the introduction of new technologies that substantially alter the production or management methods used in them.

As regards training, the steps that need to be taken to meet requirements not at present covered (e.g. the training of systems engineers) will be examined in an appropriate setting in the first half of 1983.

5. Diffusion of advanced technologies

The competitive weakness that threatens the supremacy of the European capital goods industry lies mainly in the integration of advanced technologies and of electronics in particular. The problems in this field are not confined to the technological aspects, but take their place in the wider context of the market situation and its assessment, and the ability of the industries concerned to adapt to the new intersectoral relations required and come up with a satisfactory supply of products; the problem is one of selection by manufacturers.

Since there is no possibility of legislating at Community level - as has been done in Japan - to promote integration of the mechanical engineering and electronics industries, the selection process must be helped along by assisting the development of a suitable environment.

The real question is whether the European machine tool industry can count on a domestic supply of standardized numerical controls

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(1) See in particular "The new technologies and vocational training: new Community initiatives for 1983-87".

matching its requirements: the European market for numerical controls has been estimated at 100 000 units a year a few years from now compared with 12 000 at the present time.

To find the answer to this question, close concentration will be required between the machine tool industry and the manufacturers of numerical controls, so that the necessary investment decisions can be taken and agreement reached on the standardization of interfaces between the machines, the control systems and the operators. The implications of this choice for imports of numerical controls and the machine tools incorporating them will be considerable.

To facilitate decision-making, the Commission proposes to:

- place the topic of investment in the production of numerical controls and related questions on the agenda for a forthcoming meeting with the manufacturers concerned;

- begin immediately on a coordination and consultation exercise on interface standardization;

- approach the major machine tool users (motor and aerospace industries, etc.) with a view to their harmonizing their specifications.

In the field of research:

- it is now examining how the needs of the sector can be integrated in the 1984-87 outline programme of Community scientific and technical projects and in the various action programmes in the field of advanced technologies (data processing, micro-electronics, basic technological research and ESPRIT). (1) In this connection:

  . it has called on the undertakings in the sector to submit proposals, jointly with the electronics manufacturers, for ESPRIT pilot projects; (2)

  . action to meet the specific requirements of the machine tool industry will be proposed in the context of the Community support scheme under the data processing programme;

- the Commission will continue to promote active coordination of research support policies in the Member States along the lines recently proposed. (3) The Commission will take the initiative in arranging talks at Community level between the leading public and private sector heads of research in the machine tool field.

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(1) Towards a European strategic programme for research and development in information technologies (COM(82)287 and 486).

(2) Especially the projects "Design rules for computer-integrated manufacturing systems" and "Integrated microelectronic subsystems for plant automation".

(3) COM(81)574 final "Scientific and technical research and the European Community - Proposals for the 1980's".

6. The external aspects

The European machine tool industry is the world's leading exporter: hence its very survival depends on its ability to compete internationally. The industry's net exports are such that to isolate it from international competition would be (1) catastrophic.

The trend in the pattern of trade over the last two years shows a decline in its ability to face up to external competition and has given rise to commercial tensions in certain vulnerable segments of the market. (2)

The success of the recovery strategy which the European companies have embarked on will depend very much on a favourable environment which the authorities will help to create at home and abroad.

The need for more cohesion between the strengthening of industrial competitiveness and external strategy was stressed by the Council of the European Communities when, in March 1982, it asked for the setting up of a high-level working party to study questions relating to the interrelations between structural adjustment and commercial policy, having regard to the implications of Japanese export strategy for European industry. Along with the motor vehicle industry and the manufacture of television sets, the machine tool sector was one of the first subjects discussed by the working party.

For an external strategy to be effective it must be based on the Community's ability to reconcile its industrial objectives with the maintenance of satisfactory commercial relations from the point of view of safeguarding free trade.

At this stage, the Commission considers that the following points should be borne in mind:

- in the first place, the machine tool industry and, more generally, the robotics industry are strategic sectors in which the development of technico-economic relations that would place the Community in a position of dependence must be ruled out in advance. The only possible response to the risk that it may happen is to have productive capacity with a sufficient degree of self-sufficiency and competitiveness. The question still unanswered is, of course, the time required for the necessary adjustment process to come to fruition;

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(1) 2 411 million dollars in 1982.

(2) The rate of Japanese penetration in the Community market for machining centres is estimated by CECIMO at over 35% in unit terms for 1980 and about 30% for numerically controlled lathes, compared with 4.2% and 17.9% respectively in 1976.

- from this point of view, the most striking factor is the disparity of situations and attitudes within the Community, especially from the standpoint of the strategies and policy lines adopted by the authorities. We should avoid any measures that would endanger the advantage the Community industry now derives from the variety and fluidity of its internal market or would jeopardize its chances of recovery, for which solidarity within the Community is vital. This applies both to actions which tend, either overtly or in effect, to close off the internal market and also to those that re-open the question of the Community's integrity by favouring external alliances to the detriment of its industrial solidarity. Often these breakaway actions are motivated and justified by the intolerable delays in the Community's decision-making process. The Commission will do its utmost to avoid that happening in the case of the machine tool industry.

The Commission will use to the full all the means at its disposal to bring into operation a commercial policy at Community level, especially vis-à-vis Japan, on the basis of the guidelines adopted by the Council in this regard.

The European machine tool industry can only maintain its position as the leading world producer by adopting a positive attitude to counter the general weakness in investment, the increasing international competition and the changes brought about by the integration of electronics into industrial equipment.

The Commission, having taken note of the willingness of the manufacturers to take this course and their hope in making that effort to get assistance at Community level, intends to go along with that standpoint and the introduction of such an approach.

It is in this spirit that it will develop, in the coming months, its discussions with the other Community institutions and groups, the governments, professional organizations, trade unions and its principal trading partners.

Source: The European Machine Tool Industry, Commission Statement, Situation and Prospects, Commission of the European Communities, SEC (83) 151 Final, Feb. 8, 1983, pp. 4-15.