

2.0 IC Market Status and Trends

2.1. Worldwide semiconductor revenue trend

The ever increasing usefulness of the Integrated Circuit (IC) has propelled the overall semiconductor market from \$800 million dollars in 1960, to \$204 billion dollars in 2000 before the market fell back to \$139.5 billion dollars in 2001. In 2002 the market was essentially flat at \$140.5 billion dollars. In 2003 growth resumed with the worldwide semiconductor market reaching \$166.4 billion dollars and then \$212.9 billion dollars in 2004 and finally \$227.3 billion dollars in 2005. For 2006 our strategic partner IC Insights is forecasting that the market will grow to \$247 billion dollars, IC Insight's is further forecasting \$279, \$344, \$353 and \$383 billion dollars for 2007, 2008, 2009 and 2010 respectively. The IC Insight forecast is consistent with our observation two years ago that since 2000 growth in the semiconductor industry has fallen from the historical 14.9% rate to 6.1%, see figure 2.1.

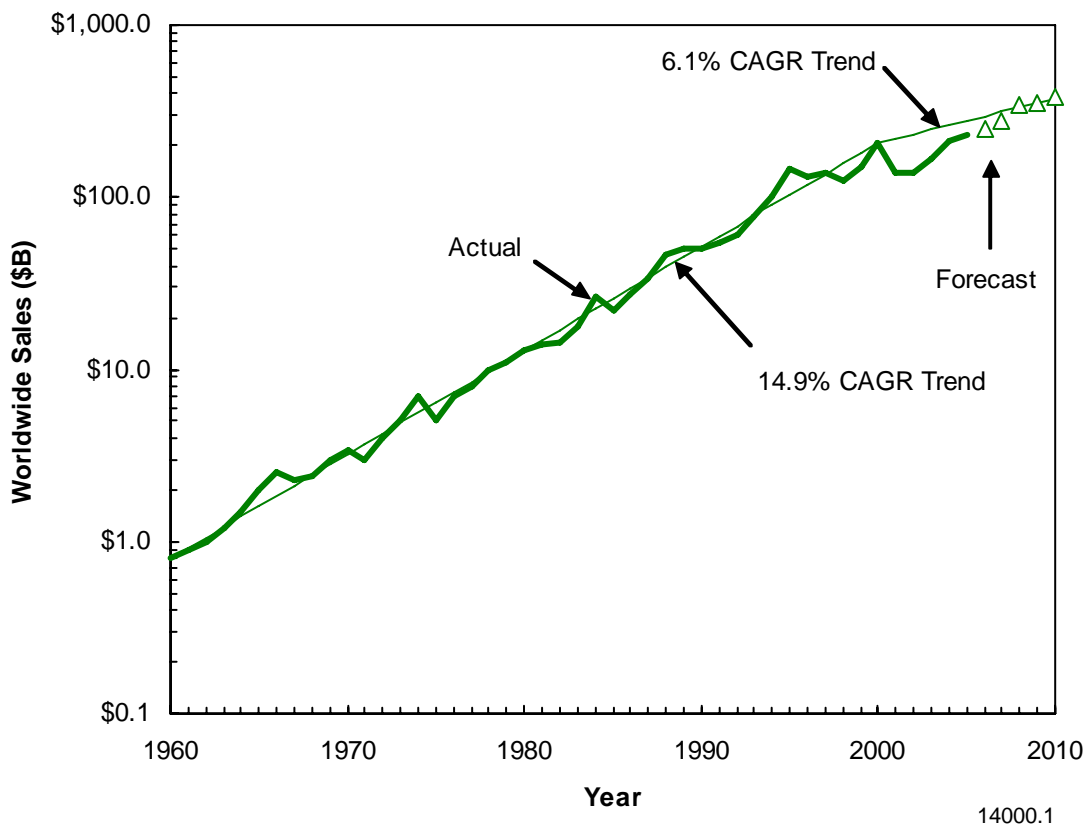


Figure 2.1. Worldwide semiconductor market trend [1],[2].

2.2. Detailed 2005 IC forecast

For the last several years IC Knowledge has been running an internal IC forecast model (this model is ICs only and does not include the discrete devices that combined with ICs makes up the total semiconductor market). We have found that quarterly unit volume patterns are similar in all years that an inflection point does not occur (more on this later). We use the quarterly units pattern to forward forecast unit volumes, we then convert units sales to wafer requirements and compare wafer requirements to forecast capacity using a database of new fab announcements and construction to forward forecast wafer capacity. We can then calculate forecast utilization rates. Since falling utilization rates are an early warning of downturns we use the forecasted utilization rates to predict inflection points allowing us to close the circle on

our modeling. We have also developed a model of ASPs versus utilization that allows us to convert unit volume forecasts to revenue.

Table 2.1. Worldwide IC actual and forecast by quarter.

Quarter	Units sold (B)	Wafer starts (millions of 200mm equiv.)	Wafer capacity (millions of 200mm equiv.)	Utilization (%)	ASP (\$)	Revenue (\$B)
1999-Q1	15.1	10.5	12.5	84.0%	\$1.94	\$29.3
1999-Q2	16.2	11.3	12.7	89.1%	\$1.81	\$29.3
1999-Q3	17.7	11.7	12.8	90.9%	\$1.86	\$33.0
1999-Q4	19.2	12.3	13.1	93.9%	\$1.97	\$37.9
2000-Q1	19.6	13.6	14.4	94.6%	\$2.00	\$39.2
2000-Q2	21.7	14.1	14.9	95.0%	\$2.00	\$43.5
2000-Q3	23.0	15.3	15.9	96.4%	\$2.08	\$47.9
2000-Q4	22.2	15.5	16.7	92.8%	\$2.09	\$46.3
2001-Q1	19.0	13.9	16.6	83.9%	\$1.94	\$36.8
2001-Q2	17.0	12.5	17.1	73.2%	\$1.72	\$29.3
2001-Q3	16.3	11.0	17.2	64.2%	\$1.60	\$26.0
2001-Q4	16.2	11.0	16.6	65.9%	\$1.63	\$26.4
2002-Q1	17.1	12.6	16.2	77.3%	\$1.63	\$27.8
2002-Q2	19.8	14.2	16.3	87.0%	\$1.46	\$29.0
2002-Q3	20.8	14.3	16.6	86.3%	\$1.51	\$31.4
2002-Q4	20.4	13.6	16.7	81.4%	\$1.58	\$32.3
2003-Q1	20.2	13.4	16.2	82.8%	\$1.53	\$30.9
2003-Q2	21.6	14.6	17.0	85.9%	\$1.47	\$31.8
2003-Q3	22.9	15.7	17.8	88.2%	\$1.60	\$36.7
2003-Q4	25.9	16.3	17.8	91.6%	\$1.57	\$40.6
2004-Q1	25.7	16.7	17.8	93.4%	\$1.59	\$40.9
2004-Q2	27.2	17.4	18.3	95.4%	\$1.64	\$44.8
2004-Q3	26.8	17.5	18.9	92.7%	\$1.74	\$46.5
2004-Q4	25.2	16.8	19.8	84.8%	\$1.84	\$46.4
2005-Q1	25.8	16.6	19.6	84.8%	\$1.81	\$46.7
2005-Q2	27.5	17.7	19.9	89.1%	\$1.65	\$45.4
2005-Q3	31.0	18.5	20.5	90.1%	1.60	\$49.7
2005-Q4	32.1	19.5	21.2	91.8%	\$1.59	\$50.9
2006-Q1	30.5	19.0	22.0	86.6%	\$1.58	\$48.2
2006-Q2	33.4	20.6	22.6	91.2%	\$1.65	\$55.0
2006-Q3	36.0	21.4	23.3	92.0%	\$1.70	\$61.1
2006-Q4	37.3	22.6	24.1	93.9%	\$1.75	\$65.3

Our IC only forecast is predicting 19.1% revenue growth for 2006. Our strategic partner IC Insights is predicting revenue growth for the overall semiconductor industry for 2006 of 8.7% so we are considerably more bullish on the 2006 outlook.

2.3. The status of the recovery

Figure 2.2 illustrates semiconductor industry revenue by month for 2004, 2005 and 2006 year-to-date. In figure 2.2 the grey line represents 2004 revenue and the brown line represents 2005 revenue, notice how all the months in Q1 and Q2 up until June had been above the same months in any previous Q1 or Q2 but June dipped below 2004 levels, July moved back slightly above 2004 levels, August and September were above 2004 levels with September showing strong growth, October showing moderating growth and November and December once again showing strong growth. The green squares represent 2006, note how January falls almost directly on top of January 2005, February shows some growth and March shows strong growth.

Although March ends Q1- 2006 on a very strong note, we should caution that in the SIA announcement it was noted that some inventory building may be taking place and that high energy prices threaten consumer spending.

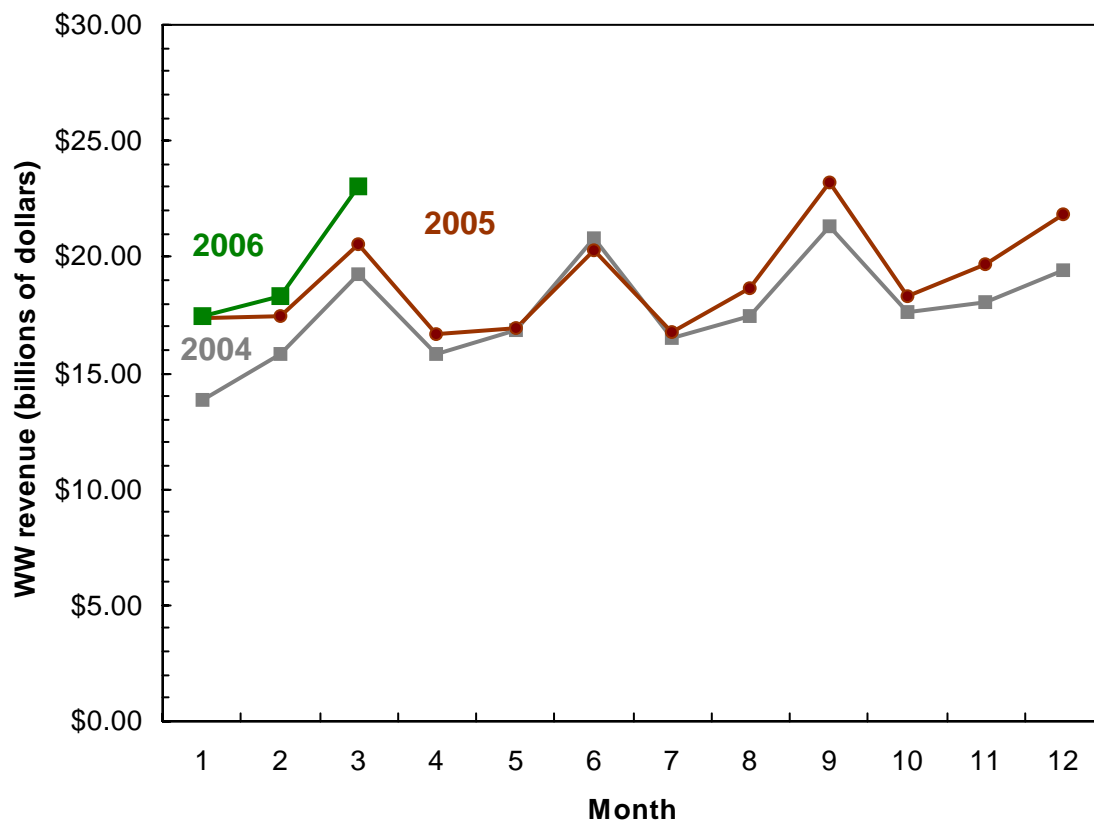


Figure 2.2. Monthly worldwide semiconductor revenue for 2004 - 2006 [1].

2.4. The semiconductor market relationship to electronic systems and GDP

The relative size and growth rates of worldwide GDP, electronic systems and semiconductors are illustrated in figure 2.3. At the top level is 2005 world-wide Gross Domestic Product (GDP) of \$57.3 trillion dollars, up from \$51.7 trillion dollars in 2004. For 2005 world-wide electronic systems reached \$1,076 billion dollars, up from \$1,000 billion dollars in 2004 [2]. At the bottom level there is \$227 billion dollars in 2005 world-wide semiconductor revenue, up from \$213 billion dollars in 2004 [1],[2].

From 1980 to 2000, the world-wide GDP, electronic systems and semiconductor outputs grew at 3.2%, 6.3% and 14.9% respectively, see figure 2.3. Prior to 1980, electronic systems were growing at a faster rate

but since 1980 the growth rate has been slower. From the difference in growth rates it can be seen that electronic systems have increased as a percent of GDP from approximately 0.8% to 1.6%, and semiconductors as a percentage of electronic systems from approximately 5.4% to 21.0%. As will be shown in the next section, the percentage of electronic systems that semiconductors represent has recently stopped growing, this comes at the same time that electronics systems revenue shrunk for two consecutive years in 2001 and 2002 before resuming growth in 2003 and 2004! The combination of saturation of semiconductors as a percentage of electronic systems and slower electronic systems growth suggests that semiconductor may be entering a period of slower long-term growth, perhaps as low as 6 - 7%. The forecast for the next five years from our strategic partner IC Insights are in-line with this prediction (hollow orange diamonds).!

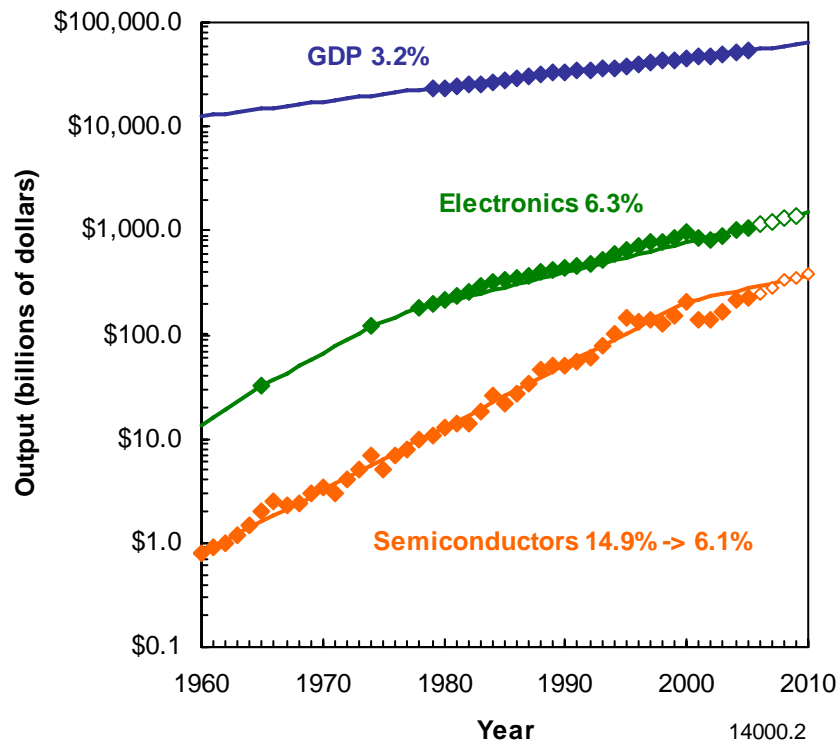


Figure 2.3. Worldwide market trends [1],[2],[3].

2.4.1. Semiconductor content in electronic systems

Figure 2.4 illustrates the semiconductor content of electronic systems on a relative revenue basis. As can be seen from the figure, semiconductors rapidly increased as a percentage of electronic systems until 1995 when the ratio hit 21.6% before dropping back. The 21.6% high mark was once again approached in 2000 when the ratio hit 21% before again falling back and in 2004 when the ratio hit 21.3% and 2005 when the ratio was 21.1%.

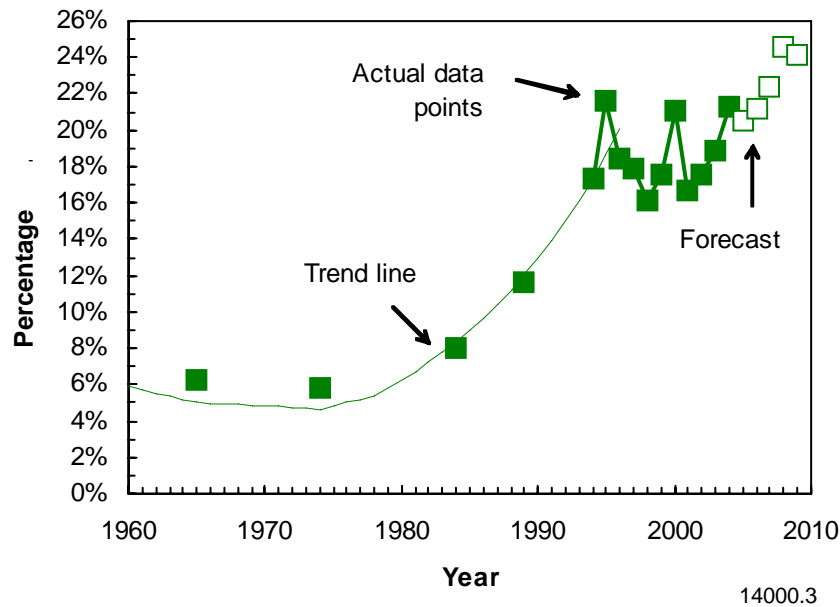


Figure 2.4. Semiconductors as a percentage of electronic systems.

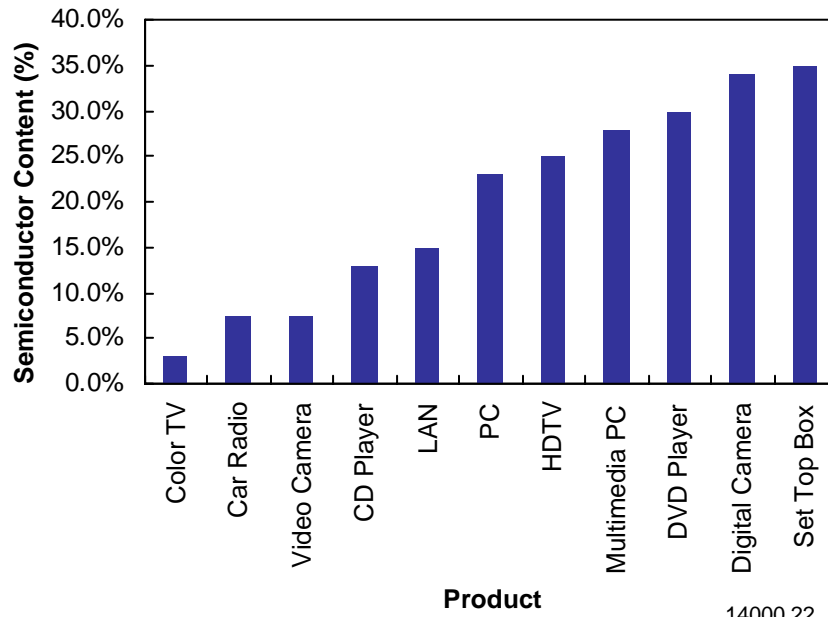
Many observers believe that 30% is an upper limit for semiconductor content in electronic systems. At IC Knowledge we believe that in the short term 30% is too aggressive. Although there are some newer electronic systems such as digital cameras, set top boxes, internet game consoles and internet access devices that have semiconductor content between 30% and 35%, the vast majority of systems fall in the 15% to 25% range, and some older electronic systems such as color televisions, car radios and video cameras have semiconductor content <10%, see figure 2.5. The higher semiconductor content products are certainly in the hot growth markets, but it will take time to bring the average up.

The hollow green squares in figure 2.4 represent the forecast semiconductor content in electronic systems based on IC Insights forecasts for semiconductors and electronic system through 2009 [2]. We have some concern that these predicted levels of 21.6%, 22.8%, 26.3%, 25.3% and 25.7% for 2006, 2007, 2008, 2009 and 2010 respectively may be too aggressive calling into question the likelihood of the forecasted semiconductor growth.

2.4.2. Semiconductor market growth rate

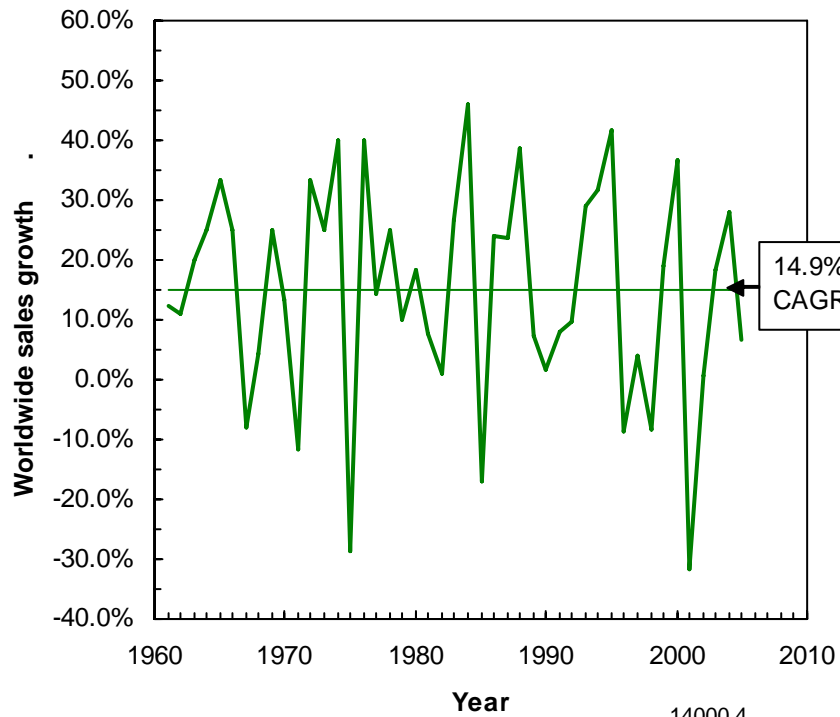
The semiconductor industry average growth rate is 14.8% from 1960 through 2003, however, the industry growth is very volatile and hasn't ever actually grown the average amount in any single year - see figure 2.6. The industry moves in cycles. Generally rising demand drives up utilization in existing facilities and therefore profits, construction of a large number of new facilities begins, the new facilities come on-line and prices drop rapidly as the market moves into over-supply and companies try to keep their new facilities full. This cycle is driven by the long time required to bring up a new facility and the highly fixed cost nature of the facilities.

Changes in the worldwide economy and over-inventory can also trigger downturns. In fact, during times of tight supply it is not unusual for companies to double order trying to get parts, artificially overstating demand.



14000.22

Figure 2.5. Semiconductor content in some common electronic systems [4].



14000.4

Figure 2.6. Worldwide semiconductor growth rate. Calculated from figure 2.1.

An analysis of triggers for previous downturns from IC Insights [2] is:

- 1974 - 1977 - economy and capacity
- 1981 - 1982 - economy and capacity
- 1985 - inventory
- 1989 - 1992 - economy and capacity
- 1996 - 1998 - economy and capacity
- 2001 - 2003 - economy, capacity and inventory.
- 2005 - 2006 capacity and inventory.

The downturn in 2001 has been the most severe in the history of the industry. Not only did all three contributing factors happen at once, but the electronic systems market had it's first downturn ever driven by the collapse of the telecommunications bubble.

2.5. Semiconductor revenue by region

The semiconductor industry was originally pioneered by United States based companies, and in the very early days of the industry the North American market share was nearly 100%. Initially the US based companies focused on driving technology but put little emphasis on yield and quality.

In the eighties the Japanese began to dominate commodity product areas like DRAM memory chips with a relentless focus on yield, quality and cost. The Japanese also continued to invest in new facilities during downturns capturing increased market share in each upturn.

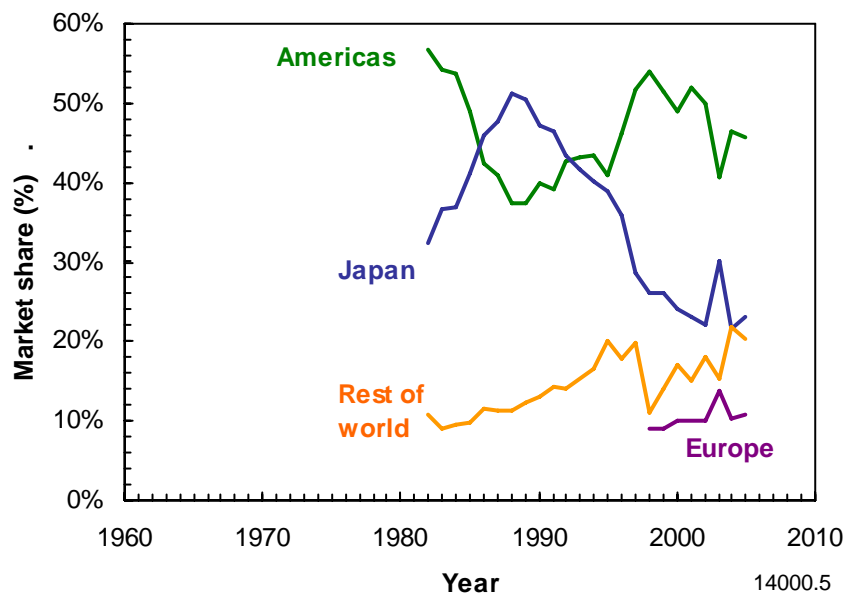


Figure 2.7. Semiconductor market share by country the company is headquartered in [1],[2].

In the late eighties and early nineties a number of factors combined to end the Japanese dominance of the semiconductor market. Led by the SEMATECH consortium of government and private companies, US based companies began to improve manufacturing capabilities. The Koreans and later the Taiwanese entered the DRAM market and began to make huge investments in new facilities. In 1995 the DRAM market peaked at nearly \$41 billion dollars, by 2001 the DRAM market had shrunk to just under \$11 billion dollars although it has now recovered to \$26.7 billion dollars and \$25.7 billion dollars in 2004 and 2005

respectively. The improvements in manufacturing capabilities at US companies and the market shift to products such as microprocessors, DSPs, and specialty memories such as SRAM and Flash where US design strengths are relatively more important, drove North America back to the top of the market share ranking. Figure 2.7 illustrates the worldwide market share held by each region. Please note that rest of world (ROW) included Europe until 1998 when Europe was broken out separately and that the values for 2003, 2004 and 2005 are estimated based on the top 25, 50 and 50 semiconductor companies respectively. 2004 represents a huge upturn for the rest of the world catching Japan for the first time although in 2005 Japan once again pulled slightly ahead.

2.6. Semiconductor revenue by end use

Figure 2.8 illustrates the 2004 semiconductor industry revenue by end-use. In 2004 Computers and office equipment maintained the number one market share at 33.4% with communications in second place at 24.6%.

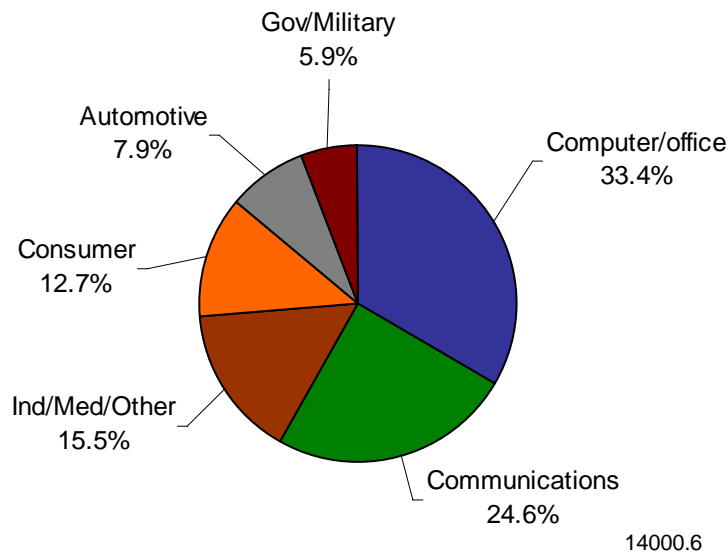


Figure 2.8. 2004 semiconductor revenue by end use [2].

2.7. Semiconductor revenue by product

In figure 2.9 the 2005 IC market is broken up by product type. A number of observations are immediately apparent:

- IC's dominate the semiconductor industry.
- MOS IC's dominate the IC industry.
- Digital IC's dominate the MOS market.
- Last year Micro was much larger than Logic or memory, this year both segments have grown faster than Micro and all three are now nearly equal.

Product definitions.

- Discrete - a single semiconductor device per piece of semiconductor material.
- Integrated Circuit - an electronic circuit where multiple elements of the circuit are integrated together on a single piece of semiconductor material.
- Compound - a semiconductor formed by combining multiple semiconducting elements together. Compound semiconductors generally have higher electron mobility, operate at higher temperatures and pro-

vide higher frequency performance than silicon. Compound semiconductor use has increased in recent years driven by cell phones but is still a small fraction of silicon's usage due to difficulties in fabrication.

- Bipolar - a semiconductor device that uses both holes and electrons for conduction simultaneously. In this case an integrated circuit made up of bipolar devices.
- MOS (Metal Oxide Semiconductor) - a type of semiconductor device fabricated with a conducting layer and a semiconductor layer separated by an insulating layer. MOS semiconductors are unipolar devices that use either holes or electrons for conduction, but not both at once, i.e. they are not bipolar devices. MOS IC's are IC's made up of MOS devices.
- Analog - a signal in an electrical circuit that can have a continuous range of values.
- Digital - a signal in an electrical circuit that is limited to certain discrete values.
- Logic - applications specific integrated circuits, programmable logic devices, standard cell and gate arrays.
- Micro - a category that includes, microprocessors, microcontrollers, microperipherals and digital signal processors.
- Memory - IC's that can store information for later retrieval.

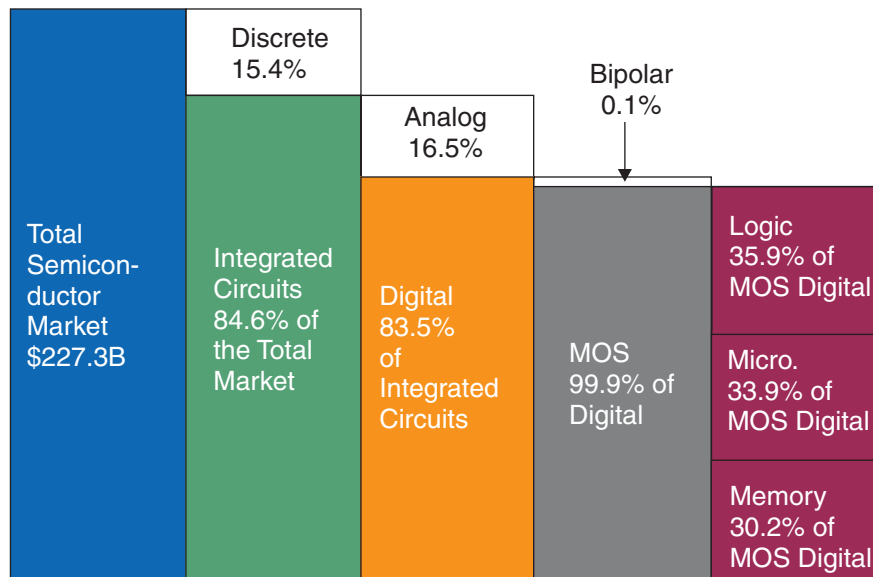


Figure 2.9. 2005 semiconductor revenue by product [2].

2.8. Top 10 semiconductor companies

For 2005 the big winners in the top ten were Sony with 19% growth and Intel with 15% growth helping Intel to comfortably maintain its position as the largest semiconductor company in the world over two times the size of number two Samsung and Sony to move from 12th place in 2004 to 9th place in 2005. The top three semiconductor companies, Intel, Samsung and Texas Instruments all maintained their relative position for 2005 over 2004, Toshiba moved up from 7th to 4th place with 11% growth, STMicroelectronics moved up from 6th to 5th place with 1% growth versus Infineon and Renesas that both moved down two places with -8% growth. TSMC held 8th place and Philips held steady in 10th place.

Table 2.2. Worldwide top 10 semiconductor companies [2].

Rank		Company	Country	Revenue (\$M)		% Change
2005	2004			2005	2004	
1	1	Intel	U.S.	\$35,475	\$30,900	15%
2	2	Samsung Semiconductor	South Korea	\$17,830	\$15,830	13%
3	3	Texas Instruments	U.S.	\$11,330	\$10,700	6%
4	7	Toshiba	Japan	\$9,500	\$8,531	11%
5	6	STMicroelectronics	France	\$8,870	\$8,756	1%
6	4	Infineon	Germany	\$8,400	\$9,180	-8%
7	5	Renesas	Japan	\$8,310	\$9,000	-8%
8	8	TSMC	Taiwan	\$8,217	\$7,648	7%
9	12	Sony	Japan	\$6,025	\$5,070	19%
10	10	Philips	Netherlands	\$5,925	\$5,692	4%

The top 10 semiconductor companies sales for 2005 represent 52.7% of the overall semiconductor market versus 53.5%, 56.0% and 54.5% for 2004, 2003 and 2002 respectively.

2.9. Further reading

This chapter is only intended to provide a brief overview of market trends, market research is not the focus of this book. For a more in depth treatment of the semiconductor market we recommend the IC Insights publication “The McClean Report” available from IC Insights at www.icinsights.com.

2.10. References

- [1] “World Semiconductor Trade Statistics” SIA, http://www.semichips.org/pre_statistics.cfm.
- [2] “The McClean Report 2006 Edition: An In-Depth Analysis and Forecast of the Integrated Circuit Industry,” IC Insights (2006).
- [3] International Monetary Fund.
- [4] Dataquest.