CHAPTER 7

Prospective Competitive Futures

Contents

List of Tables

List of Figures

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Overview

At several points, earlier chapters touched on the futures of the steel, electronics, and automobile industries. Here, probable trends in each sector are examined more directly—a rather speculative exercise. Although attempts are made to look ahead to the end of the century, uncertainty quickly mounts past the next few years.

A major source of uncertainty is the timing of technological developments, This is particularly true in electronics, where the technology is evolving rapidly. Even in steel, new process technologies could bring significant departures from present methods—such as direct reduction of iron ore, in limited use already, or plasma arc steelmaking. Although potential technological changes in the automotive industry may not seem as radical as in other sectors, newly refined powerplants, increasing use of electronics, and downsizing and repackaging represent substantial shifts in automobile design.

The future prospects of these sectors depend heavily on rates of economic growth for both the United States and the world. In an unstable international political and economic environment, long-term growth remains largely unpredictable, though reasonable bounds can be drawn. For instance, it is unlikely that the industrial nations will soon regain the growth rates of the 1950's and 1960's. At the same time, by the end of the 1980's, rates of economic growth in the industrialized world seem likely to surpass the depressed rates of the 1970's. The developing countries are not expected to do much better in the current decade than in the 1970's, although their growth rates should continue to exceed those of the industrialized nations.

The competitiveness of the American steel industry during the rest of the century will depend heavily on the ability of firms to generate and attract capital for modernization, on continuing shifts of production to new and efficient nonintegrated mills, and on the strength of competition from imports. Some of this import competition will arise from burgeoning steel capacity in the developing world. Domestic steel demand will rise only slowly. U.S. capacity will likewise remain relatively stable—perhaps increasing slowly, perhaps contracting slightly.

In electronics, as technology continues its rapid advance, sectors such as semiconductors and computers will remain sources of U.S. strength. Market growth will be fueled by a multitude of new applications. Competition on a world basis will intensify, but the United States should remain the leader in both technology and production—though its world market share will probably continue to decrease somewhat—provided that the industry's needs for capital, manpower, and open markets are met. It is also likely that more labor-intensive operations will continue to move abroad, where wage rates are lower.

Automobile sales will, as for steel, experience only slow growth in the developed countries because markets are close to saturation. Growth in demand will be considerably higher in the Third World, particularly in wealthier, rapidly industrializing countries. But while independent steelmaking firms are common in developing countries, automobile manufacture will be dominated by a few large corporations operating on a translational basis with widespread production facilities. Two of these firms are likely to be American-owned, Foreign competition in the ,lucrative U.S. market will remain intense. No doubt imports will have continuing success, but their penetration in the United States may recede somewhat from 1980 levels,

Economic Growth

A key determinant of the future prospects of the American steel, electronics, and automobile industries will be economic growth—both in the United States and in the rest of the world. A healthy domestic and international economy is vital to these, as to other industries, because it makes adjustment to changing circumstances—e. g., adoption of new technologies—easier.

Assuming a moderately expanding labor force, relatively slow increases in Government expenditures, and a gradual decline in inflation and unemployment rates between 1980 and 1990, the U.S. gross domestic product (GDP) should grow at roughly the same rate as for the past 30 years: about 3,3 percent per year in real terms (table 25). In the 1970's the average was somewhat less.

Table 25 indicates that in other industrialized countries, rates of growth are also expected to accelerate. The period from 1950 to 1970 was one in which GDPs in Europe (with the exception of the United Kingdom) and Japan grew at rates considerably above that of the United States. All experienced major declines in rates of growth during the l970's. The continued high growth rates expected for Japan are noteworthy, although these are much lower than for the 1950's and 1960's.

Slow growth in the industrial countries will have its effects on developing nations. The Third World is heavily dependent on industrial countries as markets for exports, Given favorable international economic conditions, developing countries should be able to sustain economic growth rates roughly equal to the 5- to 6-percent level of the 1970's (see table 25). As might be expected, oil-exporting developing countries have excellent prospects for the coming decade,

The following sections, dealing with the steel, electronics, and automobile industries individually, assume moderate economic growth. If expansion in the U.S. and world economies is substantially below the forecasts, impacts on the steel and motor vehicle industries are likely to be severe; these industries are particularly vulnerable to economic downturns. The outlook would be less clear for electronics, which at times in the past has seemed almost recession-proof, and at other times has shared in aggregate downturns.

Table 25.—Economic Growth Rates, 1950-90 (gross domestic product (GDP))

	Average annual rate of growth of GDP in real terms				
	1950-60	1960-70	1970-77	1978-85[P]	1985-90[P]
united States	3.2%	3.90/0	3.1 %	3.70/0	3.0°A
France	4.8	5.6	4.0		
West Germany	8.5	4.7	2.6	:.;	;.:
United Kingdom	2.8	2.8	1.9	2.4	2.9
Japan	8.0	11.1	5.2	5.9	5.0
All industrialized countries	na	5.1	3.1	3.0- 3.7% for the 1980's	
All developing countries	na	5.6	5.6	4.8- 6.6% for the 1980's	

P = projected na = not available

SOURCES Historical— Individual countries Statistical Abstract of the *United* States, 1979
All industrialized countries *World Development Report,* 1979 *and 7980* (Washington, D C The World Bank, 1979, 1980)
Projections–Energy Policies and Programs of IEA Countries, 1979 Review (Pans Organization for Economic Cooperation and Development, 1980), pp 54, 121, 151, 212, and 223, *World Development Report, 1979,* p 18, and *World Development Report, 1980,* pp 6, 11, and 99

Steel

The competitiveness of the American steel industry over the next 20 years will be shaped by:

1. the adoption of new process technologies, both those already proven and those still in the developmental stages (new steel technologies are discussed in detail in the OTA steel study);
2. continued restructuring of the domestic industry, with nonintegrated firms taking a larger share of the market:
3. structural change in the world steel industry, including the emergence of developing countries as major steel producers and the possibility that overcapacity may persist;
4. continued reliance by U.S. steelmaker on domestic market demand as the primary spur to growth; and
5. public policies, particularly those that affect the ability of the U.S. industry to generate and attract capital for modernizing and improving productive efficiency.

In addition, developments such as increasing prices for raw materials and energy, and domestic inflation will be important. Few large integrated mills are likely to be built in any of the industrialized nations. Market growth in the United States will be slow, and demand met by modernizing existing mills to increase yield and productivity, by roundout additions to capacity, and by constructing relatively small nonintegrated mills.

Supply and Demand

Table 26 summarizes forecasts for the world steel industry. Most estimates indicate relatively slow growth in total steel capacity until at least 1985. Projected growth rates for capacity in the 1980-85 period range from zero to about 1.3 percent. Higher growth in capacity is expected for 1985-2000 as the excess of capacity over demand diminishes.

Table 26.—World Raw Steel Capacity and Demand Estimates (millions of tonnes)

	Capacity		Demand	
Year	Western countries	World total	Western countries	World total
1980. . . .	555-590	725-840	435-545	-680
1985. . . .	610-660	-820	535-625	760-860
1990. . . .	-720	-1,100	700-725	1,000-1,100
2000. . . .	-1,100	-1,400	-1,100	1,350-1,550

SOURCES Adapted from Technology *and Steel Industry Competitiveness* (Washington, D C Office of Technology Assessment, U S Congress, June 1980), p. 146, also, .Steel *in the* 80s, Organization for Economic Cooperation and Development Paris Symposium, February 1980 (Paris Organization for Economic Cooperation and Development, 1980), pp 90 and 125

The United States is expected to continue to be a net importer of steel. According to estimates by the Bureau of Labor Statistics, imports will grow slightly faster than exports and the trade deficit in steel may approach $4 billion (in 1972 dollars) by 1990.[1]

Future Competitiveness

A fundamental competitive problem for the American steel industry is that on average it is no longer the world's most efficient producer (and has not been since the 1960's). A basic question then is: What are the prospects, with and without new public policies, for the industry to become competitive in production costs? This is difficult to answer. First, while the Japanese may now be the world's low-cost producers, other nations could become prime market opponents of both the United States and Japan in the future. In fact, the Japanese have already sensed their longer term vulnerability and begun to reduce the relative importance of the steel sector to their economy. Japanese industrial policy is now based on the assumption that the country is becoming relatively disadvantaged in steel.

[1] *Employment* Projections *for the* 1980's, BLS bulletin 2030 (Washington, D.C.: Department of Labor, Bureau of Labor Statistics, 1979), pp. 79 and 82.

A second factor complicating estimates of the future competitiveness of the U.S. industry concerns the effects of capital investment. As discussed elsewhere, up to a quarter of U.S. steelmaking capacity is obsolescent. Modernizing this plant' and equipment would increase yields and productivity, decrease energy use, hence cut production costs. All of these are desirable, but new investment cannot guarantee a meaningful increase in U.S. competitiveness in steel. A variety of other factors—both inside and outside the United States—are also important. Although the circumstances certainly differ, the Government of the United Kingdom has invested heavily in steel with no appreciable impact on the ability of the British industry to compete.

Competitiveness also depends, for example, on the characteristics of existing and prospective processing technologies. If steelmaking remains relatively labor-intensive, nations with low wage rates may be able to maintain advantages. If new processing technologies depend on natural gas or petroleum, then countries with abundant supplies of these fuels would benefit. Continued use of coal-based processes would work to the advantage of the United States.

The American steel industry clearly must modernize its plant and equipment by installing technologies that improve yields and productivity and lower costs, just to maintain its competitive position. Among the technologies for which U.S. firms lag in installation and use compared to countries such as Japan are continuous casting and computerized process control. [2] Other important new technologies—some available now, others prospective—include: refinements to the basic oxygen process involving energy savings, control of alloy content, desulfurization, and degassing; direct quenching of rolled products; and a variety of other thermomechanical processing methods, often continuous. Further off are technologies such as large-scale installations for direct reduction of iron ore, plasma steelmaking, and continuous steelmaking. At least some of these are likely to be practical realities by the end of the century.

There is another difficult technological question relating to the future of the steel industry. Efficient scales of operation could move downward with the advent of new processing technologies. For example, the OTA steel-study suggests that direct reduction (DR) processes, apparently already economic in some parts of the world, may soon be more cost efficient in the United States as well. The technical data on DR processes, thus far confined to smaller plants, indicate that scale economies may be less significant than for present steelmaking methods. Moreover, DR appears to be both capital- and labor-saving, although more intensive in its use of energy. Such factors could have substantial impacts on the industry. For example, the potential cost advantages of large facilities based on blast furnaces might diminish, creating a tendency for dispersion of the industry to regional production centers, Internationally, the DR process would give advantages to countries with ample supplies of natural gas, such as Mexico.

What, then, is the outlook for the American steel industry? Production increases at somewhat more than 1 percent per year could be achieved by improvements in yield and productivity stemming from modernization and replacement of capacity. Little or no new capacity would be needed under such circumstances, In addition to modernization—which may be limited by the ability of the industry to generate and attract capital—a number of other factors will help maintain U.S. competitiveness:

1. Major competitors such as Japan can no longer expect large productivity improvements from building new greenfield plants using the latest technology. Because Japan, like the United States, will be adding little if any new capacity, future productivity gains will result from incremental improvements to existing mills. The U.S. industry should be able to

'Technology and Steel Industry Competitiveness (Washington, D. C.: Office of Technology Assessment, U.S. Congress, June 1980), ch. 9.

Photo credit American iron *and Steel/ Institute*

Continuous casting and rolling of steel

retain parity in absolute labor productivity, provided it can continue to operate at higher levels of capacity utilization than Japan.

2. Long-term price trends for raw materials used in making iron and steel—especially energy—should favor the United States, Rising transportation costs will harm the price competitiveness of imports in U.S. markets.
3. In the United States, obsolete mills with high production costs are being closed—a rationalization that was probably inevitable. This will help maintain high labor productivity.
4. New and efficient nonintegrated mills are being built in larger numbers.

An important counterweight to optimism is the possibility of continued excess capacity on a worldwide basis. Substantial overcapacity would almost inevitably lead to attempts by foreign producers to dump steel in the United States.

The American industry has been combating dumping for more than 20 years. As a cause of lowered domestic prices and profits, its seriousness remains a matter of debate. { A recent survey by the General Accounting Office found that—along with price—quality, plus the availability of some kinds of mill products, were major factors leading to purchases of imported steel.[4] The large integrated firms, however, claim that dumping is the single most serious problem facing American steelmaker. If excess world capacitiy exists, dumping will almost certainly continue to be a concern—one that may be aggravated where governments own or control steel industries and face strong pressures to maintain employment.

Recently it appears that industry and Government in the United States have moved closer to accommodation on the control of dumping. The latest development-part of the Carter administration's steel revitalization program—takes the form of a reconstituted trigger-price mechanism (TPM). TPM, like other antidumping remedies, is likely to remain a source of conflict, particularly when imports expand and the industry believes the trigger price is too low. However, trigger pricing is more manageable than existing antidumping laws for dealin~ with widespread and persistent complaints.

Other Government policy initiatives might also help to improve the outlook for the industry. These could take the form of aggregate policies designed to stimulate business in

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[3]R. W. Crandall, "Steel Imports: Dumping or Competition" *Regulation*, July August 1980, p. 17.

[4]*New Strategy Required for Aiding Distressed Steel Industry* (Washington, D.C.: General Accounting Office, Jan. 8, 1081), pp. 3-3 to 3-7.

general, or sector-specific programs targeting the steel industry.

Aggregate stimuli are generally intended to encourage new investment by increasing rates of return on invested capital. Most such policies fit into two broad categories: 1) measures that reduce corporate taxes and so increase cash flow; and 2) measures that encourage savings, reducing interest rates and lowering the cost of capital.

Investment incentive schemes would stimulate some investment across the entire steel sector, but most such proposals would have differential effects on various subdivisions of the industry. The large integrated firms have been steadily increasing their long-term debt, and in many cases now appear near the limits of their fundraising abilities in established capital markets. Decreases in effective corporate tax rates—for example, by accelerated depreciation schedules, such as the much-discussed 10-5-3 proposal—would increase the internally generated cash flow available to such companies (for nonsteel diversification as well as steelmaking), While the steel industry presently must depreciate its capital equipment over longer time periods than most other U.S. industries, many proposed tax modifications would increase the ability of industries throughout the economy to attract external capital, Under such conditions, the relative attractiveness of investment in steel might not increase,

In general, accelerated depreciation favors larger firms with larger absolute profits. As a result, such measures might benefit the major integrated steelmaker more than nonintegrated and specialty producers. To the extent that investors judge the latter to have better prospects for high profitability, however, tax changes could help them attract outside investment.

Aggregate (rather than sector-specific) programs fostering the development of new technology would probably not have large effects on the steel industry, Steelmaker have not in the past made heavy investments in R&D (less than 1 percent of sales, well below many other U.S. industries),[5] presumably believing the returns insufficient. Aggregate R&D incentives would be likely to have their greatest impacts on supplier firms. Developments by such firms in process equipment or controls would be available to both domestic and foreign steelmaker, and therefore would probably have only marginal net effects on competitiveness. Sector-specific incentives or programs for steel R&D would be more likely to enhance the long-run competitiveness of the U.S. industry.

For reasons such as those outlined above, the OTA steel study concluded that without targeted Government support the industry might be unable to modernize and build its competitiveness. Examples of the forms such assistance might take can be found in the steel revitalization program announced by President Carter on September 30, 1980. In addition to the modified TPM, it included proposals for liberalized depreciation allowances, tax credits for investment, relaxed environmental standards, increased adjustment assistance, and initiatives to encourage R&D.

Most observers agree that at the core of the industry's difficulties are its very large capital needs for modernization—table 27. The capital base for the industry is now as much as 25 percent obsolescent; just to replace the outdated capacity would cost more than $30 billion,[6] The renewal or high-investment scenarios in the table would require substantial Government assistance, much greater than the Carter steel plan provided for.[7] The potential effects of such assistance on competitiveness can only be judged in the context of structural changes occurring elsewhere in the world steel industry.

Although the American steel industry is primarily domestic—with few exports or foreign investments—its future is inextricably tied to the changing competitive environment worldwide, At present, Japan is the most effi-

[5] *Technology and Steel Industry Competitiveness*, op. cit., p. 275.

[6] *New Strategy Required for Aiding Distressed Steel Industry*, op. cit., p. 2-9.

[7] Ibid., p. 7-12,

Table 27.—Scenarios for the American Steel Industry

	Scenario	
	Slow decline	Renewal/high investment
Capital investment[a]	Low	$3 billion (OTA renewal scenario) to $5 billion ("high Investment" scenario proposed by Industry)
Change in capacity	Zero or decrease	Moderate increase (about 1590 per year)
Import penetration	May rise to 30% or more	Remains at about 15°/0

[a]For modernization and capacity expansion only Does not include Investment for meeting Government regulations or for non steel diversification

SOURCE *Technology and Steel Industry Competitiveness* (Washington D C Office of Technology Assessment U S Congress June 19801 ch 2

cient steel-producing nation; European firms enter the U.S. market when they have excess capacity. However, developing countries are becoming significant factors, now accounting for about 30 percent of U.S. imports. Despite mill construction costs in industrializing countries that may be 20- to 30-percent higher than in the United States,[8] Third World steel capacity is expected to reach 100 million to 105 million tonnes by 1985, This would increase their share of free world production to 15 percent, versus 10 percent in 1978. Most of the new capacity will be used to meet internal needs, but some Third World steel may find export markets in the United States and other industrialized nations, including Japan. Countries such as Korea have already taken over some Japanese export markets. In virtually all industrializing countries, steel production plays a central role in development strategies. Symptomatic of the growing importance of the steel industries of the developing world is a recent estimate by the International Iron and Steel Institute that, for 1980, steel production in the industrialized countries fell by 8 percent, while rising 4 percent in developing countries.[9]

An increasing number of technology transfers and financing consortia are being arranged between developed countries such as Japan and those which are now industrializing such as Brazil.[10] Over the next 20 years, the latest technology and methods could become concentrated in those countries installing new facilities. It is quite possible that Third World steel industries will develop along patterns similar to those found in advanced countries such as the United States: a small number of firms in nations with integrated steel capacity may produce most of the raw steel output of the region or group of countries they serve (just as a relatively small number of integrated companies supply most of the U. S. market). In addition, a much larger number of nonintegrated companies might use electric furnaces and/or finishing equipment to produce or finish the simpler kinds of steel products. (Over 50 developing countries have some type of steel industry, but only 19 have integrated steelmaking capacity.)

Such factors need careful analysis before new public policies are designed. Increased investment in the United States could lower the average age of plants and raise productivity without substantially enhancing competitiveness—but be necessary just to maintain the present position of the American industry.

[8]*Technology and Steel Industry Competitiveness*, op. cit., p. 326

[9]"World Crude Steel Output Drops," *ASM News*, February 1981, p. 1.

[10]*Technology and Steel Industry Competitiveness*, op. cit., p. 302

Electronics

Predictions about the future of the electronics industry are risky because the technology is evolving so rapidly. Even where developments seem to be following stable and predictable paths, surprises can occur. It is not only impossible to project trends in electronics technologies very far—particularly for semiconductor devices and their applications—it is also difficult to forecast applications in other industries,

Automobiles, for example, are becoming an important market for integrated circuits (ICS). Other applications that are providing (or will provide) large markets include: office equipment such as word processors, electronic funds transfer systems, electronic mail as well as telephone and other communications systems, and the continually expanding market for digital logic and memory in computer systems. Generalities about such applications are easy, But the timing of growth in markets, their eventual dimensions, and the sorts of technologies that will prove dominant are more problematical.

Supply and Demand

No long-term projections of worldwide demand for electronics products are available. Short-run sales forecasts generally predict growth at better than 10 percent per year for most segments of the industry. [11]

Longer range estimates for the United States alone have been made. Table 28 is a forecast, by broad categories, of sales in the United States of electronics end products for 1987. This table indicates that total sales will more than double over a 10-year period. Such predictions are typical of the continued rapid expansion expected in this industry. The fastest growing segment is expected to be computers—the slowest, sales to Government and the military. The table also projects that U.S. consumer electronics markets will expand at lower than average rates, While table 28 includes only end products, components such as ICs and other semiconductor devices will grow at least as rapidly as the average for end products.

Of the three sectors of particular interest —consumer electronics, semiconductors, and computers— consumer electronics sales will also grow the slowest on a world basis—at least in the developed countries. Markets for more mature consumer products—e.g., TVs and home audio equipment—will increase at relatively moderate rates.[12] Sales of newer consumer products—video-cassette recorders/players (VCRS), digital clocks and watches, microwave ovens, video games— are expected to grow more rapidly. Markets for many of these products are far from saturated. If prices fall, and particularly if some rationalization of VCR technology occurs, consumer demand should be strong.

Semiconductors will show stronger growth than consumer electronics. Table 29 gives near-term estimates of world semiconductor production. In this table, overseas production by U, S.-owned firms is attributed to the United States, On this basis, growth in IC production for American-based companies (both merchant and captive) is expected to average over 20 percent for the next few years. Slower rates of growth, near 10 percent per year, are projected for Europe. In Japan, 20-percent growth rates are also anticipated,

Sales of computers and related data processing equipment are also expected to increase at high rates, The most rapid growth will be in minicomputers, desktop or personal machines, and small business computers, Office automation and data communications will expand at comparable rates.

Exports of computers and peripheral equipment have been projected to increase at

Table 28.—U.S. Markets for Electronics, 1978 and 1987 (billions of current dollars)

	Sales	
	1978	1987
Business/office	$ 5 (6%)	$15 (8%)
Communications	1 3(1 7°/0)	32(1 7%)
Consumer	8 (10%)	14 (7%)
Computers	23 (30°/0)	63 (33%)
Government/military	16 (21 %)	34 (13%)
Industrial	6 (8%)	14 (7%)
instruments	6 (8%)	16 (8%)
Total	$77	$191

SOURCE: H H Jones, 'Forecast of VHSIC/VLSI Market s," VHSIC *A New Era in Electronics,* San Francisco, Calif , American Institute of Aeronautics and Astronautics, May 15.16, 1980

[11] P. Evison, Electronics: *The Market to 1982* (London: The Financial Times Ltd., Business Publishing Division, 1978], p.5.

[12] Ibid., p. 33.

Table 29.—Estimated World Semiconductor Production by Geographic Location of Firm Headquarters (millions of current dollars)

Headquarters location	Production 1978	1980	1981	1982
United States				
Ics				
Merchant	$3,238	$5,640	$ 7,330	$ 8,790
Captive	1,344	2,580	3,400	4,080
Total ICs	$4,582	$8,220	$10,730	$12,870
Discrete semiconductors	1,540	2,200	2,530	2,910
Total semiconductors	$6,122	$10,420	$13,260	$15,780
Western Europe				
Total ICs	$ 453	$ 680	$ 750	$ 830
Discrete semiconductors	960	1,080	1,150	1,220
Total semiconductors	$1,413	$1,760	$ 1,900	$ 2,050
Japan				
Total ICs	$1,195	$1,850	$ 2,220	$ 2,660
Discrete semiconductors	1,295	1,570	1,730	1,900
Total semiconductors	$2,490	$3,420	$ 3,950	$ 4,560
Rest of world				
Total ICs	$ 482	$ 730	$ 940	$ 1,130
Discrete semiconductors	985	1,050	1,090	1,130
Total semiconductors	$1,467	$1,780	$ 2,030	$ 2,260
Total integrated circuits	$6,712	$11,480	$14,640	$17,490
Total discrete semiconductors	4,780	5,900	.6,500	7,160
Total semiconductors	$11,492	$17,380	$21,140	$24,650

SOURCE Status '80(Scottsdale, Arlzintegrated Circut Engineering Corp ,1980), p 4

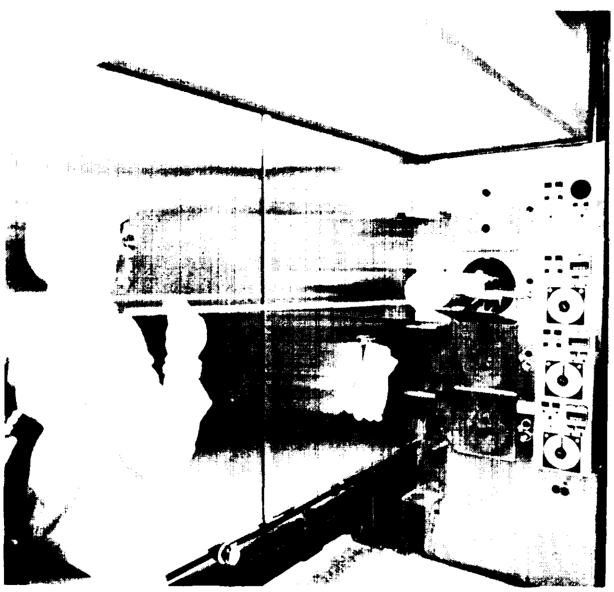


Photo credit National Semiconductor Corp

Semiconductor wafers being loaded into diffusion furnace

an annual rate of 6.3 percent, far outstripping the 2.7-percent growth rate for imports.[13] By 1990, the dollar value of computer exports should be more than 12 times the value of imports.

The rapid growth and technological change expected throughout much of the electronics industry should make it easier for the United States to maintain its competitiveness, These are the conditions under which American firms typically thrive,

Technology

The consumer electronics sector might be considerably altered by the successful commercialization of new product technologies such as flat screen TVs, particularly if the innovators are firms outside the mainstream

[13] *Employment Projections for the 1980's*, BLS bulletin 2030 (Washington, D.C.: Department of Labor, Bureau of Labor Statistics, 1 979), pp. 79 and 82.

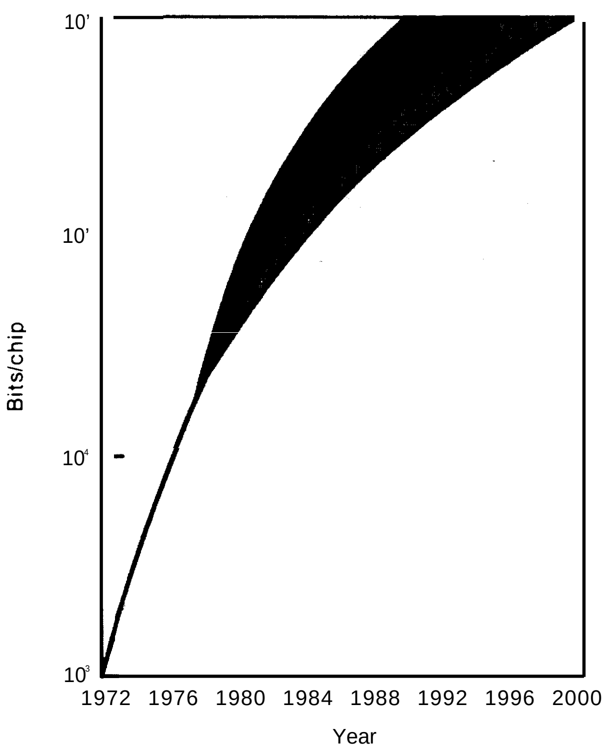
home entertainment sector. Microcomputers for home use may also become important consumer products, perhaps evolving along with VCRs, video toys and games, and TV receivers into integrated home entertainment and information systems. The timing of such developments is unpredictable.

Progress in major categories of semiconductor devices—such as ICS for computer memory or microprocessors—seems at present to be following predictable patterns. For memory circuits, as density increases (fig. 11), costs per bit go down (fig. 12). Figure 11 indicates that the rate of density increase in dynamic random access memories (RAMs) is slowing; the 64K RAM is still in infancy and may not outsell 16K devices until 1983, production of 64K RAMs having proven more difficult than anticipated.[14]

Microprocessors are likewise continuing their evolution—from 4 bit to 8 bit to 16 bit. The market has yet to decide which of the various 16-bit microprocessor designs will be the biggest sellers, but 32-bit processors are already on the horizon. Needless to say, there is also continuing evolution and innovation in other types of semiconductor devices, for example, gate arrays for logic, displays, and solid-state transducers. Among the most important are ICs for interfacing digital circuitry with the analog world—essential for

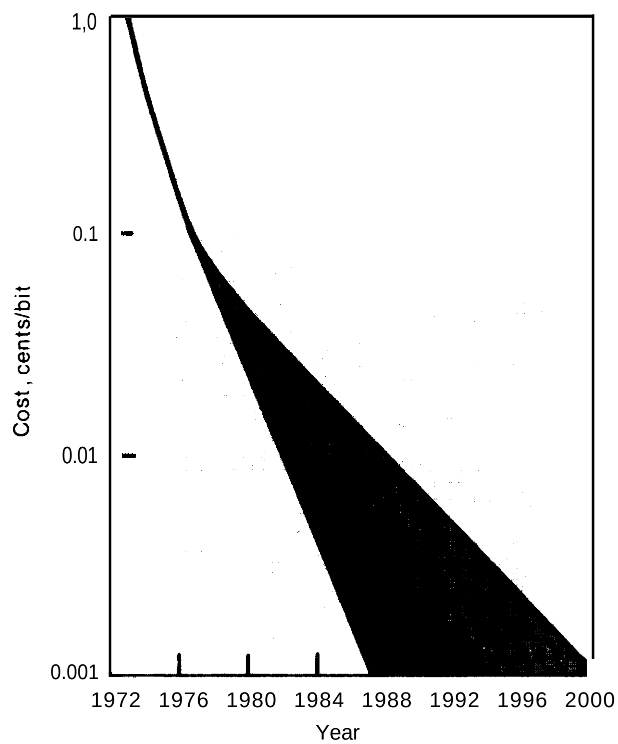
[14] J. G. Posa, “Dynamic RAM’s: What to Expect Next, ” *Electronics*, May 22, 1980, p. 119.

Figure 11 .—Projected Increase in Density of Random Access Memory Circuits



SOURCE K D Wise, K Chen, and R E Yokely *Microcomputers: A Technology Forecast to the Year* 2000 (New York John F Wiley & Sons, 1980), p 57

Figure 12.— Projected Decrease in Cost per Bit for Random Access Memory Circuits



SOURCE K D Wise, K Chen, and R E Yokely, *Microcomputers A Technology Forecast to the Year 2000 (New* York John F Wiley & Sons. 1980). p 57 many applications of semiconductor electronics.

In several respects, computer technology evolves in parallel with that of semiconductors. This has been true since the late 1950's, when discrete transistors were adopted for second-generation mainframe machines; logic and memory for computers are now firmly based in IC technology. Innovations such as Josephson junctions for processing, and optical storage, may find a place in the future; but in 1981 computer hardware continues to depend on silicon logic and memory for most such functions, Much of the other hardware in computer systems uses quite different technologies—e. g., disk and tape drives for mass storage, cathode ray tube display terminals, card readers, printers. But even the electromechanical input/output devices depend in various ways on semiconductors.

Computer hardware is diversifying in technology and range of capabilities as minicomputers and microcomputers grow in importance. Furthermore, microprocessors are being used in many new dedicated applications to make other machinery and equipment ''smart '—whether automobile engines, telephones, or toys. The bottleneck in many cases—whether computers for computing or for dedicated applications-is software. While hardware costs have been falling, programing costs have not; productivity in software is about the same now as 10 years ago. Furthermore, good programmers are in short supply (ch. 5), Thus, the proportion of user cost accounted for by software has gone up rapidly. In some cases, software represents 90 percent of the cost to the user. While the United States leads the world in software as in hardware, the software bottleneck is a potential constraint on the future growth of computer sales and on applications of microprocessors and computers.

Future Competitiveness

Chapter 5 examined the present competitive positions of the U.S. consumer electronics, semiconductor. and computer industries. While the consumer electronics sector did not appear particularly healthy, both the semiconductor and computer sectors continue to be vigorous, and very strong internationally.

If past trends continue, the prospects for the U.S. consumer electronics industry seem mixed at best. American firms face continued strong competition from foreign producers on cost as well as noncost dimensions, particularly in products such as TV receivers. Imports already constitute 85 percent or more of U.S. consumption of black and white TVs, VCRs, household radios, and CB radios (see table 16 in ch. 5). Although import penetration in color TVs is much lower, this is due to restrictions imposed by Orderly Marketing Agreements.

There are two basic questions for future competitiveness:

1. To what extent is labor intensity likely to fall as a result of new technologies. allowing U.S. firms to repatriate offshore operations?
2. Will American firms be able to compete in new generations of consumer electronics products?

The first question depends on both product and process technologies, Automated manufacturing requires product technologies appropriate to the available process techniques. For example, vacuum tubes were too fragile for automatic insertion using methods available for transistors and ICs. In any case, although labor content for many products will continue to fall, competition in the consumer electronics sector is so intense that low wages in overseas locations will probably continue to attract much of the value-a(i(ied. Japanese firms are also moving to other far Eastern countries with lower wage levels.

The second question deals with the ability of U.S. firms to compete in emerging consumer electronics products. Just as most U.S. TV manufacturers lagged the Japanese in adopting sol id-state designs, American firms did not aggressively develop new ho)me entertainment products during the 1 970's (except for electronic toys and games). No American company makes consumer VCRs. In video disk players, RCA is making a strong bid, but faces intense competition from disk systems developed in Europe and Japan.

Outside the traditional home entertainment (radios, TVs) portion of the industry, U.S. firms have been much more aggressive in developing new products—e,g., home computers, electronic toys and games. The Japanese have not yet mounted a challenge to U.S. microcomputer producers. As the markets for these products grow, Japanese companies will probably begin to compete in hardware, but may have more trouble developing attractive software packages.

U.S. firms do not retain the technological advantages of 10 years ago in semiconductors or computers. Even so, their positions remain strong. In both industries, the United States is a leader in innovation and new product development— simply not as far ahead as in the past. There will be vigorous future competition in both sectors, particularly from Japanese companies.

As in any industry which is rapidly growing, ample opportunities will exist for both gains and losses in market share—depending on factors such as success at R&D and product development, as well as marketing. Further shakeouts in semiconductors and computers may occur, and more American firms could be absorbed through mergers or takeovers. In some cases, foreign manufacturers may establish strong positions, as they have in consumer electronics. On an overall basis, however, the United States should remain the strongest force in the world market for semiconductors and computers. At the same time, the relative strength of the United States will probably decline,

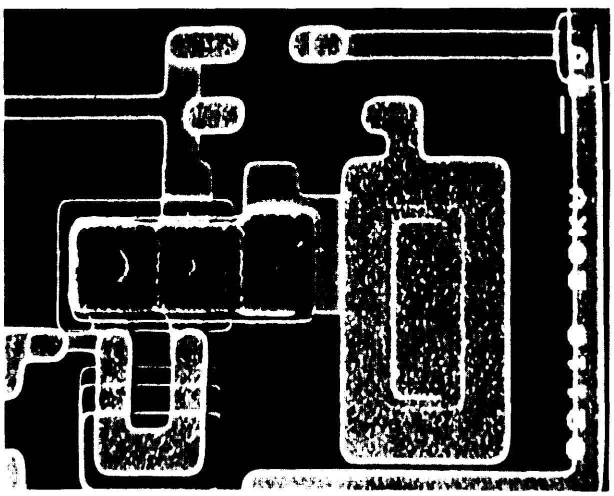


Photo credit IBM Corp.

Experimental Josephson junction logic gate—a candidate for future computers that could operate many times faster than those of today

To maintain competitiveness in the future, U.S. firms must have: 1) sufficient capital to keep pace with rapidly expanding markets; 2) an adequate supply of technicians, engineers, and scientists to staff their operations; and 3) access on fair terms to foreign markets. Not all manufacturers will fare equally well in meeting these needs. Profits in the semiconductor industry have sometimes failed to keep pace with capital needs for expansion, According to several estimates, the U.S. semiconductor industry may have to invest more than $30 billion during the 1980's to maintain its current market position (ch. 5). Not only is the industry growing, it is becoming more capital intensive; an IC fabrication facility cost about $2 million in the late 1960's—now the cost is $50 million or more,

Virtually all U.S. electronics firms could benefit from public policies encouraging increased R&D, and investment in new production facilities. Among the suggestions have been tax credits for R&D, encouragement of industry-funded R&D in universities, and cooperative (Government/industry/university) technology centers, Most costs associated with R&D—in this or any industry—can now be deducted in the year incurred: but R&D typically amounts to only a small fraction (e.g., 10 to 20 percent) of the expenses associated with commercializing new products or processes. Thus, tax policies in the United States are not a particularly strong stimulus for innovation, " In foreign countries, incen-

[15] C. A. Barrun, "Microelectronics: A Survey," *The Economist*, Mar. 1, 1980, p. 4.
[16] T. Gallagher, "Tax Policy and Industrial Innovating, " Congressional Research Service, Jan. 11, 1980.

tives are often more extensive. The Japanese Government, for instance, gives a tax credit of 20 percent for increases in R&D spending, as well as a variety of sector-specific tax breaks—for example, to firms developing computer software. Given the importance of R&D in electronics, there is ample scope in the United States for new policies to stimulate developments in both product and process technologies, and in particular to encourage the commercialization of R&D.

Accelerated depreciation of manufacturing equipment would not affect semiconductor producers to as great an extent as firms in many other industries. Equipment used by semiconductor manufacturers can already be depreciated rapidly because the advancing technology makes equipment obsolete in short order. Changes in depreciation schedules might be more beneficial to consumer electronics firms.

A more generalized policy for encouraging capital investment, designed to stimulate the venture capital markets which are important for many high-technology industries, would be to allow capital gains tax rollovers; if funds were reinvested within a specified period of time, capital gains taxes would be deferred. There are many other possible avenues for encouraging new capital investment broadly across American industry. The effects of such policies vary widely among sectors—and among firms within a sector, The costs and benefits of such policies can in fact only be evaluated on a sector-by-sector basis.

Public policy could also help to increase both numbers and quality of technical personnel—a crucial part of the human resource for the U.S. electronics industry. Examples include R&D support to colleges, universities, and technical schools that train engineers and technicians, funding for purchases of laboratory equipment for use in research or instruction, and student loan programs.

Not only might the Government act to enhance the attractiveness of investment and to ensure adequate supplies of trained manpower, but it can also promote free trade and investment. U.S. firms sometimes assert that they are denied access to foreign markets, particularly in Japan. The Japanese market for electronics products is now more open than in years past, and impediments to U.S. firms with operations in Japan less serious,'" but improvements can still be made. Particularly important for the future is the ability of U.S. firms to compete on even terms within Japan through direct investment as well as exports,

The Multilateral Trade Agreements (MTAs), ratified by the United States in 1979, are a further step toward a more open system of international trade. Japan and the European Community made important tariff concessions for computers and electronics components, However, the tariff decreases by themselves are not expected to have major impacts on U.S. exports, First, the tariff reductions are now scheduled to be staged over an 8-year period, and so would not be in full force until the late 1980's (the staging is still being negotiated). More important, nontariff barriers to trade have been the true impediments to U.S. exports of electronics products.

The MTAs include language covering nontariff barriers such as licensing, product standards, customs valuation, and government procurement. As the dispute between the United States and Japan over the procurement practices of the Nippon Telegraph and Telephone Public Corp. indicates, the effectiveness of the accords will depend on how they are interpreted and enforced. Yet the combined impact of tariff reductions and new agreements on nontariff barriers could result in a significant increase in U.S. access to foreign markets, If American firms are allowed to compete on an equal footing with their foreign competitors in all markets, their

Kijoho no Kaisetsu (An Explication of the Law for the Promotion of Specific Machinery and Information Industries] (Tokyo: Tsusho Sangyo Sho (MITI), 1980), p. 78ff.

[18] J. Gresser, High *Technology and Japanese Industrial Policy: A Strategy for* [1, S, *Policymakers* (Washington, I), C.: Subcommittee on Trade, Committee on Ways and Means, 1]. S. House of Representatives, Oct. 1, 1 980), p. 57.

proven ability to innovate and to develop new products should enable them to maintain a strong presence in semiconductors, computers, and other high-technology branches of electronics. On the other hand, a movement towards protectionism by the United States—in any industry—could impede the further opening of international markets and harm competitive American firms.

Automobiles

World automobile production is dominated by large firms with headquarters in the United States, Western Europe, and Japan. Though production takes place in many other countries— sometimes under the constraints of local content rules—it is usually carried out by foreign subsidiaries of the major U.S. or European firms; Japanese automakers have thus far preferred (and mostly been able) to produce at home and export.

While assembly will probably remain dispersed, automobiles produced by a given firm in different countries are becoming more similar. The "world car" will share many design features wherever built. This will make international production—for example, engines in one country, transaxles in another—easier, Government regulations—in the United States and other countries-will continue to be strong influences on automobile design and engineering.

Like steel and other mature industries, automobile markets in the United States are growing only slowly. Sales will expand more rapidly in most other parts of the world, particularly in developing countries. In the two decades prior to 1980, the number of autos in the U.S. fleet doubled; the number in Western Europe quadrupled. Over the next two decades, it is the automobile fleets in Eastern Europe and the Third World that will triple or quadruple. As in the steel industry, there is substantial overcapacity at present in the world automobile industry, Market growth, even with optimistic assumptions for industrializing countries, is not likely to be rapid enough to keep all of the world's auto plants busy.

Supply and Demand

Projections for long-term expansion in the U.S. market for automobiles (and light trucks) generally fall in the range of 0.4 to 2 percent per year. 'g Growth at the low end of this range, table 30, would give sales of a little over 12 million passenger cars in the year 2000.

Table 30 also includes forecasts for other parts of the world. The growth rate expected

[19] *U.S. Industrial Outlook 1980* (Washington, D. C.: Department of Commerce, 1980), p. 281, estimates 1.5 to 2 percent, Another recent forecast (*U.S. Automobile Industry Trends for the 1980's, A Delphi Forecast* (Chicago,: Arthur Anderson & Co., 1979)) predicts domestic sales by U.S. automakers to be 11 million to 12 million cars in 1985, rising to 12.5 million to 13 million by 1990 (about 2-percent average annual growth), A later panel (*Worldwide Competitiveness of the U.S. Automotive industry and Its Parts Suppliers*, Arthur Anderson & Co., February 1981) predicted less than 1 percent annual growth. In addition, the 1979 Delphi panel predicts that Japanese firms will produce 225,000 to 300,000 cars in the United States by 1985 and 500,000 to 600,000 by 1990. Thus Japanese production in the United States might account for close to 3 percent of the 1985 market, 5 percent by 1990. The panel expects Japanese imports to add another 15 percent—about 1.5 million units—to the 1990 figure.

Table 30.—Projected Sales of Passenger Cars in Major World Markets

	Sales (millions Of cars) 1978	2000	Growth rate (% per year)
United States.	11.1	12.1	0.40/0
West Germany, France, Italy, United Kingdom. .	7.4	10.2	1.5
Japan	2.9	4.4	2.0
U. S. S. R., East Germany, Yugoslavia, Czechoslovakia, Poland	1.8	4.3	4.0
Rest of world	8.0	17.2	3.5
World total	31.2	48.2	2.0%

SOURCE *The Changing World Automotive Industry Through 2000* (Cambridge, Mass Arthur D Little, Inc , January 1980) in the United States is the smallest by far—a factor of 5 below that for the world as a whole. The consensus on this point seems clear: market growth in the United States will be slower than growth in GDP (table 25), as well as slower than sales growth in other countries.[20]

Along with a market that is more nearly saturated than many others, rising energy costs will constrain motor vehicle sales. Although the United States is highly dependent on cars and trucks for transportation, the fleet is already very large and many vehicles are not heavily utilized. Rising fuel costs may encourage replacement of older, less-efficient automobiles, and developments in specialized vehicles such as very small commuter cars might also help sales. But with multiple-vehicle ownership already common, these effects are not likely to be dramatic. Thus market expansion will remain slow.

The net U.S. trade balance in motor vehicles and parts will almost certainly remain negative. Although imports of passenger cars exceeded 25 percent of the U.S. market during 1980, most observers think their share will decrease somewhat. Estimates for the 1990 period generally show imports in the 15- to 20-percent range. Given the presently unsettled state of the market, there is ample room for uncertainty; import market shares greater than 20 percent are not impossible.

Table 30 projected sales in the major countries of Western Europe increasing from 7.4 million in 1978 to 10.2 million in 2000, an annual growth rate of about 1.5 percent. Sluggish growth in Europe would be of concern to Ford and General Motors, which have large European operations. (Ford, with a manufacturing capacity of 1.8 million units, and General Motors, with 1.6 million, have about 25 percent of total European capacity.)

Annual rates of market growth projected for Japan are about the same as for Western Europe—1 to 2 percent (table 30). Much faster growth is expected for the countries of Eastern Europe and the Third World. Table 30 shows 4-percent annual growth in Eastern Europe: by 2000, sales in Eastern Europe may equal those in Japan.

Forecasts for the developing world vary widely—from 3.5 percent annual growth to 9 percent,[21] There will be much variation from country to country, with demand depending on income levels, fuel costs, and other factors. The more rapidly industrializing countries, particularly those where automobile manufacturing facilities are located, will likely fall at the high end of the growth range, By 2000, the Third World may account for 30 percent of world auto sales, becoming the largest of the markets listed in table 30. Firms that can capitalize on these rapidly expanding markets will emerge at the end of the century in strong competitive positions.

Automotive Technology

The fundamentals of automotive technology are relatively stable, although engineering designs have been changing-particularly for cars made in the United States. An automobile is a rather complex system: regulations and consumer demands for greater gas mileage have forced changes in the way the individual elements of the system are designed, and also the way they are integrated. Big gains in fuel economy—while preserving interior space, reliability and durability, and flexibility in use—come from modifying the system at many points. Powerplants are refined, as are transmissions; aerodynamic drag and rolling resistance are reduced; weight decreased. Front-wheel drive is now commonly chosen to give more interior space for a vehicle of given size and weight—particularly important for small cars—though at the expense of somewhat greater mechanical complexity and thus higher manufacturing costs.

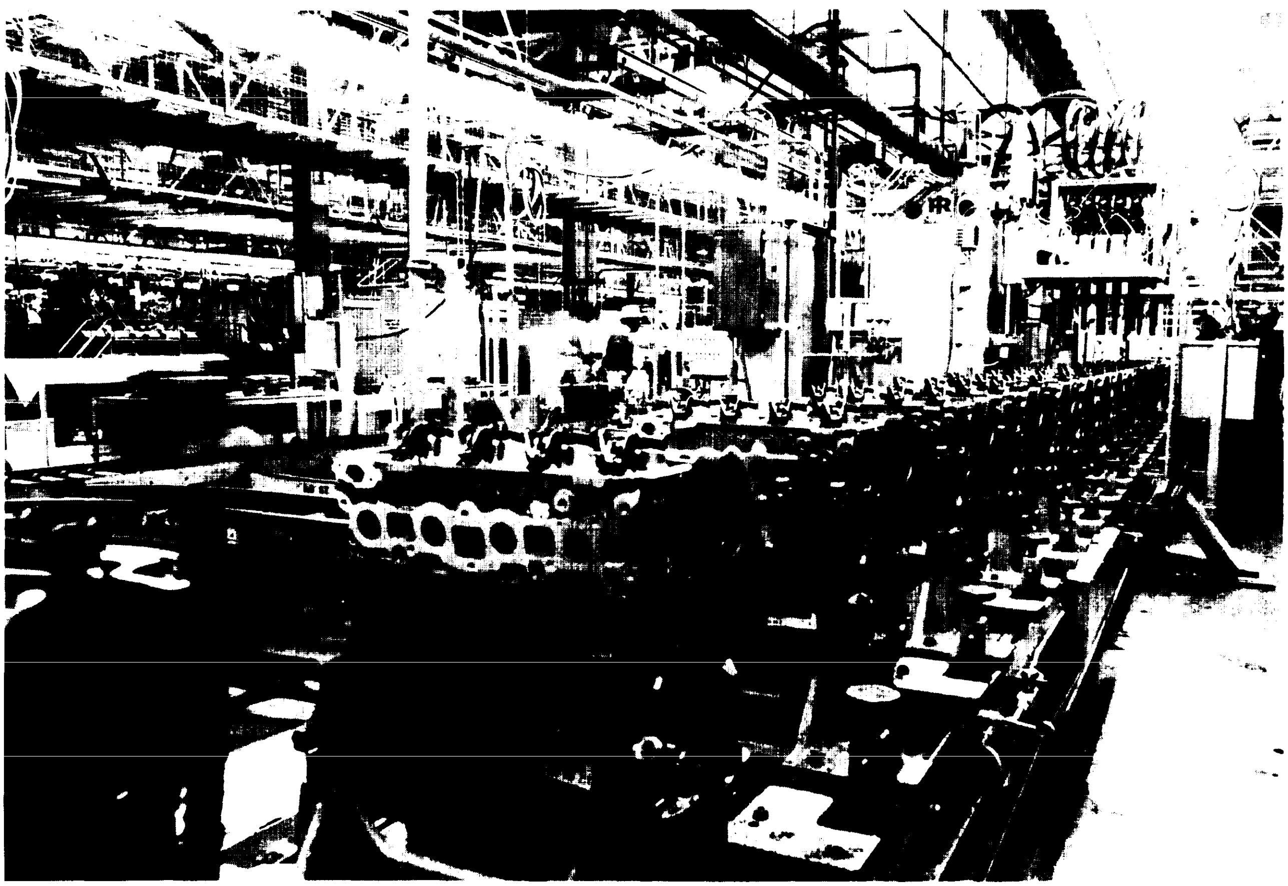
[20] See also, *Long Term Perspectives of the World Car Industry* (Paris: Organization for Economic Cooperation and Development, February 1978); Bhaskar, *The Future of the World Motor Industry* (New York: Nichols Publishing, 1980).

[21] *The Changing World Automotive Industry Through 2000* (Cambridge, Mass.: Arthur D. Little, Inc., January 1980).

[22] *Long Term Perspectives of the World Car Industries*, op. cit.

Technological change through the end of the century is likely to continue to follow these patterns. Powerplants and package sizes will become smaller. Eight-cylinder engines will be replaced by sixes and fours. Three-cylinder engines will also appear. The detail design of spark-ignition engines will be continually modified and improved to more nearly optimize fuel economy and emissions. Diesels will be more widely used, but alternative heat engines are not likely to see widespread application.

Engine weights for given power output will continue to be reduced by means of thinner walled castings, as well as increased use of aluminum for components, including cylinder heads and some engine blocks. Plastics and ceramics may become practical for limited use in internal engine applications, Efficiency will be improved by reducing engine friction and heat rejection to the cooling system. Compression ratios may increase somewhat as combustion chamber designs are tailored to available fuels and electronic control systems are used to prevent detonation. Integrated engine control systems will be even more important for regulating parameters such as fuel-air ratio and spark timing to maximize fuel economy consistent with permitted emissions levels. Improved transmission designs—perhaps eventually continuously variable transmissions—will further integrate engine and transmission control. Relatively large increments in driving cycle fuel economy could result from such systems,



Four-cylinder engines for 1981-model U.S. small cars which would permit engines to operate in the speed and load ranges where efficiency is highest,

Turbocharging, though costly, will be used more widely, particularly on diesel engines—but continuing applications of diesels to passenger cars may be limited by emissions regulations. The outlook for alternative fuels is uncertain, and in the United States depends to a considerable degree on energy policies; technologies can probably be developed to accommodate whatever fuels—including synthetics—are available.

Prospects for electric vehicles, like alternative heat engines, seem to keep receding into the future. While a slowly growing presence in the marketplace is possible, significant penetration of electric passenger cars by the end of the century appears unlikely.

Just as in powertrains, technological change elsewhere in the vehicle system will be gradual though cumulatively significant. Downsizing and weight reduction will continue; more high-strength steel, aluminum, and perhaps magnesium will help cut weight. Plastics and composites will appear in primary structural applications—perhaps wheels, for example.

Further changes in package designs are more problematical, The fleets of most U.S. automakers will be largely front-wheel drive by the late 1980's. The market for special-purpose commuter cars has yet to be tested in the United States, If very small two-passenger cars should prove popular, Japanese manufacturers—with their experience in half-liter "microcars"—may initially have an edge.

Developments in manufacturing technology will also be gradual but cumulatively have major impacts, particularly when associated with new materials. Innovative manufacturing techniques may speed the use of structural composites. For metals, near-net-shape processing will continue to be a goal, as will more rapid machining, Pressure for low production costs, along with somewhat longer time periods between model changes, will maintain the incentives for large-scale dedicated manufacturing facilities. FIexible automation—e.g., use of robots—will also increase, particularly for arduous and potentially health-threatening tasks such as painting and welding, and for work demanding precision or high quality.

U.S. manufacturers will participate in developments in motor vehicle technology on a more-or-less equal footing with automakers in other parts of the world, As in the past, unique technology is not likely to play a major role in the competitiveness of automobile firms,

Future Competitiveness

Much of the recent public debate over the problems of the U.S. automobile industry has centered on the slump in sales by domestic manufacturers during 1980, and the concurrent rise in imports from Japan, Both the United Auto Workers and the Ford Motor Co, asked for import quotas and/or tariff increases, blaming Japanese imports for the bulk of the difficulties of the domestic industry.

Trade protection—whether tariffs or quotas or both—would aid the domestic industry to the extent that imports are a cause of its current problems. As pointed out in chapter 5, there are a variety of other factors at work—recession, high interest rates, rising gasoline prices, and shifting consumer tastes, But if trade restrictions were imposed, they would nonetheless tend to increase sales of domestically produced vehicles, raise profits, and also raise employment in both the auto firms and their suppliers.

The rationales for limiting imports of automobiles (and light trucks) are similar to those used earlier to justify quotas and other measures intended to insulate the steel and consumer electronics industries (ch. 6). Restrictions on imports for a limited period of time could, in principle, allow domestic firms

[21] J. Yamaguchi, "Three Semi-Automatics for Light Cars," *Automotive Engineering*, vol. 88, September 1980, p. 119.

to increase their revenues, hence their ability to generate investment capital. Investment—in new products as well as in plant and equipment—could help the industry to revitalize itself and restore its competitive position. The U.S. automobile industry does have large capital needs, as discussed below and in chapter 5. A key question for policymakers considering trade restrictions such as quotas or tariffs is: To what extent will limiting imports of cars and trucks increase the cash flow available to American automakers for reinvestment? The corollary, of comparable importance, is: What would be the costs and benefits to the economy as a whole of such measures?

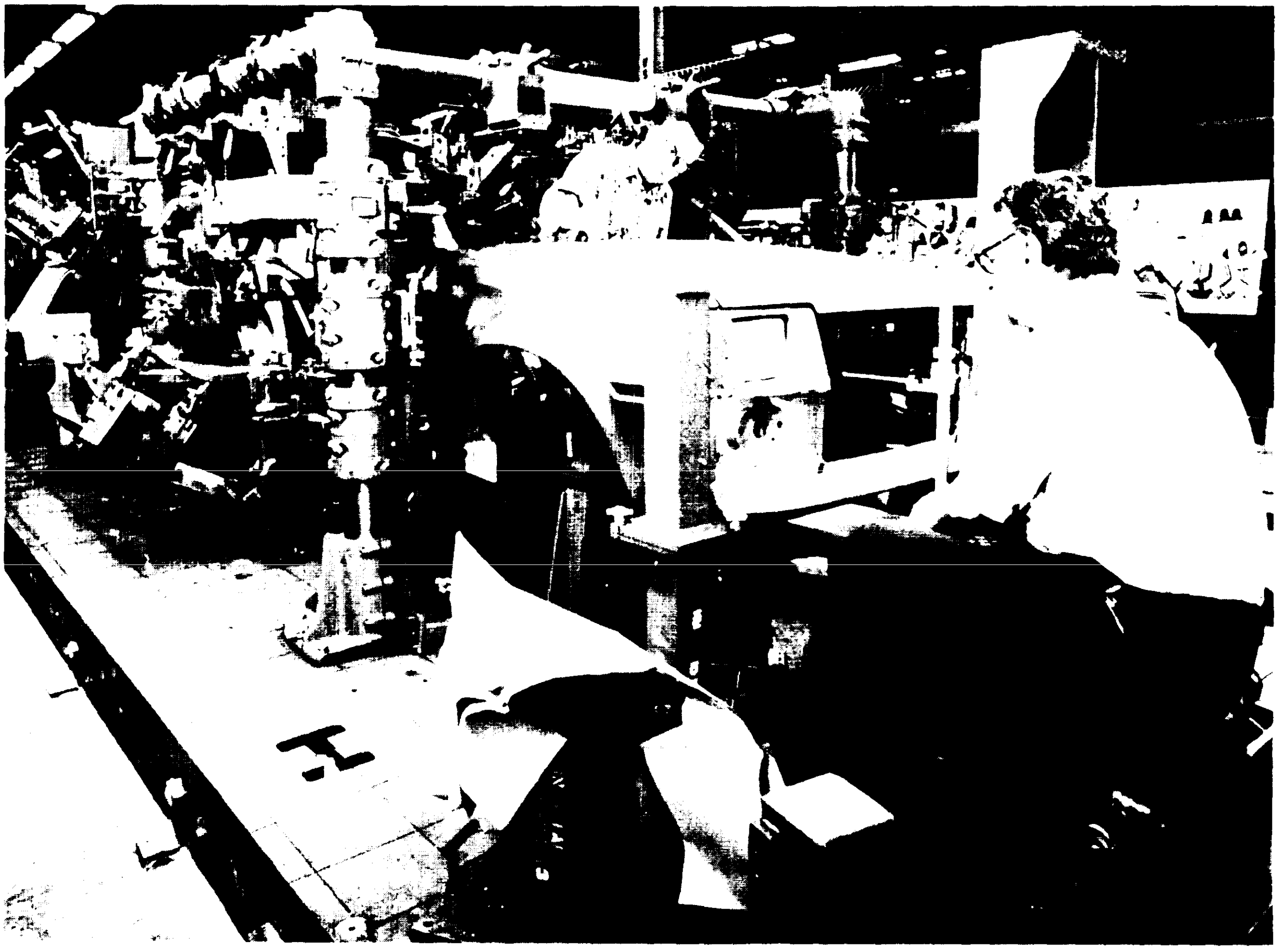
Increases in capital available for new investment would depend essentially on increases in sales of domestic vehicles resulting from trade protection, and on the price increases that might result because of lessened competition from imports in the marketplace, These two factors are of course interrelated; higher prices would be expected to reduce sales. Presumably, the increase in sales volume of domestic cars resulting from import restrictions would be less than the reduction in imports because some consumers would defer purchases if denied imports. However, import restrictions could also help the industry attract external capital by decreasing the risks perceived by lenders, Reductions in unemployment among autoworkers would be a direct benefit to the economy because payments for unemployment insurance and trade adjustment assistance would decrease. Many other less direct benefits could follow—e.g., revival of local economies in regions heavily dependent on the automobile manufacturers and their suppliers.

The costs to the public at large of import restrictions—primarily through higher prices—could also be large, perhaps several billion dollars.'" Thus, it is not clear that import restrictions could substantially benefit the domestic industry without imposing high costs on consumers. Even if import relief measures helped solve the near-term difficulties of the U.S. auto industry—e.g., profitability and employment—they might still have little effect on long-term problems of restructuring, particularly the need for investment capital to finance redesign and retooling, simply because these capital needs are large compared to the probable results of import restrictions.

Expenditures both here and overseas by U.S. firms for conversion to newly designed small cars—including costs of engineering design and development, as well as new plant and equipment—are estimated at about $7o billion (in 1980 dollars) during the 1979-85 period (ch. 5), more than double the rates of capital spending during the 1970's. Most spending estimates have been based on changeovers to product lines that will meet the Corporate Average Fuel Economy mileage standards scheduled for these years. If market demand for small, high-mileage cars continues to outrun these standards, or if the Government calls for large additional improvements in mileage for the post-1985 period, then further rounds of redesign and retooling could be required. This would place an additional and heavy burden on the U.S. industry, Not only would automakers face new outlays, but facilities that are now being designed and built for downsized cars might become obsolete well before the investments had been paid back. Under such circumstances, the financial resources of even the strongest American manufacturers might continue to be stretched in comparison to their overseas competitors, who can undertake more gradual changes in their own car lines—which in many cases already include models considerably smaller and more economical than any exported to the United States (e.g., the Japanese microcars mentioned above).

Should aid for U.S. automakers directed at such long-term concerns be judged necessary—whether as a supplement or a substitute for trade restrictions—this could, as for the steel industry, take the form of either aggregate or sector-specific policies, Relaxation

[34] "Summary of FTC staff testimony before the International Trade Commission, " Oct. 8, 1980, p. lo.



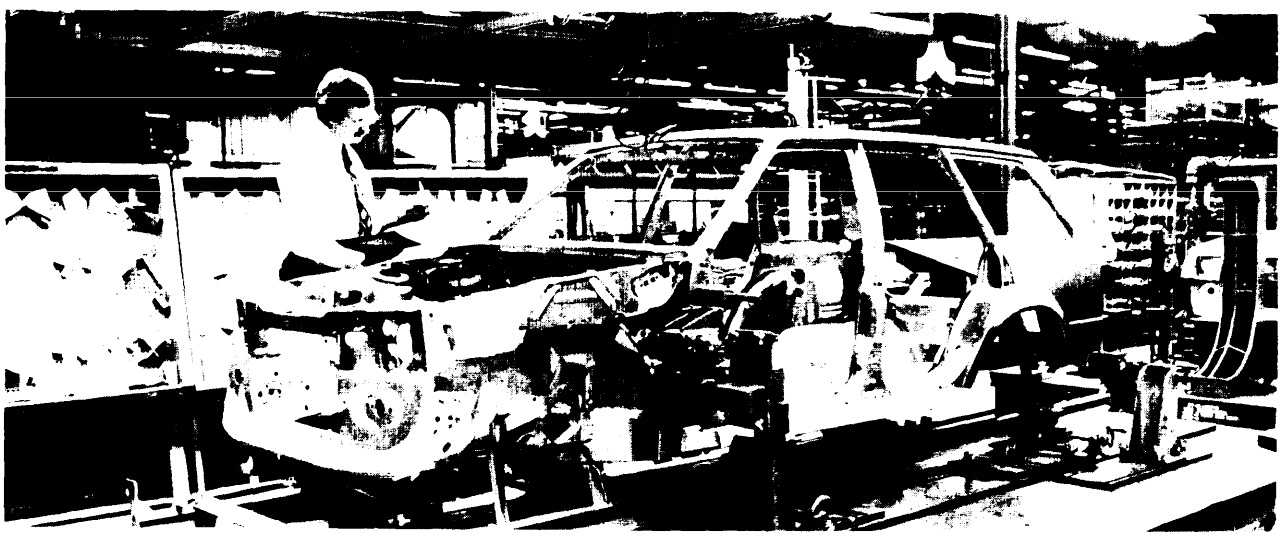


Photo credit *Ford Motor Co*

Quailty inspection using body gages supplementing regular assembly line inspection of regulatory standards provides an example of the latter. The more commonly proposed types of aggregate policies have been those mentioned earlier in the context of other industries—measures designed to increase capital investment across all sectors, such as accelerated depreciation allowances or lower tax rates.

That aggregate policy changes would help the U.S. automobile industry raise substantial amounts of capital is not immediately obvious. Automakers already depreciate special tooling over a 3-year period. Tooling expenditures accounted for nearly 40 percent of the industry's total spending on plant, land, and equipment in 1979.[25] The scope for significant cash flow benefits from measures such as IO-5-3 depreciation may thus be limited. Of greater importance, most types of tax incentives are directly beneficial only when a company is profitable and has paid taxes at some point during the preceding 3 years. Generalized tax changes would do little to help firms losing money unless refundable taxes—in the form of payments for years when losses occurred—were adopted. Expectations of improved profitability in the future, however, could help attract outside investment,

If policies intended to apply in the aggregate appear insufficient to meet the needs of the automobile industry, sector-specific programs could be enacted. Examples include: tax credits; still faster writeoffs for plant and equipment, e.g., a l-year depreciation period for special tooling; loan guarantees; and relaxed environmental and safety standards requiring lower levels of investment by domestic manufacturers (but also by manufacturers of imports).

The last two forms of aid have already been implemented to some extent. Chrysler currently depends on Federal loan guarantees, and the Reagan administration has recently proposed a package of relaxed regulatory standards which, it is claimed, would save domestic firms up to $1.4 billion in future expenditures.

Greater certainty over future regulations—including fuel economy standards—could also help by creating a more stable climate for investment. Even more important, this would allow automakers to plan investments—in both new vehicle designs and new production facilities—with greater assurance that they would not be outmoded by changing regulations.

Regardless of its immediate problems, the U.S. automobile industry appears to have the capacity to remain internationally competitive. The two largest domestic manufacturers are strong worldwide and have been for many years (this is a major difference between the steel and automobile industries). Their chief international rivals—particularly in Europe—also have their ups and downs. Many American small cars are competitive in price with imports (although the profitability of small car production in the United States remains uncertain). U.S. firms are placing renewed emphasis on reliable, high-quality products, As the domestic industry begins to produce a broader range of small, high-mileage cars, and as the economy emerges from recession, the larger American automakers should again become healthy and competitive.

At the same time, many observers expect a shakeout in the world auto industry, with less than 10 firms—perhaps only 6 or 7—dominating global markets by the end of the century, (This is not to say that small manufacturers of high-priced specialty cars could not continue to prosper.) If this scenario comes to pass, two of the firms would probably be General Motors and Ford. The others might be the larger European firms such as Peugot-Citroen, Fiat, Volkswagen, Renault, plus Nissan (Datsun), and Toyota. General Motors appears to have ample resources to adapt as needed. Ford will have more difficulty, but is not alone. Some of the European firms—most notably BL Ltd. (formerly British Leyland), but also Fiat and Peugot—are in rather pre-

[25] "Current Problems of the U.S. Automobile Industry' and Policies to Address Them," staff working paper (Washington, D. C.: Congressional Budget office, National Resources and Commerce Division, July 1980), p. 53.

carious financial straits, and may need continuing assistance from their governments.

As part of this worldwide restructuring, automobile firms are becoming more closely tied through joint design and/or production ventures. The increasing similarity of cars produced in various parts of the world is part of this trend. The larger American manufacturers are all linked to foreign automakers—not only their overseas subsidiaries, but also through partial interests in Japanese firms (General Motors-Isuzu, Ford-Toyo Kogyo, Chrysler-Mitsubishi). Other ties involving U.S. producers may develop; in the AMC-Renault case, the state-owned French partner is now dominant, Worldwide, more than 70 joint ventures currently link automobile manufacturers.

Motor vehicle production in rapidly industrializing countries such as Spain, Mexico, Brazil, and Korea—both to serve local needs and for export—will make the industry increasingly a translational one.[26] Parts manufacture and assembly for the Ford Escort, for example, is spread over seven countries. Such changes will also affect supplier firms—where there will probably be a good deal of consolidation in the years ahead. To some extent, manufacturing facilities are being located in developing countries because of local content requirements; many countries look to automobile production, along with steelmaking, as a foundation for industrialization. But low labor costs are also important—just as for TVs or semiconductors. The ability to adapt to this changing world structure of production and sales is one of the keys to prosperity—perhaps survival—for the major automobile manufacturers of the United States, Europe, and Japan,

[26] S. Lall, "The International Automotive Industry and the Developing World," *World Development*, vol. 8, 1980, p. 789.

Summary and Conclusions

The electronics and automobile industries are evolving toward more fully international operations; the world steel industry is also becoming more dispersed. Yet the patterns in each sector differ: as shown in earlier chapters, they are unique in their specifics.

Competition will remain intense in world steel markets as long as overcapacity exists, Raw steel capacity is being added by Third World countries, aided by joint ventures and technology transfers from steel firms in industrialized nations. While none of the American companies have extensive international operations, they will nevertheless be affected by these trends, along with steelmaker elsewhere. The impacts will be particularly significant if Third World steelmaker have excess capacity and export to the industrialized countries.

Structural change in the U.S. steel industry is likely to continue, with nonintegrated firms taking a more prominent place, and alloy/specialty steels continuing to be a strength. The competitiveness of large, integrated firms will depend to a considerable extent on their ability to generate or attract capital for modernization. New technologies for making iron and steel will also play an important role in shifts in competitiveness over the rest of the century,

The electronics industry is already thoroughly international in sectors such as semiconductors and computers, in most parts of the world dominated by American firms. Consumer electronics is also an international industry, but here most of the leading world-scale manufacturers are Japanese, While semiconductors, computers, and other high-technology branches of electronics will continue their rapid growth, demand in consumer electronics will spring from new products and from the industrializing countries, where markets are far from saturation. If the U.S. electronics industry can generate capital, find qualified personnel, and maintain open access to foreign markets, it will continue to be highly competitive in sectors such as semiconductors and computers. Recovery of the U.S. consumer electronics sector would remain problematical, and appears to depend on successful commercialization of new products.

In the automobile industry, the era of the "world car" is beginning. International design efforts are a reality, with American-made cars increasingly resembling those developed in Europe and Japan. These changes are evolutionary; automobile technology is not likely to change radically through the 1990's, but continual refinements to existing design concepts will have dramatic cumulative impacts.

Growth in U.S. automobile sales will be slow—as in most of the industrialized world. The fastest expansion, hence the greatest opportunities for multinational automakers, will be in Eastern Europe and the Third World. The most successful of the world's automakers will be those that can maintain their competitiveness in the developed world while also establishing strong positions in emerging markets.

Given current trends, there may be a further concentration of the world automobile industry, with perhaps as few as six or seven large firms commanding most of the market by the end of the century. Such a restructuring would be difficult and painful. American firms will continue to be among the world leaders, but will not be able to rest unchallenged in their home market. Not only are imports likely to provide continued competition, but Japanese firms will probably begin assembling cars, as well as light trucks, in the United States,