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SEMICONDUCTOR INDUSTRY MEETING

U.S. DEPARTMENT OF COMMERCE

FEBRUARY 28, 1984

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# AN OVERVIEW OF THE SEMICONDUCTOR MARKET

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Prepared by:
Office of Components & Related Equipment
Science & Electronics
International Trade Administration

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## Purpose

This report attempts to provide both a statistical and analytic understanding of the worldwide semiconductor industry. It seeks to assess the present competitive position of the major producing nations and delineate the historical trends most responsible for the current situation. As part of this effort, it traces international trade and investment patterns while analyzing technological flows and progress. Subsequent sections of this briefing book identify the elements critical to long-term competitiveness and present the policy issues whose resolution will most influence semiconductor development in the United States.

## Definition and Scope

Semiconductors are at the heart of virtually all modern electronic equipment. Their particular properties enable them to store, transmit, and process electrical current with great efficiency and speed. Advances in their design and manufacture have in turn precipitated revolutionary changes in computers, telecommunications equipment, instrumentation, and robotics, to name but a few semiconductor-based product areas.

The name "semiconductor" reflects the ability of certain materials (silicon, germanium, etc.) to function either as conductor or insulator, depending upon the specific characteristics of their immediate electrical environment. The family of semiconductor products is most commonly divided in one of three ways--by function, by design technology, or by level of integration. Table 1 provides a breakdown according to each categorization scheme.

All of these product areas will contribute to the aggregate statistical presentations in this study. But the in-depth analysis of market shares, growth rates, and technological trends will emphasize five segments in particular: very large scale integrated circuits (VLSI); memory and microprocessors; bipolar and MOS technologies. The evolution of semiconductor products and their manufacturers point toward developments in these commodity groups as the foremost indicators of the international competitive situation.

Table 1
SEMICONDUCTOR NOMENCLATURE

labeled by:

**Integration Level**

- Discretes
- Integrated Circuits
  - Small-Scale Integration--SSI (1-10 gates/chip)
  - Medium-Scale Integration--MSI (10-100 gates/chip)
  - Large-Scale Integration--LSI (100-1K gates/chip)
  - Very Large-Scale Integration--VLSI (1K-10K gates/chip)

**Function**

- Power
- Signal
- Microwave
- Optoelectronic
- Analog
  - Amplifiers
  - Regulators
  - Other
  - Consumer
- Digital
  - Logic
  - Memory
  - Micro-processors and Peri-pherals
- Hybrids

**Technology**

- Transistors
  - Bipolar
  - Field-Effect
- Diodes
- Rectifiers
- Thyristors
- Linear
- Bipolar
- Metal-Oxide Semiconductors (MOS)
  - CMOS
  - nMOS
  - pMOS
  - HMOS
- Hybrids

Statistical Note:
Government statistics organize data on U.S. semiconductor shipments under Standard Industrial Classification (SIC) Code 3674, entitled "Semiconductors and Related Devices". Import figures derive from Tariff Schedule of the United States (TSUSA) sections 687.7 and 687.8, export numbers from Schedule B code 687.60. This report uses official statistics wherever judged complete. But in the many cases where supplementary information is required, the study draws on industry associations, corporate literature, and independent market analysts, as well as internal Commerce Department research. All such adjustments will be clearly referenced as estimates.

## THE WORLD SEMICONDUCTOR MARKET

### Production

World production of semiconductors reached $26.4 billion in 1983, a 19% increase over the previous year's output. This recovery from a 1981-2 slowdown signalled the industry's return to the robust growth pattern of the late 1970s, and most forecasters consider a 15-20% per year pace sustainable through 1990.

Three forces should drive this expansion: rapid technological progress, exploiting new design concepts and materials in the development of higher-performance chips; greater productivity in the semiconductor fabrication process, stemming from the improving capabilities of production and test equipment; and strong demand from a dynamic group of end-use sectors, ranging from personal computers to automotive electronics.*

The structure of the semiconductor industry involves four basic types of manufacturers:

a) "captives", who produce primarily (and in some cases exclusively) for their internal needs. These are therefore companies who ultimately market equipment with a significant semiconductor content.
Examples: GM/Delco, Hughes, IBM, Tektronix, Western Electric.

b) "diversified merchants", who offer a broad range of semiconductor products, and for whom semiconductors represent a major fraction of total firm sales.
Examples: Intel, Motorola, Texas Instruments.

c) "integrated merchants", whose semiconductor production is directed at both the open commercial market and the needs of other internal corporate divisions engaged in the manufacture of semiconductor-intensive electronic products.
Examples: Hitachi, Fujitsu, NEC, Siemens, Philips.

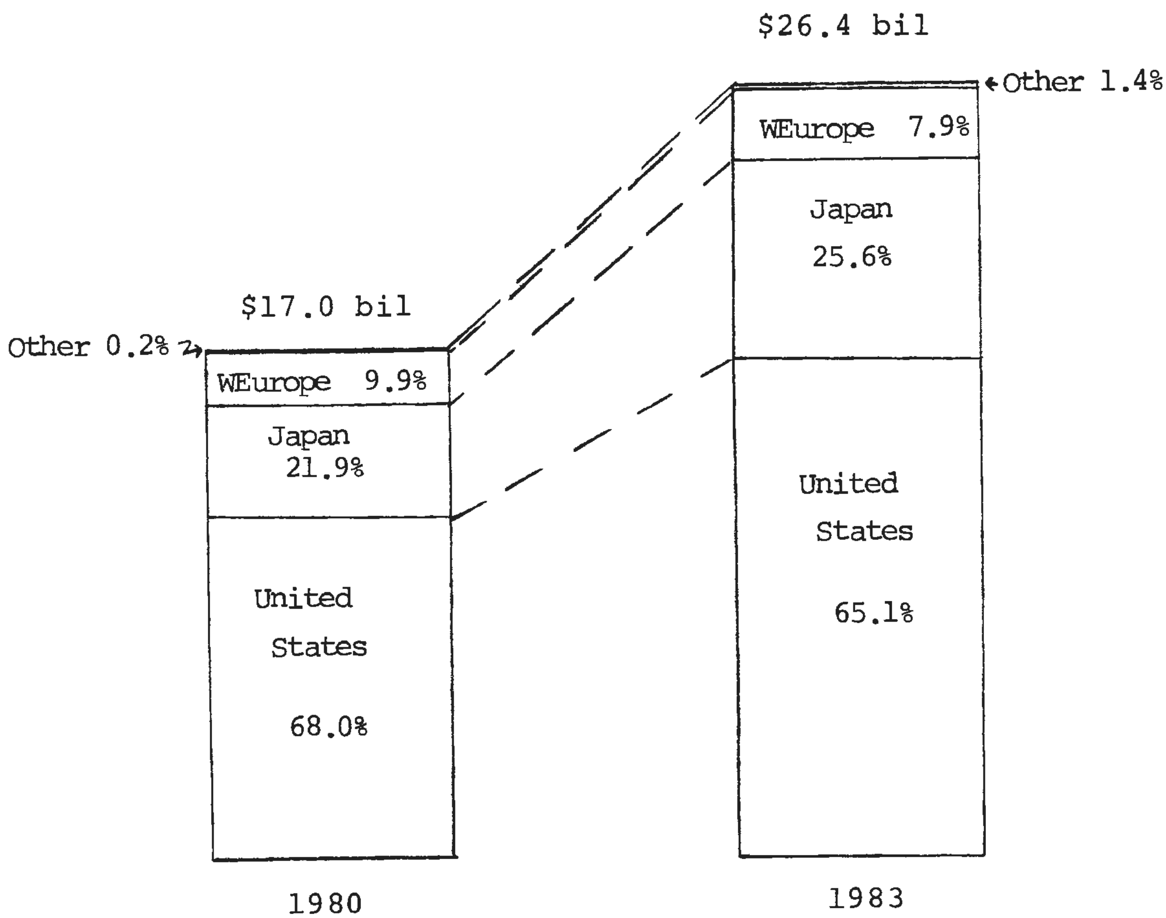
d) "specialized ventures", whose research efforts and semiconductor offerings are more concentrated in specific market segments and whose production heads exclusively to the merchant arena.
Examples: Monolithic Memories, Seeq, Zilog.

*Semiconductor consumption patterns are discussed beginning on page 7.

The international distribution of semiconductor production, by country of ownership, shows the United States with a declining majority share, Japan in an improving though still minority position, Western Europe falling ever farther behind both rivals, and the developing countries with a tiny but rapidly expanding capability. Diagram I illustrates the shifting balance between these national groups, and the table which follows ranks the world sales leaders.

DIAGRAM I

WORLD SEMICONDUCTOR MARKET SHARES
(by ownership)*




*Includes all captive and merchant activity.

SOURCE: DOC Estimates.

Table 2
LEADING SEMICONDUCTOR FIRMS - WORLDWIDE

| | 1983 Chip Sales (mil $) | 83/82 | Merchant Market Shares |
|---|---|---|---|
| Texas Instruments | 1,638 | +25.5% | 9.2% |
| Motorola | 1,547 | +26.9% | 8.7% |
| NEC (Japan) | 1,413 | +31.4% | 7.9% |
| Hitachi (Japan) | 1,181 | +34.7% | 6.6% |
| Toshiba (Japan) | 983 | +37.7% | 5.5% |
| National Semiconductor | 845 | +25.6% | 4.7% |
| Intel | 775 | +24.0% | 4.4% |
| Fujitsu (Japan) | 688 | +48.0% | 3.9% |
| Matsushita (Japan) | 600 | +40.8% | 3.4% |
| Advanced Micro Devices | 505 | +53.5% | 2.8% |
| Top Ten TOTAL | 10,175 | +32.0% | 57.1% |
| Merchant Market TOTAL* | 17,810 | +22.0% | 100.0% |

SOURCE: Dataquest, DOC
*Provided for reference purposes only. The table lists the total shipments (merchant and captive) of the largest merchant firms.

For two important reasons--extensive foreign subsidiary activity by the larger internationalized firms and a vast network of "offshore" assembly facilities developed to minimize labor costs--the geographic structure of production is much more diversified than its ownership. Table 3 presents the industry's global composition in value-added terms, reflecting the actual location of manufacturing activities. The European investments of American and Japanese firms reflect 1)"tariff jumping" and 2)the advantages of a physical market presence for service, support, and overall responsiveness. The considerable importance of Southeast Asia and Latin America indicate their sizeable role in the largely non-technical, labor-intensive phases of the production process.

Table 3
TOTAL VALUE ADDED BY SEMICONDUCTOR INDUSTRY
(1983 Estimates by Country)*

| | 1983 Value Added (mil $) | Share of World Total |
|---|---|---|
| United States | 13,010 | 49.2% |
| Japan | 6,100 | 23.1% |
| Malaysia | 1,100 | 4.2% |
| West Germany | 760 | 2.9% |
| United Kingdom | 630 | 2.4% |
| Singapore | 605 | 2.3% |
| Philippines | 585 | 2.2% |
| France | 550 | 2.1% |
| Canada | 535 | 2.0% |
| Korea | 515 | 2.0% |
| Top Ten Total | 24,390 | 92.3% |
| World Total | 26,430 | 100.0% |

*Denotes value added in each country listed. Figures include all captive and merchant production.

SOURCE: DOC estimates

A breakdown of world semiconductor production by type of device indicates first that integrated circuits (ICs) comprise the vast majority--over 75%--of total output. Slower growth among the remaining discretes (5% per year versus nearly 20% for ICs) has steadily eroded their market share since the advent of integration some 20 years ago.

In functional terms, the largest dollar-volume IC segment is memory, led at present by $1-1.5 billion in expected 1984 shipments of the 64K dynamic random access memory (DRAM) chip. Considerable Japanese success in this product line (as well as with its 16K predecessor and 256K heir) has fueled that nation's rise to semiconductor prominence over the last decade. The microprocessor field, one bastion of undisputed U.S. dominance, comprises another 8-10% of the international total.

In terms of design technology, bipolar and metal-oxide (MOS) semiconductors now divide the lion's share of total output. However, differing growth rates have led forecasters to predict the continued emergence of MOS devices as the industry leaders. The current balance reflects a user choice between speed and power consumption features; but greater recent success in lowering MOS access times than in improving bipolar efficiency portends a continuing shift in the present balance.

Consumption

Demand for semiconductors has progressed in a manner that reflects the new market opportunities created by improvements in the devices themselves. This symbiotic relationship between chip-makers and end-users has generated a flurry of unprecedented electronic products, ranging from digital watches to supermicro computers, from the the simplest video games to the most advanced weapon guidance systems. The relative success of these items has in turn determined the relative importance of the semiconductor industry's main customer groups.

Most observers identify five major types of semiconductor users according to the chips' ultimate equipment application: computers, telecommunications, industrial (including autos), consumer, and government (military and space). Table 4 indicates their respective shares of world semiconductor demand. The balance, however, varies widely between the leading geographic markets: computers play the greatest role in the United States and consumer electronics retain their preeminence in Japan, while Europe offers a balance between telecom and industrial applications.

Table 4
WORLD SEMICONDUCTOR DEMAND
(by end-use sector)

| | United States | Japan | Western Europe |
|---|---|---|---|
| Computers | 35% | 17% | 20% |
| Telecom | 19% | 9% | 23% |
| Industrial | 18% | 20% | 27% |
| Consumer | 17% | 54% | 22% |
| Government | 11% | negl. | 8% |
| Est'd 1983 value | $13.7 bil | $4.2 bil | $4.1 bil |

SOURCE: DOC, EIAJ, Financial Times

In sum, the world semiconductor industry has apparently resumed the vigorous expansion that characterizes "high-technology" sectors. As the basic building block of all electronic hardware, the semiconductor holds the key to improving product performance and dynamic long-term growth in a broad range of end-user industries. But despite the tremendous opportunities ahead, or perhaps because of them, competition for sales and market share should continue to stiffen, while product lifetimes should continue to shrink. A $75 billion world market by the year 1990 offers great promise to those who can lead the way. The country-by-country analysis which follows offers a more detailed look at just who that might be.

## COUNTRY-BY-COUNTRY ANALYSIS

### United States

The United States presently accounts for about 1/2 of the world semiconductor market, a position solidified by impressive domestic growth over the last two years. The value of 1983 product shipments reached $13 billion, up some 18% from the 1982 figure; total consumption, reflecting a larger trade deficit, was estimated at $13.7 billion. The immediate future appears very bright, with record book-to-bill ratios promising 1984 increases in the 18-22% range. But long-term prospects are dimmed by more extensive Japanese penetration of the U.S. market. Predictions through 1990 generally expect a more modest 13-15% per year pace for overall U.S. industry growth.

Approximately 33% of all U.S. semiconductor production stems from captive manufacturers, who simply transfer output within their respective companies to divisions manufacturing semiconductor-based products. Most of the remainder eventually reaches the merchant market, though its actual sale, in nearly half of all U.S. cases, follows processing through offshore assembly facilities in the developing world.

American firms, through either of these channels, satisfy 89% of total domestic demand; excluding the captive segment lowers this share to 83%. The U.S. leaders, ranked by their 1983 worldwide shipments, are listed in Table 5.

Table 5
WORLDWIDE SEMICONDUCTOR SALES OF U.S. FIRMS (1983)

| Company | Est. Sales (mil $) | Share of U.S. Total |
|---|---|---|
| Texas Instruments | 1,638 | 14.4 |
| Motorola | 1,547 | 13.6 |
| National Semiconductor | 845 | 7.4 |
| Intel | 775 | 6.8 |
| Advanced Micro Devices | 505 | 4.4 |
| Fairchild (Schlumberger) | 450 | 3.9 |
| Signetics (Philips) | 435 | 3.8 |
| Mostek (United Technologies) | 315 | 2.8 |
| RCA | 303 | 2.7 |
| General Instrument | 293 | 2.6 |
| Top Ten Total | 7,106 | 62.3% |
| Merchant Total (est) | 11,400 | 100.0% |

SOURCE: Dataquest, DOC

The product composition of U.S. output reflects both the unique nature of domestic demand (see Table 4) and the particular strength of domestic suppliers. A strong and diversified group of U.S. computer manufacturers requires 1)vast quantities of memory devices, drawn from both U.S. and Japanese sources, as well as 2)growing numbers of microprocessors and peripheral chips, a particular American forte. A relatively weak production base in the consumer electronics field has by contrast limited development of the linear and logic segments of the domestic semiconductor industry. American firms have also, in the aggregate, retained more of an orientation towards bipolar devices than their Japanese counterparts. This may again reflect a combination of demand conditions and predictable commitment, on the part of a more established industry, to more mature technologies. Census figures, presented in Table 6, summarize this breakdown.

Table 6
U.S. SEMICONDUCTOR SHIPMENTS BY PRODUCT TYPE
(1982 Census Bureau Figures)

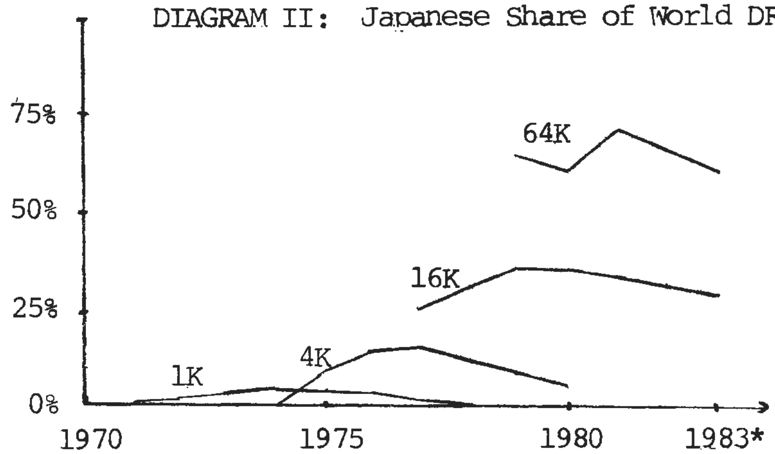
| Classification Title | Value (mil $) | Fraction |
|---|---|---|
| Integrated Circuits | 7,557.2 | 69.5% |
| Hybrid | 951.2 | 8.8% |
| Monolithic | 6,606.1 | 60.7% |
| Digital | 5,743.3 | 52.8% |
| Bipolar | 1,948.4 | 17.9% |
| MOS | 3,794.9 | 34.9% |
| Analog | 862.8 | 7.9% |
| Discretes | 1,076.3 | 9.9% |
| Transistors | 604.1 | 5.6% |
| Drodes/Rectifiers | 472.2 | 4.3% |
| Others (mainly "parts") | 2,241.0 | 20.6% |
| Current Industrial Report Total | 10,874.5 | 100.0% |
| Adjusted Annual Survey Total | 11,327.6 | - |

SOURCE: U.S. Department of Commerce, Bureau of the Census

State-of-the-art semiconductors attract the most attention because of their tremendous significance, under conditions of rapid growth and obsolescence, for both commercial and technological competitiveness. The present transition in both the DRAM* and MPU* markets reveals much about the present position of the U.S. industry.

The highly publicized 256K DRAM devices will finally arrive in commercial quantities during 1984. But most of the initial offering will be Japanese, with five firms (Hitachi, Fujitsu, NEC, Oki, and Toshiba) challenging but one early U.S. starter (Western Electric). The main American entrants will not jump in until at least 1985, a critical delay since the previous experience of generation-to-generation slippage in U.S. market share indicates that relative fraction is generally established within the first 24 months (see Diagram II). On the other side of the ledger, the U.S. industry remains the undisputed leader in the microprocessor field. Though the 8- and 16-bit segments continue to show great strength, several companies--including AT&T, Intel, NCR, National, and Hewlett-Packard--have also moved on to 32-bit chips.

DIAGRAM II: Japanese Share of World DRAM Market




*Estimates.
Shares based on units shipped.
SOURCE: Dataquest.

But the balance is far from static. Many forecasters expect American memory producers, lured by the prospects of a multibillion dollar annual worldwide 256K market in the late 1980s, to retain the 30-35% share achieved in the 64K fray. This would arrest, though not reverse, the Japanese advance in this all-important arena. But at the same time, Japanese memory successes have provided their industry with a firm foundation for broadening their semiconductor portfolio into other competitive lines. Evidence of such expansion is already strong: recent announcements of impressive static RAM capabilities indicate that this field now rests under Japanese leadership; and trade statistics even show a rapid rise, though the values remain small, in Japanese microprocessor exports.

*Dynamic Random Access Memories and Microprocessor Units.

In commercial terms, the U.S. industry clearly recognizes that it faces some formidable Japanese rivals. It now appears that the challenge, despite stereotypes to the contrary, will be technological as well. Market share analysis, especially on a national scale, tends to reduce competition to an either/or proposition. The disguised, but more likely, results will be a gradual differentiation of both countries' industries and an acceleration of overall progress in the most hotly contested fields.

## The U.S. Trade Position in Semiconductors

For the last ten years, the overall U.S. trade position in semiconductors has deteriorated steadily. A long-standing but shrinking surplus finally turned to deficit in 1982, with preliminary 1983 figures now showing a shortfall of over $600 million. The two primary reasons behind the current imbalance: a continued surge in imports from Japan and a sluggish performance by U.S. exports to Europe.

Shipments to and from American-owned offshore assembly facilities still account for the bulk (70-75%) of U.S. foreign trade in semiconductors. Accordingly, semiconductor "parts" comprise the heavy majority of industry exports, while returning devices make up over two-thirds of all imports. Despite the foreign content of these reimported products, the United States has long enjoyed rough parity in this aspect of semiconductor trade, primarily because a significant fraction of initial U.S. exports moves on after processing for eventual sale in third markets.*

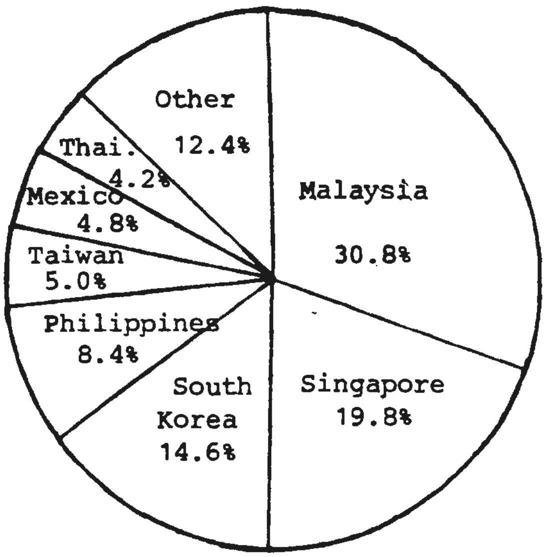
The dramatic shift has instead come in the balance between U.S. exports of completed devices and imports of foreign-owned semiconductor products. Table 7 reveals that while the former category has expanded gradually since 1978 (up 13% per year), the latter group has grown at over 40% per year during that same period. As indicated, most (63%) of this influx is traceable directly to Japan. In addition, Japanese-owned products account for an estimated 50-75% of the remaining imports from offshore facilities, for their industry has also established assembly operations through much of Southeast Asia. Diagrams III and IV provide a complete profile of the sources of U.S. imports.

*The obvious implication here is that U.S. export figures understate the extent to which American semiconductors ultimately penetrate foreign end-use markets. The problem is two-fold: a lack of information on the eventual destination of non-returning parts; and second, the difficulty in estimating the respective foreign and American contents of the final products.

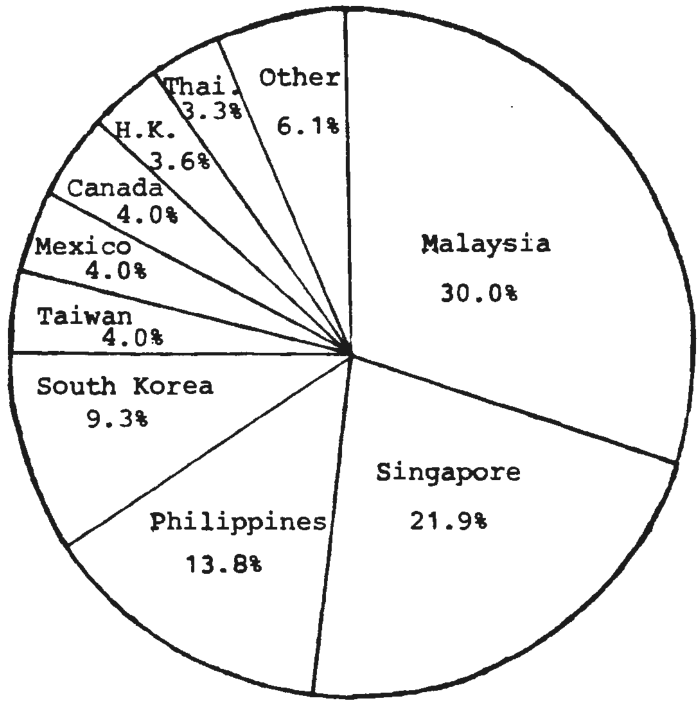
## DIAGRAM III

**SHARES OF 806/7 U.S. SEMICONDUCTOR IMPORTS***

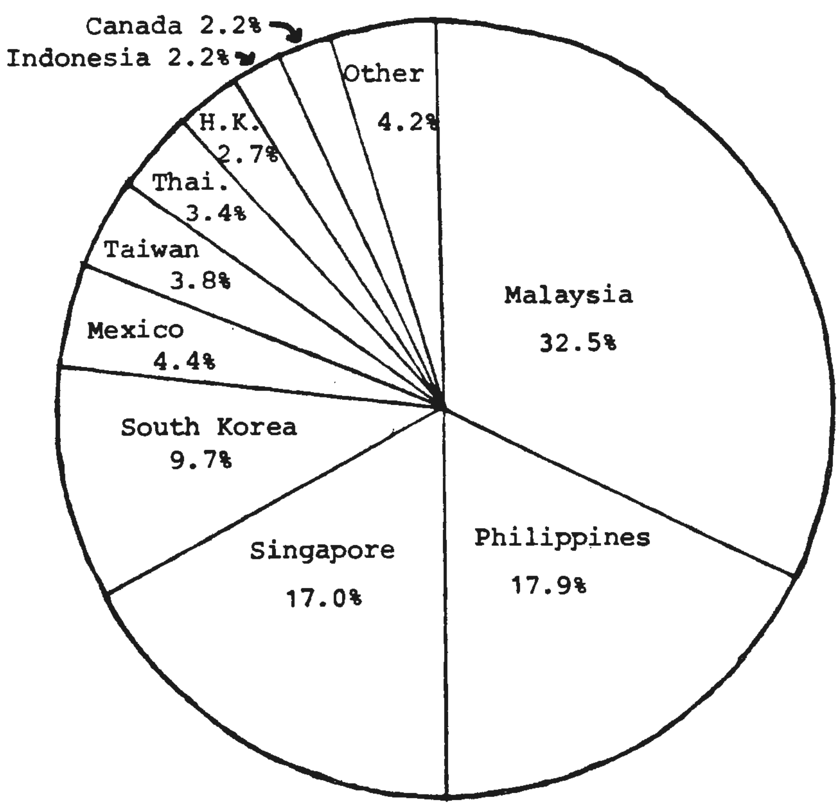
**1978, 1980, & 1982**




1978
(Total value: $1461 mil)




1980
(Total value: $2482 mil)



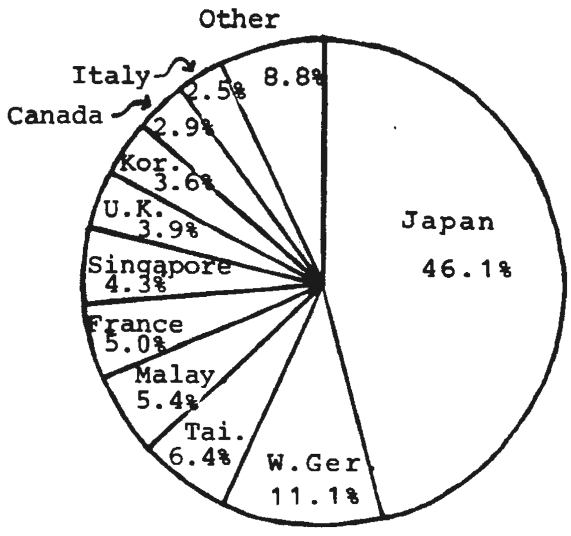

1982
(Total value: $3099 mil)

*Returning from US-owned offshore assembly facilities.

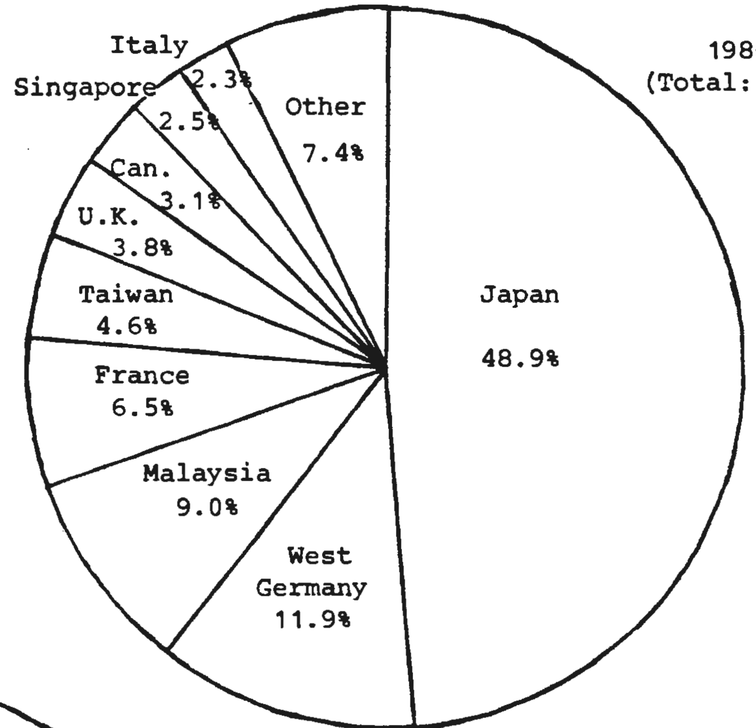
Source: Official U.S. Trade Data

DIAGRAM IV

**SHARES OF NON-806/7 U.S. SEMICONDUCTOR IMPORTS 1978, 1980, & 1982**

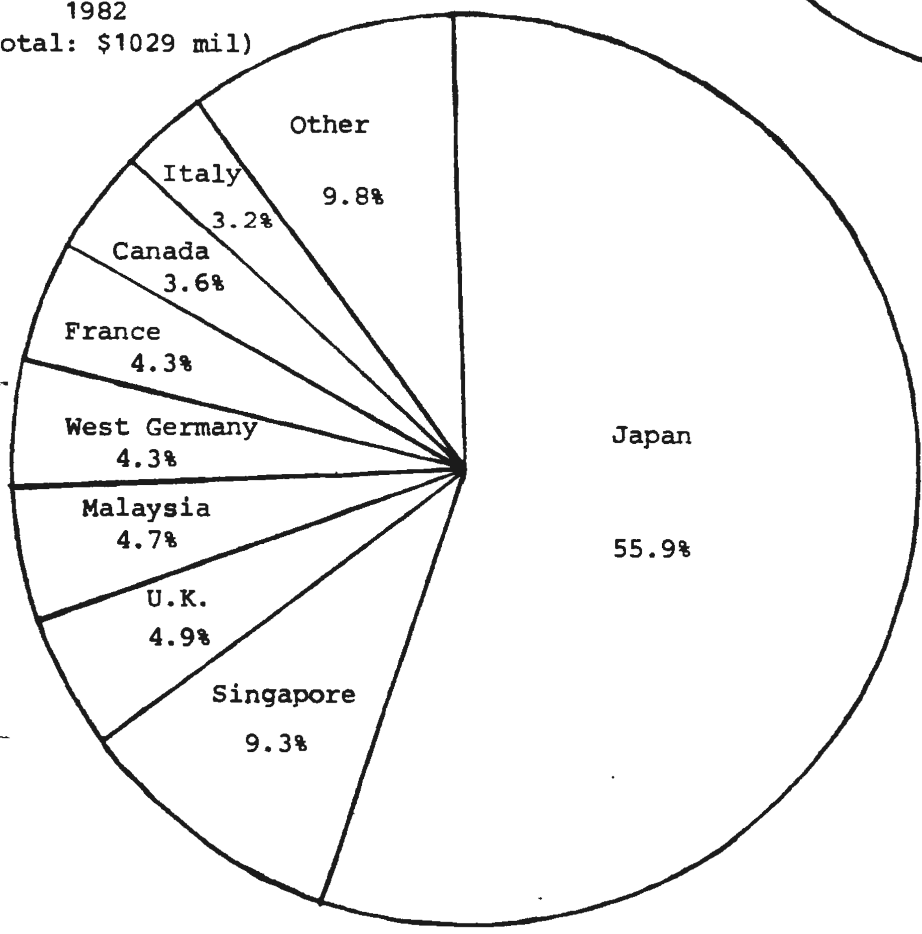



1978
(Total value: $280 mil)




1980
(Total: $797 mil)

1982
(Total: $1029 mil)




SOURCE: Official U.S. Trade Data

Table 7
U.S. TRADE IN FINISHED SEMICONDUCTOR DEVICES*
(millions of $)

| | Imports | fr Japan | Exports | Balance |
|---|---|---|---|---|
| 1978 | 280 | 123 | 667 | +387 |
| 1980 | 797 | 333 | 1,055 | +258 |
| 1982 | 1,029 | 503 | 919 | -110 |
| 1983 | 1,513 | 734 | 1,252 | -261 |
| 1978-83 growth | +40.1%/yr | +42.9%/yr | +13.4%/yr | |

*Exports exclude parts.
Imports exclude returning devices (806/7).

SOURCE: Official U.S. Trade Statistics

Since 1978, the overall effect has been a 23% yearly increase in imports, to $4.9 billion in 1983, versus a 17% annual rise in exports, to $4.2 billion. The product-specific, as well as country-specific, nature of this incursion has exacerbated trade tensions. Most of the jump in imports from Japan can be traced to memory devices, with 64K DRAMs and SRAMs comprising 47% of that total. Given current expectations of the upcoming 256K market, the U.S. deficit may briefly stabilize, but only until Japanese shipment of these chips begins in earnest. Then (roughly 1985-86), U.S. semiconductor imports should again surge, as during the high-growth phases of previous DRAM generations. But also disguised beneath the swell of memory products have been dramatic 1983 rises in U.S. imports of Japanese microprocessors(up 216%) and parts(up 117%). The first figure attests to their improving capabilities in this all-important area. The second statistic corresponds to the establishment by the top four Japanese semiconductor firms of a manufacturing capability in the United States; two additional companies plan to join this group by 1985.

A much quieter trade atmosphere prevails vis-a-vis Europe, despite continuing interference from its 17% external tariff. A delayed recovery in the European semiconductor market held 1983 U.S. exports below $550 million, up only 5.2% from the previous year. But imports of $244 million, concentrated in discrete devices, still left the U.S. with a regional surplus of more than $300 million. A weak indigenous industry gives the European market long-term importance primarily as a forum for U.S.-Japanese competition.

All in all, the United States' trade position in semiconductors reflects, both at the broadest levels and in detailed product categories, the current state of international competition. While there are still positive elements, the decline of the past few years remains striking.

Japan

The Japanese semiconductor market--both output and demand--has steadily gathered momentum since the early 1970s. Three ingredients have propelled the Japanese industry to impressive levels of technical achievment and commercial success: tremendous investment in production facilities and equipment, the commitment of significant resources (both private and public) to research and development, and a willingness to compete aggressively in terms of price and performance. At the same time, rapid expansion in other electronics sectors has provided most of the demand increase necessary to sustain strong growth in the production base.

Total Japanese semiconductor shipments in 1983 were estimated at $6.1 billion, up 19% per year in dollar terms since 1978. Consumption figures have risen more slowly--to a 1983 level of $4.2 billion--due to the greater international orientation of the industry.

The Japanese production structure differs markedly from that observed in the United States. Without exception, the leading firms are integrated manufacturers of a variety of electronics products. Table 8 illustrates the diversified character of six top companies.

Table 8
A PROFILE OF JAPANESE SEMICONDUCTOR MANUFACTURERS

| Firm | Corporate Sales* (mil$, JFY 1982) | Semiconductor Fraction** |
|---|---|---|
| Fujitsu, Ltd. | 4,000 | 12-13% |
| Hitachi, Ltd. | 16,400 | 7-8% |
| Mitsubishi Electric | 6,500 | 6-8% |
| Nippon Electric Co. | 5,400 | 20-22% |
| Oki Electric | 900 | 19-23% |
| Toshiba, Ltd. | 10,200 | 7-8% |
| | Average: | 12.6% |

*Sales figures converted at 240Y/$
**Semiconductor shipments/corporate sales

SOURCE: Annual Reports, Dataquest, DOC

The important results:

1) 25-30% of total semiconductor production is captive. But unlike in the United States, where the captive/merchant line is clearly drawn, the fraction applies to each of the major Japanese firms. This intra-corporate activity serves to stabilize the demand conditions that each company faces, insulating them somewhat--particularly in a product's developmental stages--from a volatile merchant market.

2) capital availability becomes a less pressing constraint. As progressive chip generations require ever-increasing funds to research, develop, and produce, integrated firms can more easily tap the requisite resources and channel them to their semiconductor divisions.

As indicated earlier, the product distribution of Japanese output heavily emphasizes the memory function and MOS technology. This strength in the highest volume market segments represents the key to the industry's recent growth. Table 9 tracks the performance of each major competitor.

Table 9
LEADING JAPANESE SEMICONDUCTOR FIRMS

| | 1978 Chip Output (mil $) | 1980 | 1982 | 1983 | 1978-1983 Growth Rate |
|---|---|---|---|---|---|
| Nippon Electric | 518 | 769 | 1,075 | 1,413 | 22.2% |
| Hitachi | 465 | 658 | 877 | 1,181 | 20.5% |
| Toshiba | 401 | 629 | 714 | 983 | 19.6% |
| Fujitsu | 124 | 419 | 465 | 688 | 40.9% |
| Matsushita | 254 | 300 | 426 | 600 | 18.8% |
| Mitsubishi | 147 | 254 | 338 | 440 | 24.5% |
| Sanyo | 120 | 180 | 241 | 329 | 22.3% |
| Sharp | Not Av | Not Av | 192 | 279 | 20.5%* |
| Oki | Not Av | Not Av | 129 | 229 | 33.2%* |
| Total Listed | 2,161 | 3,414 | 4,457 | 6,142 | 23.2% |
| Grand Total | | | | 6,768 | |

*Growth rates extended back to 1978 and 1980 for aggregate calculations.

SOURCE: Dataquest, DOC

The other areas of importance for Japanese firms correspond to the unique features of domestic marketplace. Manufacturers of consumer electronic products constitute 50% of total semiconductor demand--hence, the emphasis on linear/analog devices and low-level ROMs. But the directions of development are clear: away from these consumer applications, and towards the computer and telecommunications industries' requirements.

Japanese Trade in Semiconductors

Since 1975, Japan has enjoyed a surplus in overall semiconductor trade, a surplus now near $2 billion. Exports of integrated circuits have climbed at a 32% per year rate during that period; they now comprise 46% of total industry output, with a value more than triple that of incoming shipments. Table 10 provides a summary of the aggregate trends.

Table 10
JAPAN: SEMICONDUCTOR TRADE

| | 1978 | 1980 | 1982 | 1983* | Annual Growth (1978-83) |
|---|---|---|---|---|---|
| Exports (mil $) | 710 | 1562 | 1997 | 2800 | +31.6% |
| ICs | 248 | 809 | 1145 | 1506 | +43.4% |
| Discretes | 278 | 358 | 406 | 314 | + 2.5% |
| Parts | 184 | 395 | 446 | 980 | +39.7% |
| Imports (mil $) | 404 | 651 | 680 | 830 | +15.5% |
| ICs | 291 | 480 | 512 | 590 | +15.2% |
| Discretes | 104 | 150 | 148 | 145 | + 6.9% |
| Parts | 9 | 21 | 20 | 105 | +63.5% |
| Balance (mil $) | +306 | +911 | +1317 | +1970 | +45.1% |
| ICs | -43 | +329 | +633 | +916 | N/A |
| Discretes | +174 | +208 | +258 | +169 | - 0.6% |
| Parts | +175 | +374 | +426 | +875 | +38.0% |

*Estimate based on data thru September 1983.

Source: Japan Tariff Association

Approximately 1/2 of the Japanese surplus derives from semiconductor trade with the United States. A comparison of bilateral import penetration ratios provides an additional measure of this shifting imbalance.*

*For a further discussion of the bilateral trade relationship, see pages 8-9. Table 11 does understate each country's share of the other's market. U.S. firms have production facilities in Japan and vice versa; in addition, U.S. data exclude Japanese products entering via offshore sites.

Table 11
IMPORT PENETRATION RATIOS: THE U.S. AND JAPAN

| | Total Penetration | by Semis from Japan | by Semis from US |
|---|---|---|---|
| United States | | | |
| 1983 | 35.9% | 6.7-8.7%* | 24.8%** |
| 1978 | 31.9% | 2.4-3.4%* | 26.8%** |
| Japan | | | |
| 1983 | 16.3% | offshore data | 4.8% |
| 1978 | 16.8% | unavailable** | 4.4% |

Sources: Japan Tariff Association, EIAJ, Census Bureau, ITA.
*Japanese trade data include imports from offshore facilities with more than 50% U.S. content as imports from the United States; U.S. trade data does not. Therefore, a range is presented to cover unaffiliated (e.g., potentially Japanese-owned) U.S. imports from those same offshore centers. The lower limit reflects direct imports from Japan; the upper figure would apply if all unaffiliated imports were in fact Japanese. The truth is of course somewhere in between.
**U.S. imports under 806/7; Japan has no comparable provision, so that no data is available on products returning from its offshore sites.

The remainder of the surplus stems from European sales, offshore trans-shipments, and delivery to the consumer electronic industries in Korea, Hong Kong, and Taiwan. These other nations have had even more difficulty than the American industry in exporting to Japan--despite the deepening bilateral deficit, the U.S. share of Japanese imports has actually risen from 57% to 60% since 1978.

The composition of Japanese exports reveals two basic patterns:

- -- first, as discussed above, a disproportionate share remains advanced memory devices;

- -- second, parts shipments have risen rapidly, especially those headed to facilities in Europe and the United States. The Japanese have never relied heavily upon traditional offshore assembly operations, though their network has recently undergone some modest expansion. They emphasize instead simple exportation of complete, "home-grown" devices, or direct investment in the major foreign markets.

The overall dependence of the Japanese semiconductor industry on foreign trade (at least 37% of shipments) far exceeds that of its American and European competitors (approximately 20% of output). And while some Japanese expansion of world market share will come from above-average growth at home, most analysis indicates that this internationalization trend will also continue through the 1980s. By decade's end, however, an expected annual surplus of $4-6 billion could cause considerable trade friction.

## Western Europe

The European semiconductor producers should challenge their foreign competitors primarily in the discrete device segments of the industry. In the much larger integrated circuit field, European manufacturers, with few exceptions, will succeed only in sheltered domestic markets.

But despite sluggish growth since 1980, total European demand for semiconductors exceeds $4 billion, offering tremendous opportunities and rewards for firms that can enter successfully. Table 12 breaks down this total figure by country.

Each of the leading nations suffers a modest trade deficit, despite the protection afforded by sizeable tariff barriers. Extensive U.S. (and now Japanese) investment in European production facilities has also mitigated, but failed to neutralize, each country's shortfall.

Table 12
EUROPEAN SEMICONDUCTOR PRODUCTION AND CONSUMPTION
(1983, in millions of $)

| | Production | Consumption | Implicit Trade Balance |
|---|---|---|---|
| West Germany | 760 | 1200 | -440 |
| United Kingdom | 630 | 740 | -110 |
| France | 550 | 600 | - 50 |
| Italy | 175 | 400 | -225 |
| Netherlands | 250 | 380 | -130 |
| Other | 400 | 750 | -350 |
| Total W. Europe | 2765 | 4070 | -1290 |
| United States | 13010 | 13690 | -680 |
| Japan | 6100 | 4200 | +1900 |

Sources: Mackintosh, DOC

Table 13
LEADING EUROPEAN SEMICONDUCTOR FIRMS

| | 1978 Semiconductor Sales (mil $) | 1983 Semiconductor Sales (mil $) | 1978-1983 Annual Growth |
|---|---|---|---|
| Philips(Neth) | 431 | 469 | + 1.7% |
| Siemens(FRG) | 292 | 333 | + 2.7% |
| SGS-ATES(Italy) | 100 | 230 | +18.1% |
| Thomson-CSF(Fr) | 130 | 141 | + 1.6% |
| Telefunken(FRG) | 111 | 134 | + 3.8% |

Sources: Financial Times, Dataquest.

Although late-1983 brought an overdue recovery in European semiconductor sales, few expect regional growth rates to keep pace with either the American or Japanese figures. Behind this concern are:

-- continued trade interference, with its inefficient price and consumption effects; and

-- the gradual weakening of European end-user industries. As noted above (p.7 ), demand is concentrated in the industrial and telecommunications sectors, whose near-term performance should certainly trail that of U.S. and Japanese computer firms, for example.

In addition, the primary beneficiaries of what growth does materialize, barring implementation of further protectionist measures, will be non-European chip producers.

Developing Countries

KOREA -- Korea has pursued a native semiconductor fabrication capability more aggressively than any member of the developing world. Though the nation established itself early on as an important location for offshore assembly (95 percent of U.S. imports from Korea still qualify for 806/7 treatment), five of its leading industrial concerns have now announced their intention to produce 64K DRAMs by 1985. This goal is ambitious, but hardly out of reach. Each of the participants has gradually concentrated its activities in the electronics field, first pursuing consumer products, then low-level telecommunications and computer equipment. The current interest in semiconductors represents an important strategic choice:

1) in the near term, the desire for an autonomous, self-supporting electronics sector that need not rely on the United States or Japan for fundamental technologies or components;

2) in the long term, the opportunity to join those countries as a major force in the world semiconductor market and share in its dynamic growth.

Thus far, their approach has been straightforward--to combine the massive resources of these international conglomerates with every available opportunity for technical absorption, whether licensing arrangements, corproduction agreements, corporate acquisitions, or strategically locating overseas facilities to maintain close contact with traditional centers of innovation.

Table 14
THE KOREAN SEMICONDUCTOR INDUSTRY

| Firms | Semiconductor Shipments(1983) | Total Corp. Sales(1983) | Planned investments in the chip area | U.S. Ties* |
|---|---|---|---|---|
| Samsung | $25 mil | $8 bil | $500 mil/4 yrs | I. Tristar Semiconductor.<br>II. ITT, Hewlett-Packard, Micron Technology. |
| Goldstar | $5 mil | $6 bil | $160 mil/5 yrs | I. Bando California.<br>II. AT&T, Honeywell, Zilog. |
| Hyundai | begin 1984 | $9 bil | $500 mil/5 yrs | I. Modern Electrosystems.<br>II. None. |
| Daewoo | $1 mil | $3 bil | $200 mil/4 yrs | I. None.<br>II. Northern Telecom Ltd. (Canada) |
| KEC (Korea Electronics Co) | $30 mil | $60 mil | $150 mil/5 yrs | I. None.<br>II. Toshiba (Japan). |

*I: U.S. subsidiaries/affiliates.
II: Partners in joint ventures/licensing agreements.

Sources: US Dept of State, Solid State Technology, Electronic Business.

Forecasts of a commercial 256K device by 1988 indicate their unquestioned progress to date. Should this development continue uninterrupted, it would launch Korea far beyond the stereotype of offshore manufacturing and well into the front ranks of international competition in semiconductors.

MALAYSIA -- Malaysia now accounts for roughly $1 billion* per year in semiconductor output. But unlike in Korea, foreign-headquartered firms (from the U.S., Japan, and Europe) hold at least a majority ownership position in all producing facilities. Furthermore, over 90% of these plants house only assembly operations; fabrication represents a minor, though growing, activity.

American semiconductor firms were the first to locate in Malaysia. The economics of volume production encouraged companies to transfer the unskilled, labor-intensive stages of the process to offshore sites. Here, low wage rates combined with a variety of investment incentives (tax holidays, etc.) to provide attractive opportunities for semiconductor manufacturers.

For Malaysia, 1967 marked the beginning. The major European firms soon followed their American competitors; some years later, the Japanese began to participate as well. But neither group entered as aggressively as the U.S. industry, still dominant today with over 70% of total Malaysian shipments.

The recent establishment of three wafer fabs may signal an eventual change in Malaysia's role in the international semiconductor industry. But for now it remains the prototypical "offshore" site.

OTHERS -- Several developing countries have followed the Malaysian example, hosting significant levels of semiconductor assembly activity: the Philippines, Thailand, Indonesia, and Mexico. Yet another group--including Singapore, Hong Kong, and Taiwan--more closely emulates the Korean model. Though still important offshore centers, these nations now emphasize the development of a fabrication base and, ultimately, of a native semiconductor industry. But at least during the 1980s, none of these will mount a serious competitive challenge to the current industry leaders.

*1983 estimate for total value added.

UNITED STATES DEPARTMENT OF COMMERCE
The Under Secretary for International Trade
Washington, D.C. 20230

Dear :

In February 1983, in order to assess future problems in U.S. high technology competitiveness, the Commerce Department sponsored a series of meetings attended by leading executives of the related industries and by high-level Administration representatives. A number of policies presented at those meetings have since been supported by this Administration -- the Semiconductor Chip Protection Act, modification of antitrust laws for joint R & D cooperatives, and a more assertive U.S. role in bilateral trade negotiations, which culminated in an agreement on semiconductors by the U.S.-Japan High Tech Working Group.

On February 28, 1984, 2:30 p.m. to 4:00 p.m., in Room 4830 of the Main Commerce Building, we are planning an update on the semiconductor industry by key executives of the Semiconductor Industry Association. I invite you to attend this meeting so that all the agencies with a role in this industry are represented. We think this meeting will be pivotal in pointing the way for a wide range of policies affecting the entire high tech industry, an industry that is critical to our economic success in the eighties.

Please call John Calhoun of my staff if you plan to attend. He can be reached at 377-5855.

Sincerely,

Lionel H. Olmer

Attachment

(Identical Letter Sent to Attached List)

A

B

SEMICONDUCTOR INDUSTRY MEETING
February 28, 1984

## Agenda

| | |
|---|---|
| 2:30 - 2:40 | Introduction and Opening Remarks by Under Secretary Lionel H. Olmer |
| 2:40 - 2:55 | "Overview of Competitive Situation, U.S. vs Japan"<br>Mr. Gary Tooker<br>Executive Vice President and General Manager<br>Motorola, Inc.<br>Semiconductor Products Sector |
| 2:55 - 3:10 | "International Negotiations, Legislation and Regulations"<br>Mr. George Scalise<br>Senior Vice President and<br>Chief Administrative Officer<br>Advanced Micro Devices, Inc. |
| 3:10 - 3:25 | "Capital Formation, Cost of Capital, and Tax Policy"<br>Mr. Charles E. Sporck<br>President and Chief Executive Officer<br>National Semiconductor Corp. |
| 3:25 - 3:40 | "Innovation and Productivity"<br>Mr. Erich Bloch<br>Vice President/Technical Personnel Development<br>IBM Corporation |
| 3:40 - 3:45 | "Summation of Industry Presentations"<br>Mr. Gary Tooker |
| 3:45 - 4:00 | Discussion led by Under Secretary Olmer |

C

INDUSTRY REPRESENTATIVES
SEMICONDUCTOR MEETING
February 28, 1984

Mr. Erich Bloch
Vice President/Technical Personnel
  Development
IBM Corporation 3N2
44 South Broadway
White Plains, New York 10601
(914) 686-4460

Mr. Charles E. Sporck
President and Chief Executive Officer
National Semiconductor Corp.
Mail Stop 16-100
2900 Semiconductor Drive
Santa Clara, California 95051
(408) 721-6508

Mr. Gary Tooker
Executive Vice President
  and General Manager
Motorola, Inc.
Semiconductor Product Sector
P.O. Box 2953
Phoenix, Arizona 85062
(602) 244-4205

Mr. Thomas D. Hinkelman
Executive Director
Semiconductor Industry Association
4320 Stevens Creek Blvd., Suite 275
San Jose, California 95129
(408) 246-1181

Mr. Warren E. Davis
Vice President Public Affairs
Semiconductor Industry Association
4320 Stevens Creek Blvd., Suite 275
San Jose, California 95129
(408) 246-1181

Mr. George Scalise
Senior Vice President and
Chief Administrative Officer
Advanced Micro Devices, Inc.
901 Thompson Place
Sunnyvale, California 94086
(408) 749-2808

Mr. Alan W. Wolff
Counsel to Semiconductor Industry Association
Verner, Liipfert, Bernhard and McPherson
Suite 1100
1660 L Street, N.W.
Washington, D.C. 20036
(202) 452-7452

Meeting with Senior Executives
February 28, 1984

LIST OF GOVERNMENT ATTENDEES

Mr. Richard T. McCormack
Assistant Secretary for Economic and Business Affairs
Department of State, Room 6828
2201 C Street, N.W.
Washington, D.C. 20520

Mr. Lehmann Li
Senior Staff Member
Office of Policy Development
The White House
Washington, D.C. 20500

Dr. Richard DeLauer
Under Secretary of Defense for Research and Engineering
U.S. Department of Defense
Room 3E1006
Washington, D.C. 20301

Mr. J. Paul McGrath
Assistant Attorney General for Anti Trust
U.S. Department of Justice
Room 3107
Washington, D.C. 20530

Ambassador Robert E. Lighthizer
Deputy U.S. Trade Representative
Winder Building, Room 200
600-17th Street, N.W.
Washington, D.C. 20506

Mr. Joseph Morone
Policy Analyst for General Science
Office of Science and Technology Policy
The New EOP
Room 5055
Washington, D.C. 20506

Mr. Wendell Gunn
Special Assistant to the President for Policy Development
Old Executive Office Building
Room 224
Washington, D.C. 20500

Dr. Charles Buffalano
Deputy Director of Research, DARPA
1400 Wilson Blvd.
Arlington, Virginia 22209

Department of Commerce

Lionel H. Olmer
Under Secretary for International Trade

Olin Wethington
Deputy Under Secretary for international Trade

Richard L. McElheny
Assistant Secretary for Trade Development

John A. Calhoun
Commerce - Science and Electronics

Clyde Prestowitz
Counselor to the Secretary for Japan Affairs

Dr. D. Bruce Merrifield
Assistant Secretary for Technology Innovation

Egils Milbergs
Director, Office of Productivity, Technology and Innovation

D

# RESEARCH AND DEVELOPMENT LIMITED PARTNERSHIPS

## CASE STUDIES

Industrial Technology Partnerships Program
Office of Productivity, Technology and Innovation
U.S. Department of Commerce
Washington, D.C. 20230
(202) 377-1094

January 1984

c c Please 40 copies

## Research and Development Limited Partnerships (RDLPs) Case Studies

R&D Limited Partnerships can be offered at any dollar amount; they can be syndicated through a public or private offering; and sales can be limited locally or be nation-wide. The bulk of current RDLP activity is in small private placements. There is no accurate data yet available on the number of RDLPs formed or the total funding they represent. One private sector source estimates that RDLPs formed in 1983 account for a total of $800 million. Blyth Eastman Paine Webber alone has syndicated $130 million in 1983 and anticipates syndicating a total of $200-250 million in 1984. The following case studies represent those larger-scale RDLPs of which we are aware.

### Storage Technology Partners

In February 1981, the STC Computer Research Corporation raised $50 million through a RDLP to develop technology for a series of IBM-compatible high performance computers using advanced very large scale integrated circuitry. Smith Barney, Harris Upham & Co., was the exclusive sales agent for this private partnership placement.

STC produces electronic data storage equipment. In its partnership prospectus, STC stated that it wanted to use this partnership to "enable STC to use more of its financial resources for expansion of its existing product lines and, at the same time, avoid the adverse impact on its near-term earnings which would result if the development program were to be funded solely by STC." STC estimates its net income would be approximately $25 million more over a three-year period using a RDLP rather than using equity or cash from operations.

Another $40 million was syndicated by STC in October 1981 through Smith Barney, L.F. Rothschild, Unterberg, Tobin. This R&D limited partnership was formed to design, develop, manufacture and market a line of high performance, IBM-compatible disk drives using optical recording technology to record data, and read data from a removable media.

### Trilogy Computer Development Partners Ltd.

In August 1981, two companies, Trilogy Limited and its subsidiary Trilogy Systems Corporation, used a R&D Limited Partnership to raise $55 million to design a large scale, high performance, general purpose computer system. Since formation in September 1980, Trilogy Limited has engaged primarily in raising capital and organizing the corporate struture. Trilogy

Systems Corporation, since its formation in August 1980, has engaged primarily in obtaining facilities and recruiting personnel to begin development of the computer design. Estimates shown in Trilogy Limited's prospectus indicated that they would be competing in a $7 billion market by 1985.

The Merrill Lynch White Weld Capital Markets Group served as investment banker for the public offering. A $10,000 minimum investment was required, and partnership agreement allocated 99 percent to the limited partners and 1 percent to the general partner. Trilogy Limited agreed to grant the partnership an exclusive, worldwide, royalty free license to use the base technology. In June 1983, additional shares of stock were sold to fund completion of this project.

Diversified Technology Partners, Ltd.-1982

Bateman Eichler, Hill Richards sponsored Diversified Technology Partners, Ltd-1982 to fund R&D projects for four separate publicly-held companies. The partnership's stated investment objectives were: (1) To return Limited Partners at least 300% of their contributed capital (exclusive of tax benefits) over an eight year period; (2) To generate current year tax deductions to limited partners in excess of 90% of their contributed capital; and (3) To generate royalty income from sale of any successfully developed partnership technology, substantially all of which will be eligible for long-term capital gains tax treatment.

Based on the above objectives Diversified Technology Partners selected five projects. This $16,650,000 public offering has a minimum investment of $5,000.

Genentech Clinical Partners Ltd.

In 1982, Genentech, Inc., was faced with the need to license its new human growth hormone ("hGH") and gamma interferon technology to a foreign country. Instead, it raised $55 million through a RDLP. The RDLP off-balance sheet financing mechanism will preserve their equity ownership in contrast to venture capital funding that trades funds for equity.

Blyth Eastman Paine Webber Incorporated and Hambrecht & Quist managed the private placement of the partnership interest. Sutro & Co. participated as a member of the selling group. The minimum investment of $100,000 was payable in five installments over 3 1/2 years.

In April 1983, Genentech, Inc. syndicated another $32 million through Blyth Eastman Paine Webber to fund a development project to conduct human clinical testing and development of tissue-type plasminogen activator (t-PA)--a blood-clot-dissolving agent. The name of this second RDLP is Genentech Clincial Partners II.

Cetus Healthcare Limited Partnership

In May 1983, the Cetus Corporation raised $75 million through a RDLP to fund the later stage development of 1) infectious disease diagnostics; 2) cancer diagnostics; 3) cancer immunotherapeutics; and 4) other projects to be selected by the General Partner at a future date. Funding was syndicated through Oppenheimer & Company and Lehman Brothers Kuhn Loeb.

Hutton/PRC Technology Partners Ltd.

In 1983 E.F. Hutton and Company, Inc. syndicated a fund of $25 million through a RDLP without specifically designating all the projects that may eventually be funded. The Partnership is only committed to conduct research and development activities in connection with the commercial application of technology, to be used principally in electronic communications, data processing, robotics and other related systems. The fund was oversubscribed in the first few weeks and represents an interesting new RDLP model.

Semiconductor Research Corporation (SRC)

The SRC is working on a plan to fund the development of a multi-megabit dynamic random access memory chip. This will be a significant innovation over existing technology and will involve a large group of semiconductor and computer manufacturers. A RDLP is being considered among the various methods of funding this estimated $100 million project. SRC is also investigating the possibility of Federal government participation in the program.

Pru Tech Research and Development Partnership

In November 1983 Prudential-Bache Securities began working on a RDLP to raise $100 million. The PruTech Research and Development Partnership is a public offering with final closing no later than December 1984. Research projects will be selected from companies in telecommunications, information processing, computers, computer peripherials, software, microelectronics, fiber optics, laser technology semiconductors, robotics, genetic engineering and medical technology.

Industrial Technology Partnership Program
Office of Productivity, Technology and Innovation
U.S. Department of Commerce
Washington, D.C. 20230
(202) 377-1094
January 1984

E

BIOGRAPHY OF ERICH BLOCH
International Business Machines Corporation

Erich Bloch received his education in electrical engineering at the Federal Polytechnic Institute of Zurich (Switzerland) and his BSEE degree from the University of Buffalo, New York. He joined IBM in 1952 as a technical engineer and worked on the development of IBM's first computers.

During his career, among numerous professional and management responsibilities, he was the engineering manager for the AEC sponsored STRETCH computer system. In 1962, he headed up the development of the Solid Logic Technology program which provided IBM with the semiconductor technology for IBM's System/360 series.

In 1968, he became director of IBM's Poughkeepsie laboratory and director of large data processing system development and in 1970, he became Vice President, Operations, IBM Components Division, with responsibility for the development and manufacture of all of IBM's semiconductor efforts.

He was on IBM's corporate staff as director of technology and systems and a member of the Corporate Technical Committee. Before his present responsibility he was a Vice President of the Data Systems Division and East Fishkill General Manager. East Fishkill is responsible for the development and manufacture of logic and memory semiconductors and packaging that are used in most of IBM's sytems and products. Today he is Assistant Group Executive-Technology for IBM's Data Processing Product Group.

He is a senior member of the IEEE, and an active participant in several other professional groups.

SIA SEMICONDUCTOR INDUSTRY ASSOCIATION
4320 Stevens Creek Blvd. • Suite 275 • San Jose, CA 95129 • (408) 246-1181

BIOGRAPHY

**WARREN EARL DAVIS**

Warren E. Davis is Vice President, Public Affairs of the Semiconductor Industry Association (SIA), the trade organization which represents the American semiconductor industry.

Davis earned an undergraduate degree in political science from the University of California and an M.S. in business administration from California State University, Sacramento. From 1951 to 1959 he served in the U.S. Navy and was assigned to various ships of the U.S. Pacific Fleet.

Upon completion of his tour in the Navy, Davis worked for Aerojet General Corporation where he installed a standard cost system for rocket manufacture as well as developed a master project planning system for Minuteman, Polaris, Tartar, and Pershing missiles.

Davis' career in the semiconductor industry began in 1969 when he joined the staff of Fairchild Camera and Instrument Corporation. At Fairchild, where he held various corporate positions, Davis installed a computer-based worldwide distribution system, initiated worldwide capacity planning, and conducted pioneer semiconductor negotiations in the far east.

Davis joined the Semiconductor Industry Association in 1978, and he currently serves as Vice President, Public Affairs. Under his leadership, the SIA has become a well-known advocate for high technology in Washington, D.C.

From 1977 to 1982 Davis served as an instructor at San Jose State University where he taught courses in international business finance.

Davis has published several articles on the semiconductor industry, including "Outlook for Offshore Manufacturing in the 1980's" (1981) and "The Semiconductor Industry: A Model for Third World Development", Journal of the Flagstaff Institute (1983).

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2/84

SIA SEMICONDUCTOR INDUSTRY ASSOCIATION
20380 Town Center Lane • Suite 155 • Cupertino, Ca 95014 • 408/255-3522
Telex: 172 231 SIA CPTO

# BIOGRAPHY

## Thomas D. Hinkelman, Executive Director

Thomas D. Hinkelman is executive director of the Semiconductor Industry Association (SIA), the trade organization which represents the American semicondutor industry.

Hinkelman earned an undergraduate degree in engineering from Rensselaer Polytechnic Institute, and an MBA degree from Harvard Business School. Initially he worked on the application of semiconductor diodes in the Univac, the first commercial electronic computer. His career in the semiconductor industry has spanned nearly 30 years, and includes a variety of technical, marketing, and executive positions at such firms as General Electric, Motorola, and Monsanto, as well as Fairchild Camera and Instrument Corporation, where he served as Vice President of Planning.

Among Hinkelman's other industry achievements have been the chairmanship of the Electronic Industries Association (EIA) Trade Policy Committee and Solid State Products Division; the publication of numerous articles in professional publications; and recognition as a computer pioneer by the National Computer Conference.

Hinkelman became director of the SIA in 1977. Under his leadership the Association has developed major programs in the areas of government policy, international trade, worldwide semiconductor trade statistics, and occupational health, safety, and environment. Fifty-six semiconductor manufacturers now actively support and participate in the affairs of the SIA.

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# GEORGE M. SCALISE


| | |
|---|---|
| 26055 NEWBRIDGE ROAD | HOME PHONE: 415/941-5041 |
| LOS ALTOS HILLS, CA 94022 | OFFICE PHONE: 408/749-2608 |


PERSONAL DATA:

| | | | |
|---|---|---|---|
| AGE: | 49 | BIRTHDATE: | MAY 1, 1934 |
| MARITAL STATUS: | | MARRIED, THREE CHILDREN | |

EDUCATION:

PURDUE UNIVERSITY: BACHELOR OF SCIENCE
MECHANICAL ENGINEERING - 1956

MILITARY:

UNITED STATES ARMY CHEMICAL CORPS., PROJECT ENGINEER MATERIEL COMMAND, 1956 - 1958

PROFESSIONAL ACTIVITIES:

ADVISOR TO U.S.-JAPAN WORK GROUP ON HIGH TECHNOLOGY INDUSTRIES

ADVISOR TO U.S.-JAPAN COMMON MARKET BUSINESSMAN'S ADVISORY GROUP

ADVISORY PANEL, TECHNOLOGY AND THE AMERICAN ECONOMIC TRANSITION, OFFICE OF TECHNOLOGY ASSESSMENT

BOARD OF DIRECTORS, MICROELECTRONICS AND COMPUTER TECHNOLOGY CORPORATION (MCC)

BOARD OF DIRECTORS, SEMICONDUCTOR RESEARCH CORPORATION (SRC)

CHAIRMAN, GOVERNANCE COMMITTEE, MCC

CHAIRMAN, PUBLIC POLICY COMMITTEE, SEMICONDUCTOR INDUSTRY ASSOCIATION (SIA)

INTERNATIONAL ADVISORY BOARD, UNIVERSITY OF SANTA CLARA

NORTHERN CALIFORNIA DISTRICT EXPORT COUNCIL, DEPARTMENT OF COMMERCE

# GEORGE M. SCALISE

## BUSINESS EXPERIENCE

| | |
|---|---|
| 1981 - PRESENT | SENIOR VICE PRESIDENT, CHIEF ADMINISTRATIVE OFFICER, ADVANCED MICRO DEVICES; SUNNYVALE, CA |
| 1974 - 1981 | VICE PRESIDENT, ADMINISTRATION AND INTERNATIONAL OPERATIONS, ADVANCED MICRO DEVICES; SUNNYVALE, CA |
| 1970 - 1974 | VICE PRESIDENT AND GENERAL MANAGER, INTERNATIONAL OPERATIONS, FAIRCHILD CAMERA AND INSTRUMENT CORPORATION; MOUNTAIN VIEW, CA |
| 1968 - 1970 | GROUP DIRECTOR, FAIRCHILD CAMERA AND INSTRUMENT CORPORATION; MOUNTAIN VIEW, CA |
| 1967 - 1968 | GENERAL MANAGER, EUROPEAN OPERATIONS, MOTOROLA SEMICONDUCTOR PRODUCTS DIVISION; GENEVA, SWITZERLAND |
| 1961 - 1967 | ASSISTANT GENERAL MANAGER, INTERNAL OPERATIONS, MOTOROLA SEMICONDUCTOR PRODUCTS DIVISION; PHOENIX, AZ |

National Semiconductor

2900 Semiconductor Drive
Santa Clara California 95051
(408) 737-5000

Cable NATSEMICON
Telex 346353
TWX 910 339 9240

Charles E. Sporck

President

National Semiconductor Corporation

Charles E. Sporck is president and chief executive officer of National Semiconductor Corporation. Headquartered in Santa Clara, California, National Semiconductor Corporation is one of the largest manufacturers of integrated circuits including memory, microprocessor, linear, digital, and interface devices. The company, also produces systems products including Datachecker point-of-sale equipment, consumer electronics products, and IBM-compatible computers. National Semiconductor with 20 plants in 8 countries, employs over 35,000 people worldwide and has annual sales exceeding $1 billion.

Mr. Sporck has been president and chief executive officer of National Semiconductor since February 1967. From 1959 to 1967, he held various management positions with the Semiconductor Division of Fairchild Camera and Instruments Corporation, and was general manager of that semiconductor operation from 1964 until his departure for National. Prior to his association with Fairchild, Mr. Sporck was with the General Electric Company where he held various positions in manufacturing.

Mr. Sporck received a B.S.M.E. degree from Cornell University in 1952.

7/81

BIOGRAPHY

GARY L. TOOKER
Senior Vice President and General Manager
Motorola, Inc.

Gary L. Tooker is Senior Vice President, Motorola, Inc., General Manager for the Semiconductor Products Sector.

Prior to being named to this position in September 1982, Mr. Tooker was General Manager of the International Semiconductor Division. Prior to that, he was responsible for all discrete and electronic materials operations.

Tooker started at Motorola on the Engineering Training Program in 1962. Since that time, he has held various positions with responsibility in marketing and product areas and discrete materials, and MOS products during his twenty years at Motorola.

Mr. Tooker received his B.S. degree in Electrical Engineering from Arizona State University.

# ALAN WM. WOLFF

Alan Wm. Wolff is a partner of Verner, Liipfert, Bernhard and McPherson, specializing in international trade and investment law.

From 1977 to 1979 Mr. Wolff was United States Deputy Special Representative for Trade Negotiations, holding the rank of ambassador. Under Robert Strauss, Mr. Wolff was responsible for coordinating general trade policy within the Executive Branch, including fashioning the negotiating instructions for the United States delegation to the Multilateral Trade Negotiations (MTN) and the implementation of the results of the negotiations through enactment of the Trade Agreements Act of 1979.

Mr. Wolff often led United States trade delegations in negotiations with our major trading partners, including Japan and the European Community. He chaired a senior coordinating group on U.S. economic relations with Japan, and played a leading role in seeking greater access to Japan for United States exports. In January 1979 Ambassador Wolff was elected to be the first Chairman of the twenty-nation International Steel Committee of the Organization for Economic Cooperation and Development (OECD).

Prior to being named by President Carter as Deputy Special Trade Representative in the spring of 1977, Mr. Wolff was General Counsel of this agency, was one of the principal draftsmen of the Trade Act of 1974 and also served as chief U.S. negotiator in a number of bilateral trade negotiations.

From 1968 to 1973 Mr. Wolff was a senior attorney dealing with international affairs at the Treasury Department, serving as staff counsel to the Office of Trade Policy and to the National Advisory Council for International Monetary and Financial Policies. In 1971 Mr. Wolff served as U.S. representative for the drafting of the Articles of Agreement of the African Development Fund. Prior to moving to Washington, he practiced law in Boston and New York City.

Mr. Wolff serves on the U.S. Trade Representative's Services Policy Advisory Committee and was a member of the President's Advisory Committee for Trade Negotiations (1980 - 1982). He is a member of the Advisory Committee of the Institute for International Economics. He is a member of the American Society of International Law, the American Bar Association, the Council on Foreign Relations, the Advisory Panel of the Atlantic Council and the International Trade Committee of the U.S. Chamber of Commerce. He chairs a working group of the Chamber on problems of international trade in services.

He is a member of the bar in Massachusetts, New York, the District of Columbia and the Supreme Court of the United States and has published a number of articles on U.S. trade law.

Mr. Wolff received an LL.B from Columbia University in 1966 and an A.B. from Harvard College in 1963. He is married to Helene Novick and has three children.

Verner, Liipfert, Bernhard and McPherson
1660 L Street, N.W., Suite 1100
Washington, D.C. 20036

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