Presented in the ECWC 10 Conference at IPC Printed
Circuits Expo®, SMEMA Council APEX® and
Designers Summit 05

Business Cycles in the Electronic Equipment Food Chain - Growth Comparisons and Forecasts for Process Consumables & Equipment, Passive Components, Semiconductors and Electronic Equipment

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Abstract

Fluctuating demand for electronic equipment has led to repetitive "boom and bust" business cycles throughout the electronics "food chain." Double ordering, inventory building and component outages in expansionary times are followed by recessionary periods where demand shrinks, excess inventory must be consumed and severe downward pricing and margin pressures are the norm. Raw material and process equipment suppliers see amplified demand in growth periods and severe draughts during recessions because of inventory building and reductions at each level of the supply chain.

This paper compares the relative growth (and time shifts) at each level of the supply chain at various periods in the business cycle. Items studied include:

- Economic indicators
- Electronic equipment orders, shipments and inventories by end market
- Semiconductors
- Connectors
- Printed circuit boards
- EMS demand
- Process consumables and equipment used to manufacture and test "members" of the electronics food chain.

Global and N. American data sources are identified and utilized including process consumables from the IPC statistical surveys.

These data sources can be used to understand and predict the timing and magnitude of forthcoming downturns and recoveries in the electronic industry business cycle. The methodology discussed applies to the entire "food chain" – electronic equipment manufacturers, EMS companies, PCB and other component manufacturers and suppliers of materials and equipment to these companies.

Introduction

Business cycles are a "way of life" in the global electronics industry. They are disruptive and associated in the upturns with periods of significant "double ordering", inventory building, excessive capacity expansions and employment growth followed by broad reductions in the downturn. Erratic pricing decisions are common especially in the downside of the cycle.

In the period 2000-2004 Figure 1 electronic equipment shipments peaked globally in CY2000, largely driven by the telecom and datacom (Dot.com) bubble. When the "2000 bubble burst" in early 2001 electronic equipment demand dropped, declining 14% from the 2000 peak to the 2002 trough. However, depending upon regional differences (N. America & Europe were more dependent on datacom/telecom) some countries were "hurt" more than others. SE Asia with more dependence on consumer electronics and personal computers remained stable, while N. America plunged.

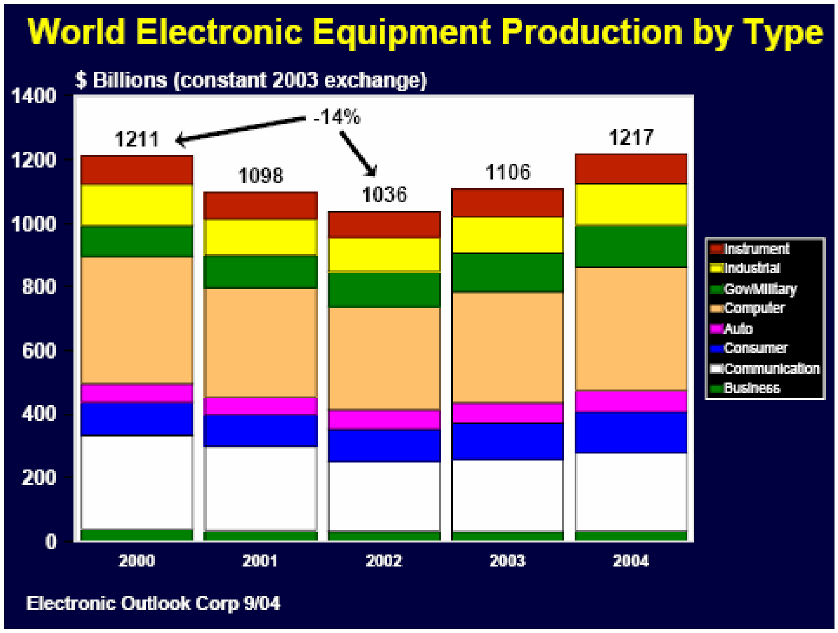

Figure 1 – World Electronic Equipment Production by Type

Component and raw material suppliers to electronic equipment manufacturers were hurt even more – as large inventory overhangs had to be used (or written off) before reordering would begin. Suppliers of PCB related process and test equipment saw orders evaporate as excess capacity was rampant.

With lower demand and significant cost pressures OEM and EMS companies used the post-2000 downturn as an opportunity to shift production to "low cost of manufacturing areas" such as China – further exacerbating the N. American downturn and severely impacting its local component, materials and process equipment suppliers. In Europe large local OEM mobile phone manufacturing operations were transferred to SE Asian EMS and ODM companies.

Business Cycle Examples

Figure 2 shows a hypothetical business cycle. Component and material suppliers "grow more" in expansion times due to inventory building at each level of the supply chain. The reverse occurs in recessions. Later in this paper actual examples will be provided. Figure 3 quantifies the global impact of the 2001 downturn, showing that despite a 1% increase in the global GDP, each level of the electronics "food chain" declined more than its own customer base.

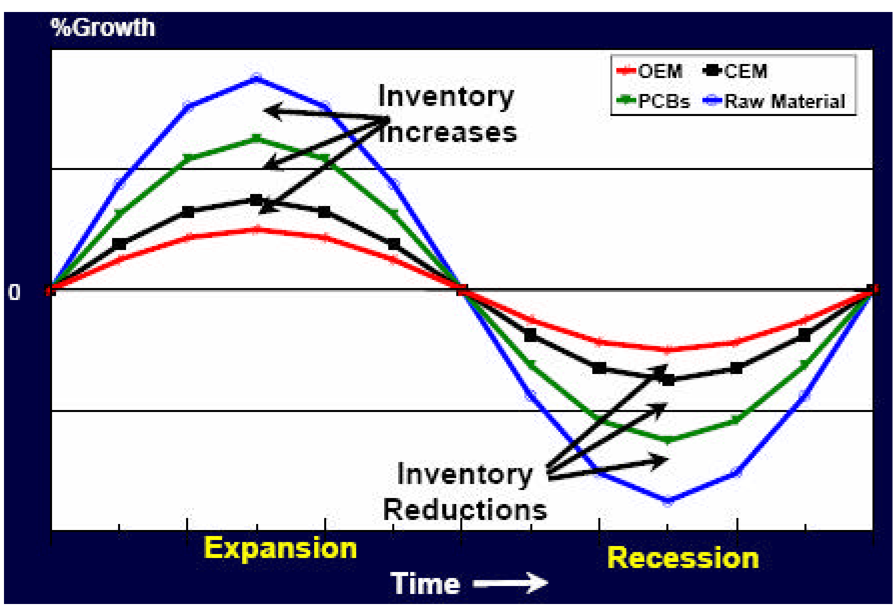

Figure 2 – Business Cycle – Supply Chain Effect

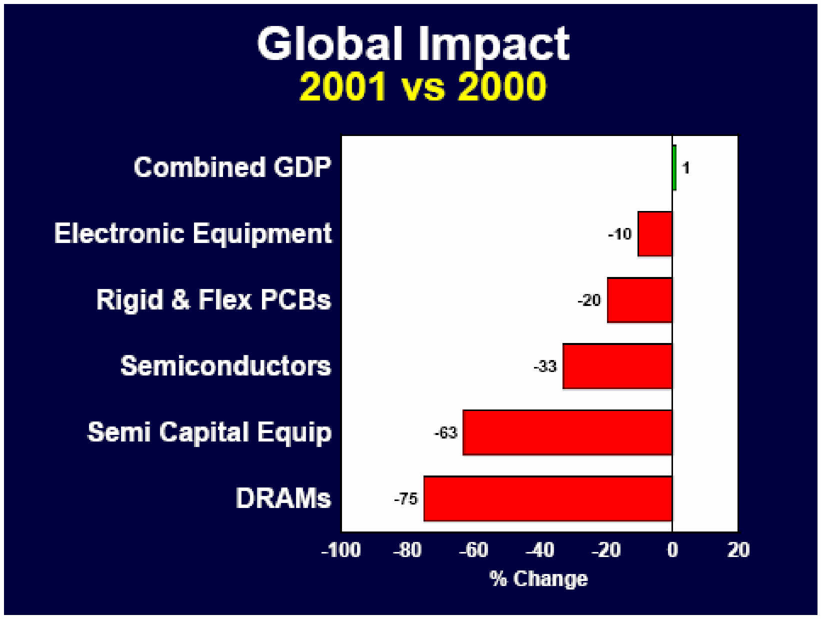

Figure 3 – Global Impact 2001 vs. 2000

In 2004, Figure 4, the industry staged a broad recovery. A 4% increase in the GDP was accompanied by 11% electronic equipment growth, a 13% PCB expansion (with disproportionate growth in China), 28% growth in semiconductors and a 52% jump in semiconductor fab, assembly, test & measurement orders. Much of this growth was in early 2004 as another industry downturn had begun by mid-2004.

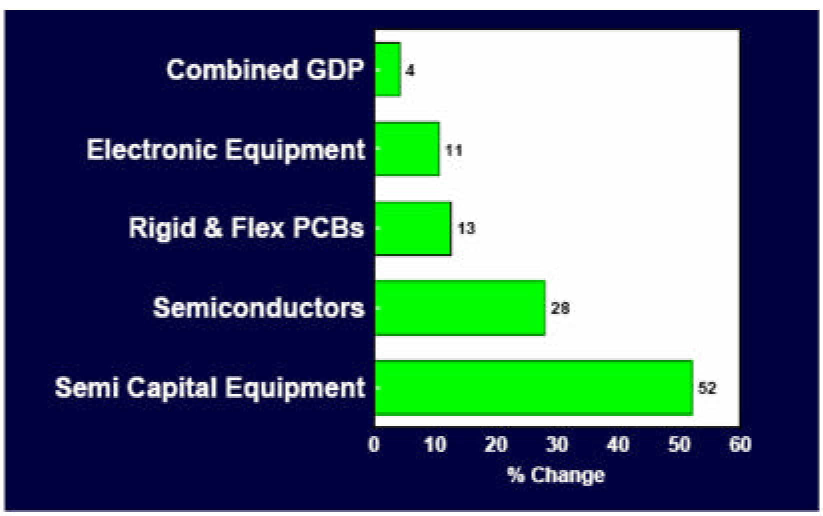

Figure 4 – Global "Electronic Food Chain" Outlook 2004 vs. 2003

Figure 5 shows the magnitude and timing of the last ten business PCB business cycles experienced in the N. American market from 1978 to the present. Notice that in each cycle PCBs grew more than U.S. industrial production which in turn grew more than the GDP.

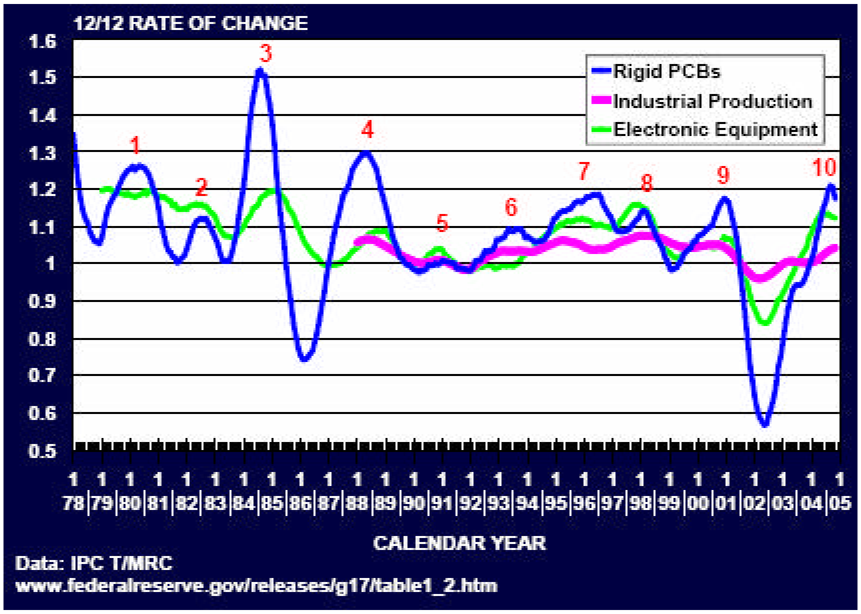

Figure 5 – North American PCB vs. US Electronic Equipment Shipments and Industrial Production

Because of inventory buildups and reductions, periods of strong growth are inevitably followed by downturns with the magnitude of the declines related to the size of the excess inventory and unneeded orders accumulated in the upturn. The post-2001 N. American PCB downturn was exacerbated by the aggressive shift in electronics manufacturing to SE Asia.

Global semiconductor shipments, Figure 6, have also exhibited strong business cycles – with 3-month (3/12 rate of change) growth exceeding 50% in 1984 and 2000. The 2000 bubble was followed by over a 40% chip shipment decline in 2001/2002.

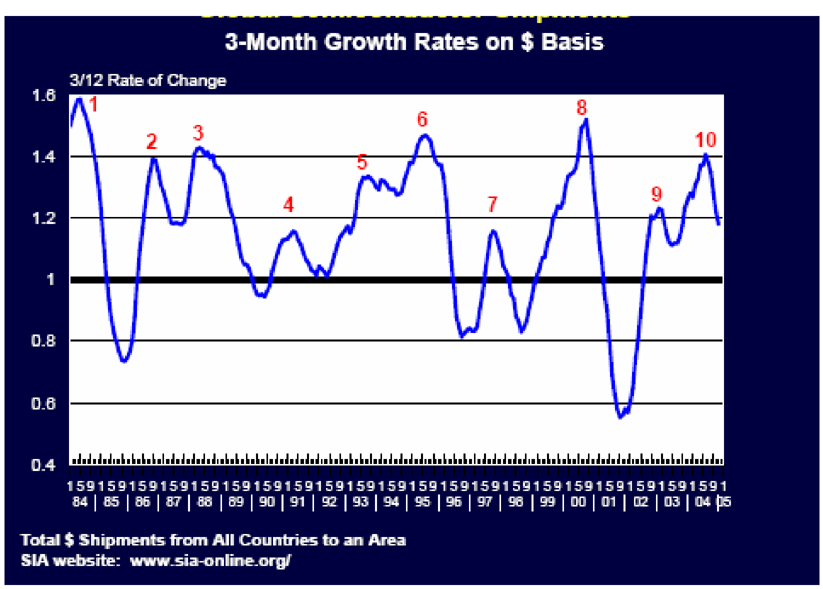

Figure 6 – Global Semiconductor Shipments

Data Analysis Challenges and Techniques

To support global business cycle studies, a wide range of data is required: It should be:

- global in scope
- monthly with timely availability - to allow rapid identification of trend changes
- spanning the entire "food chain"
- consistent in format and definition
- publicly available

Unfortunately not every country in the world collects and makes available electronic equipment orders, sales and inventories by category as published by the U.S. Department of Commerce (DOC). Similarly the IPC trade organization has a most comprehensive statistical program for printed circuits. Other major countries – China, S. Korea, Taiwan, Singapore and even most of Europe are much more silent. Collecting needed data for a paper on the dynamics of the world electronic equipment "food chain" requires foraging, trading and estimating in addition to accessing public data sources.

Once obtained, the information often arrives in multiple formats:

- seasonally vs. non seasonally adjusted
- indexed vs. actual
- growth rates vs. raw data
- monthly vs. 3-month average
- monthly vs. quarterly or annual

Figure 7 shows an example of data with an inherent seasonality due to consumer buying trends. More computers are sold during the fall "back to school" period and the Christmas holidays. No correction is needed for most analyses but these repetitive, seasonal surges create component shortages and supply concerns in the autumn "busy season" and unused capacity and price cutting from January through late spring

Figure 8 shows seasonally vs. non-seasonally adjusted electronic equipment orders from the DOC. The main cause of these "unadjusted" fluctuations is the 4/4/5 week accounting cycle that many companies use. The last month of each quarter has 5 weeks. Correcting for this and other seasonal effects smoothes the data. Seasonality corrections should have a net effect of zero for a full year as the upward and downward corrections "cancel out."

Figure 9 illustrates growth rate analyses – using both annual (12/12 rate of change) and 3-month (3/12 rate of change). 12/12 compares the sum of the present 12 months to the same months a year earlier. 3/12 compares the sum of the present 3 months to those same 3 months a year earlier.

Rate of change analysis has key advantages:

- Allows comparison of separate time series – monthly PCB $ orders to monthly industrial production to monthly interest rates to monthly process equipment sales for example.
- Clearly identifies peaks and troughs in business cycle
- Automatically corrects for seasonality as it compares data for current period to same period a year earlier

Typically the 3/12 rate of change is "noisier" but more responsive than the 12/12. It is preferred for identifying short term changes. The 12/12 is useful because it is smoothed and also represents the annualized growth rate at any period of time.

Figure 10 shows unadjusted monthly semiconductor shipment data. Fluctuations in monthly data are smoothed out by reporting a 3-month rolling average.

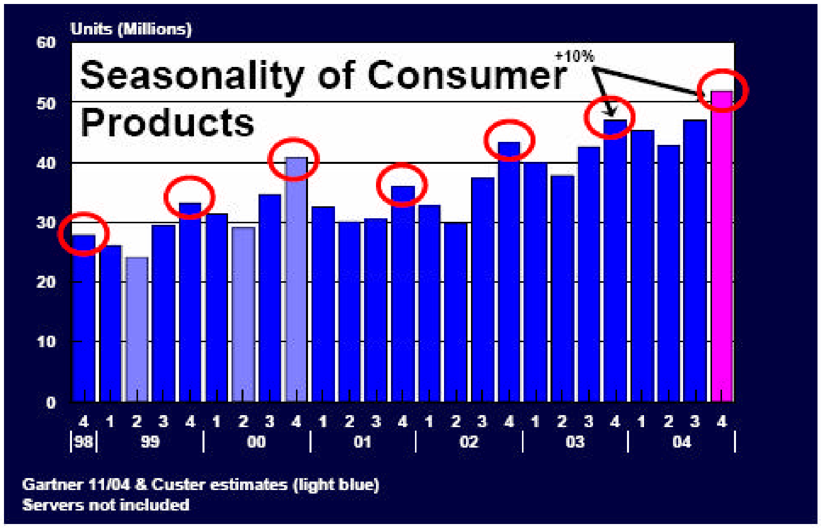

Figure 7 – Personal Computer Unit Shipments

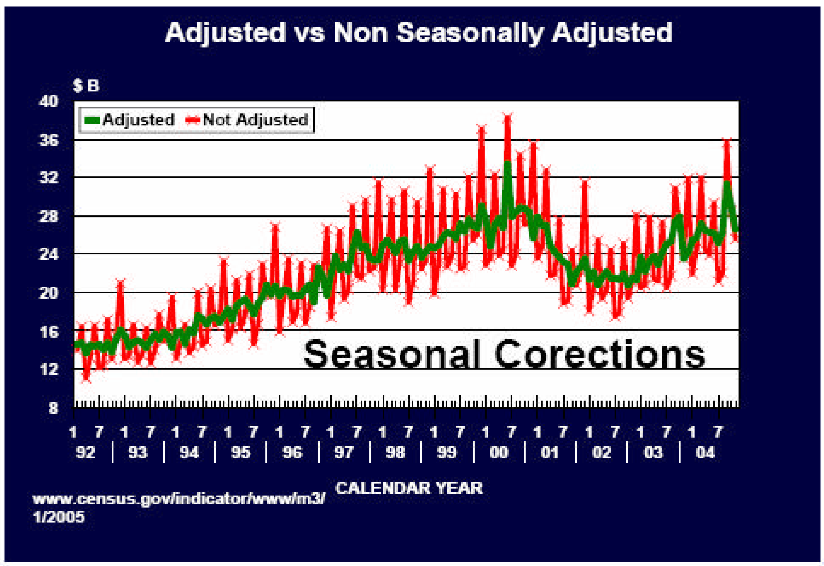

Figure 8 – US Electronic Equipment Orders

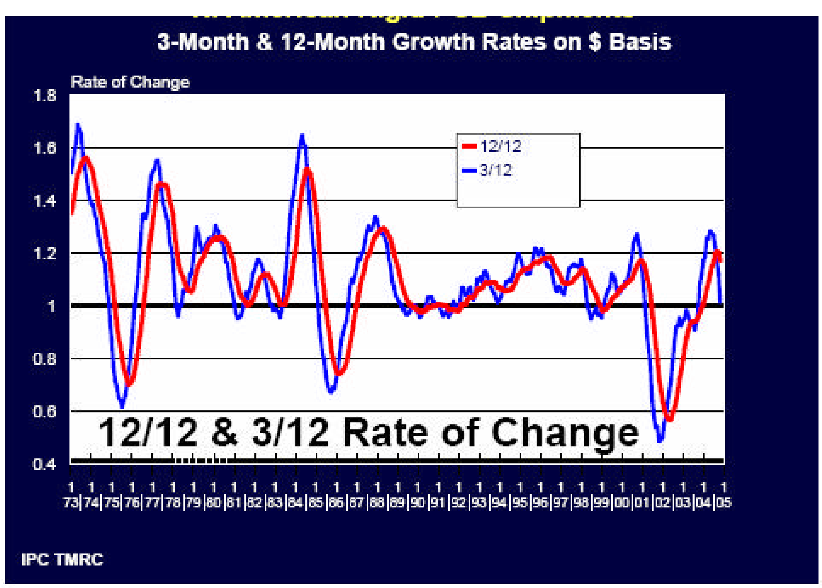

Figure 9 – North American Rigid PCB Shipments

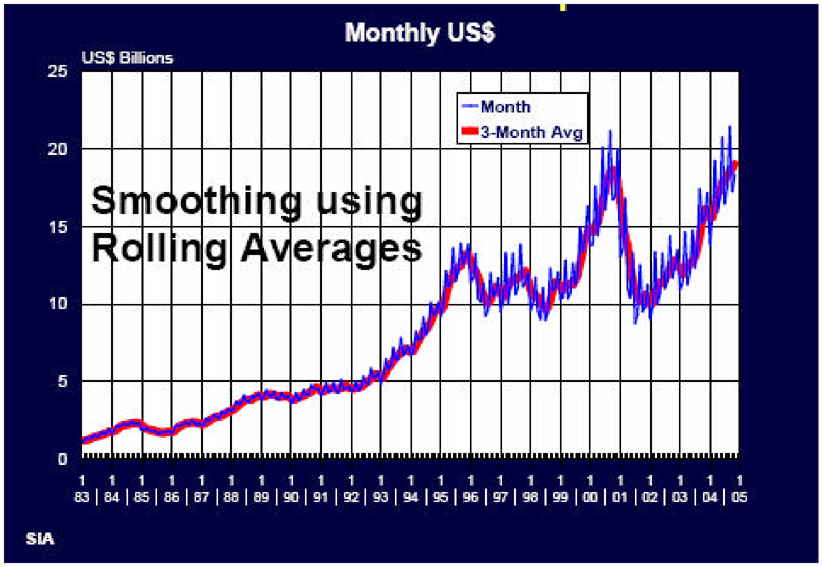

Figure 10 – World Semiconductor Shipments

Semiconductors & Semiconductor Capital Equipment

The SIA collects regional data regarding semiconductor $ shipments to an area. This is not regional production data but instead effectively consumption data and a good measure of regional electronic assembly activity. The SIA provides shipments but no orders or book/bill info.

Figure 11 shows a 3/12 rate of change for monthly global semiconductor shipments. Notice the 10 business cycles from 1984 to present and the "slowing of growth beginning in mid-2004. Since the 3/12 is greater than 1.0 chip, shipments are still growing but at a slower pace than in mid-2004.

Figure 12 provides SIA's actual $ chip shipment data for the four regions. Asia/Pacific is expanding rapidly while Japan, N. America and Europe are down significantly from their CY2000 peaks. N. America has dropped the most due to the implosion of its key end market (telecom) and aggressive outsourcing of electronic assembly to China.

Figure 13 depicts monthly shipment information for sellers of semiconductor fab, assembly, test & measurement equipment. Following the CY2000 "bubble" SEMI equipment orders plunged 81%, excess capacity was the norm and CAPEX budgets were slashed.

Figure 14 compares the 3/12 growth of SIA global semiconductor shipments to SEMI equipment. Although the SEMI data (we have) only extends back to 1999 (and hence the 3/12 data begins in mid-2000), it is clear that SEMI equipment shipment growth far exceeds chip shipments in good times and plunges deeper in recessions. The "boom or bust" nature of SEMI equipment sales clearly illustrates the hypothetical supply chain effects in Chart 4's business cycle.

Figure 15 provides composite quarterly revenues of 14 "public" SEMI related companies. SIA global semiconductor shipments are plotted on the Y2 axis.

Figure 16 depicts quarterly global wafer fab utilization rates. At the peak of the 2000 bubble the world's wafer fabs were operating at 96.4% of capacity. Values above about 90% normally signify "capacity constraints." By 3Q'01 utilization had plunged to 64.2%. It then peaked again at 95.4% at the height of the 2004 "recovery" and is now again declining.

Figure 17 compares wafer fab capacity to SEMI equipment revenues on a quarterly basis. The correlation is very obvious.

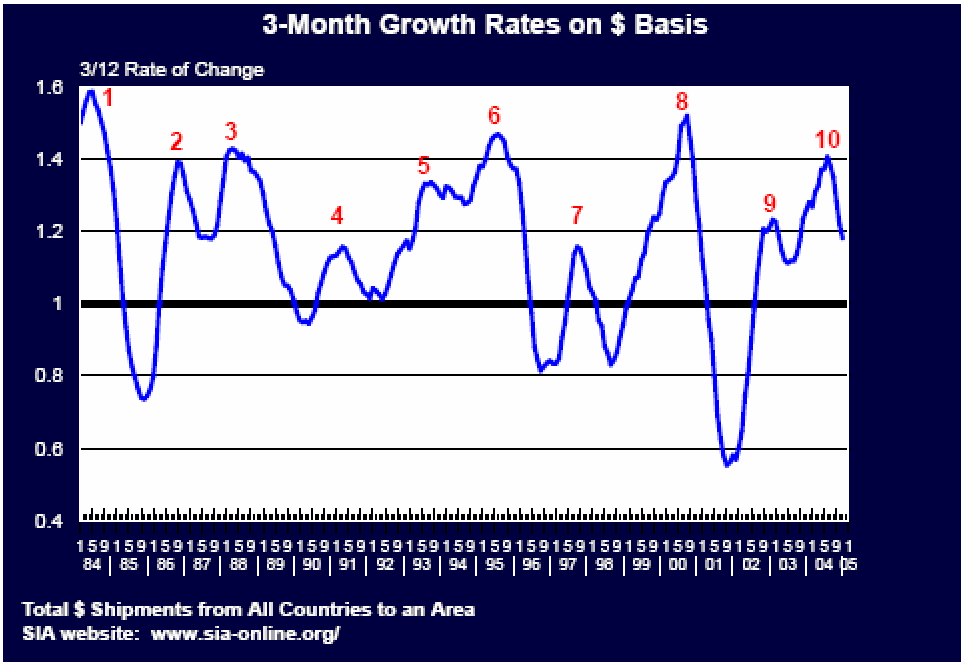

Figure 11 – Global Semiconductor Shipments

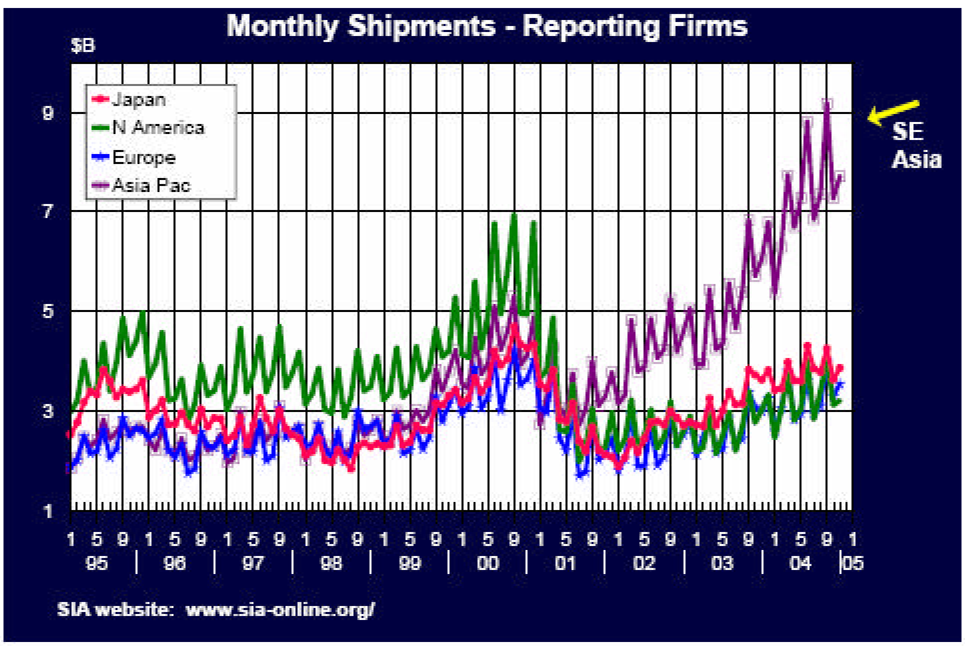

Figure 12 – Total Semiconductor $ Shipments to Area

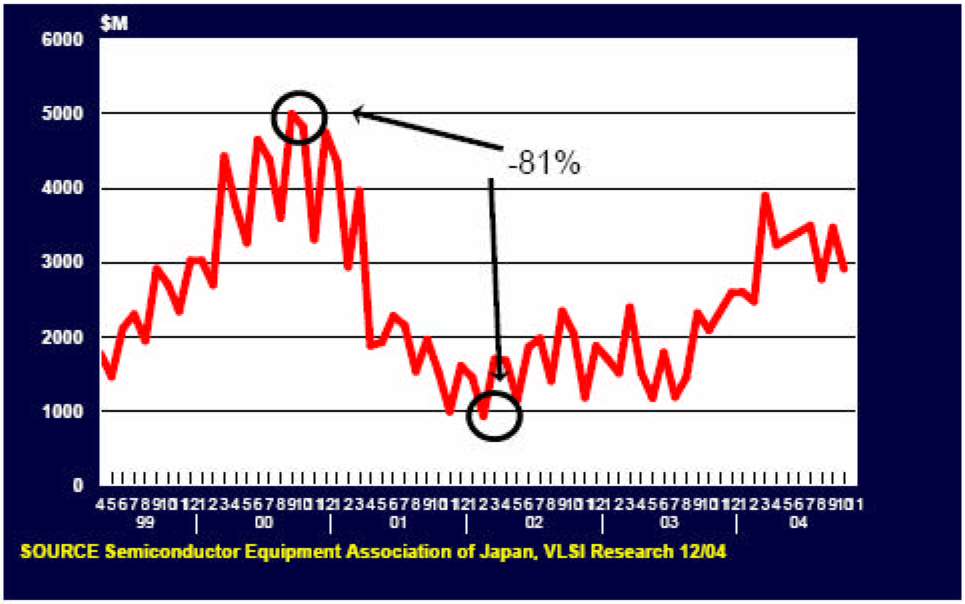

Figure 13 – World Semiconductor Equipment Industry Shipments

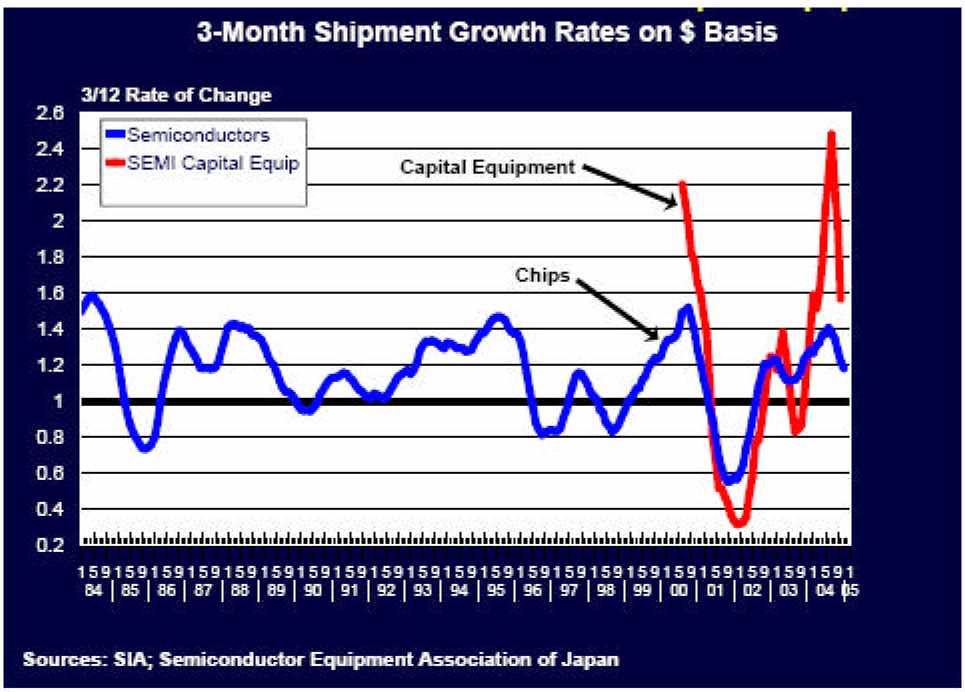

Figure 14 – Global Semiconductor and Semiconductor Capital Equipment

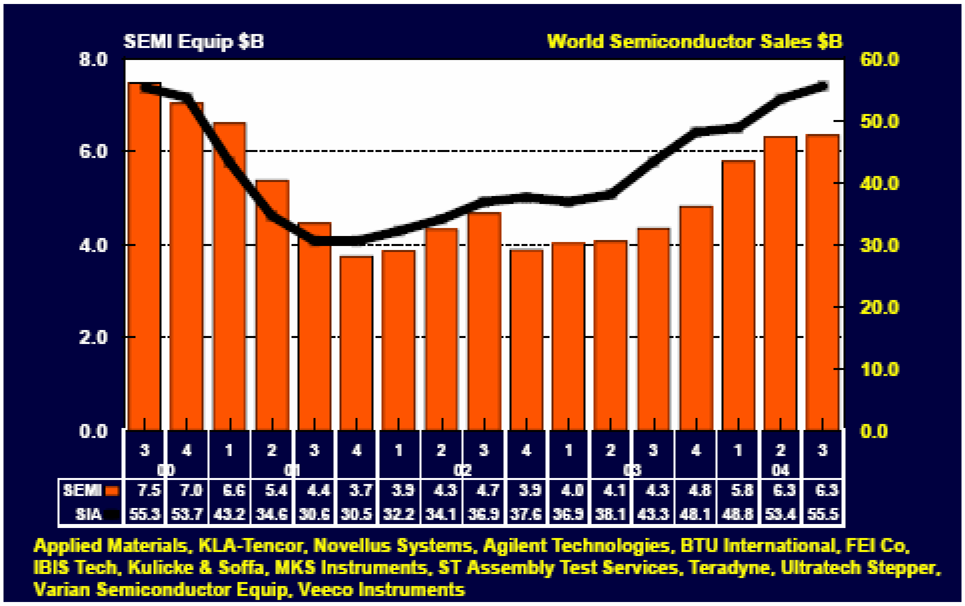

Figure 15 – Semiconductor Fab, Test and Measurement vs. Global Semiconductor Shipments

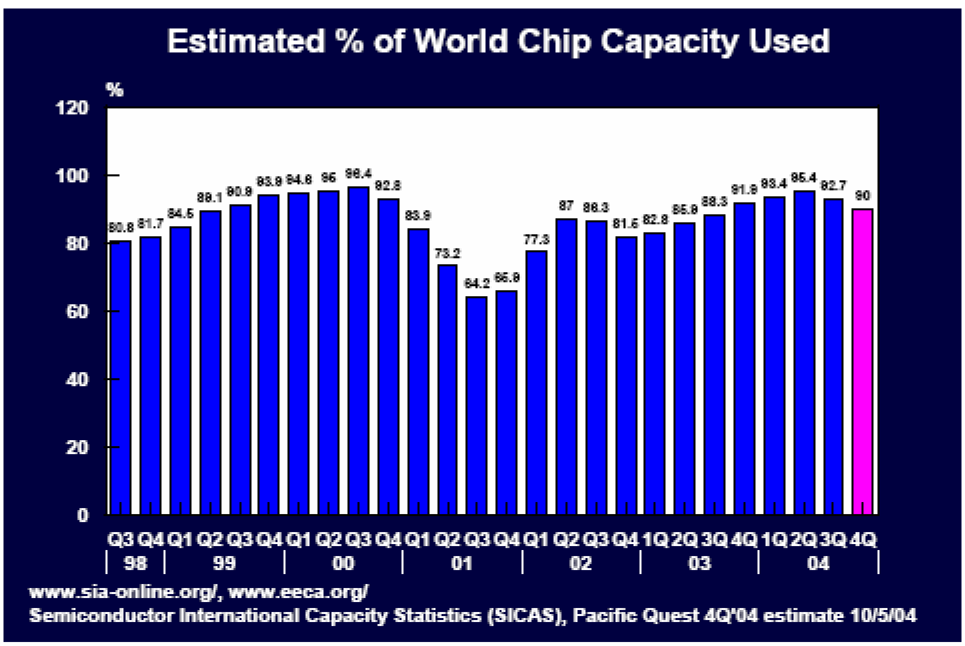

Figure 16 – Wafer Fab Utilization Rates

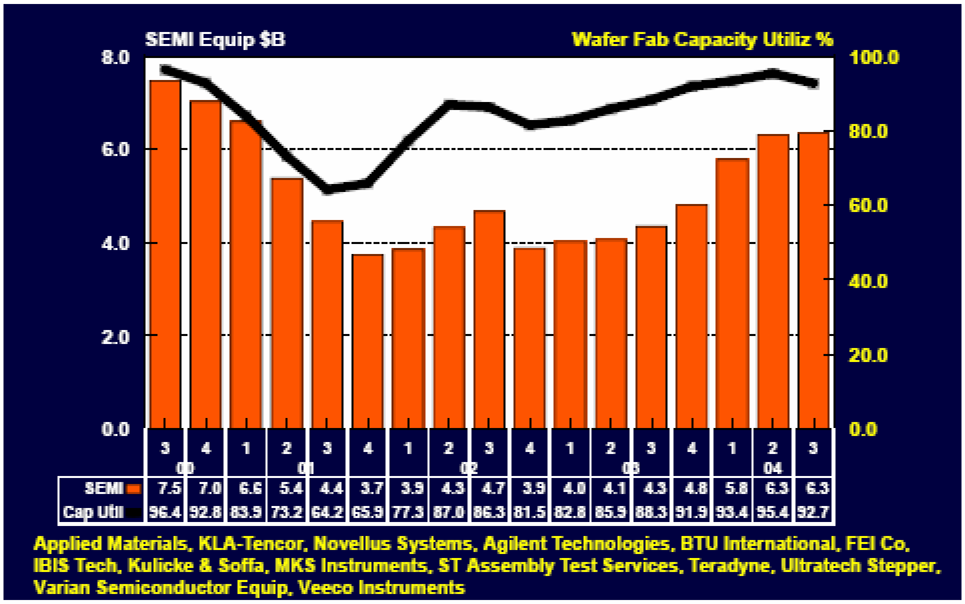

Figure 17 – Semiconductor Fab, Test and Measurement vs. Global Chip Capacity Utilization

Passive Devices & Connectors
Passive components revenues, Figure 18, dropped 51% from 3Q'00 to 3Q'01 for a composite of 5 manufacturers – due to both lower unit demand and plunging prices. Tantalum capacitor availability and pricing were especially volatile.

The global connector market saw record growth of 18.1% in 2000 followed by a record drop of 19.1% in 200,1Figure 19. Bishop & Associates produces annual connector growth charts for each area of the world as well as other detailed connector market information.

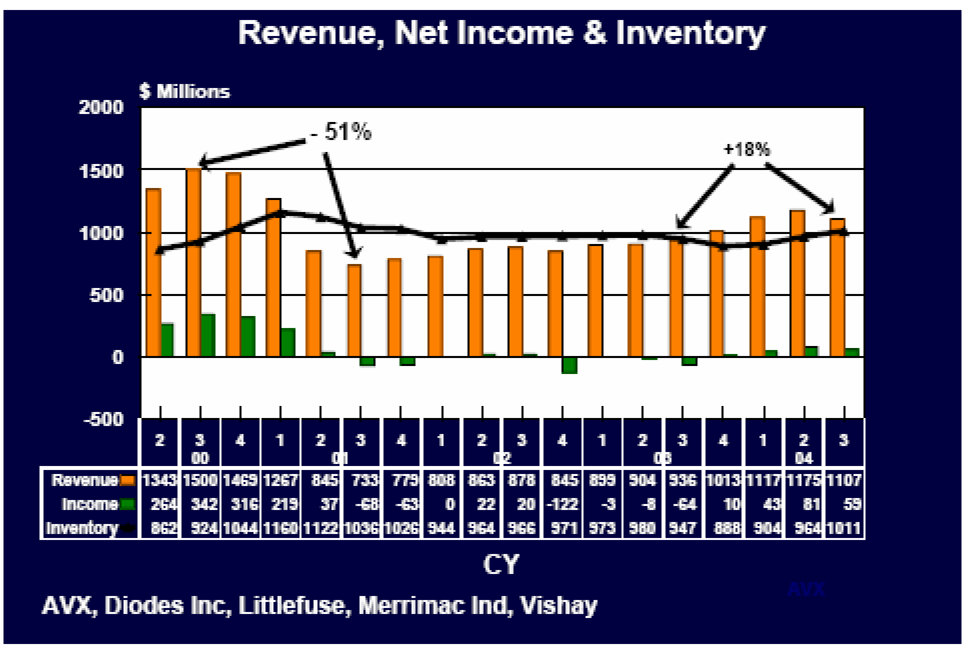

Figure 18 – Passive Devices – Composite of 5 Manufacturers

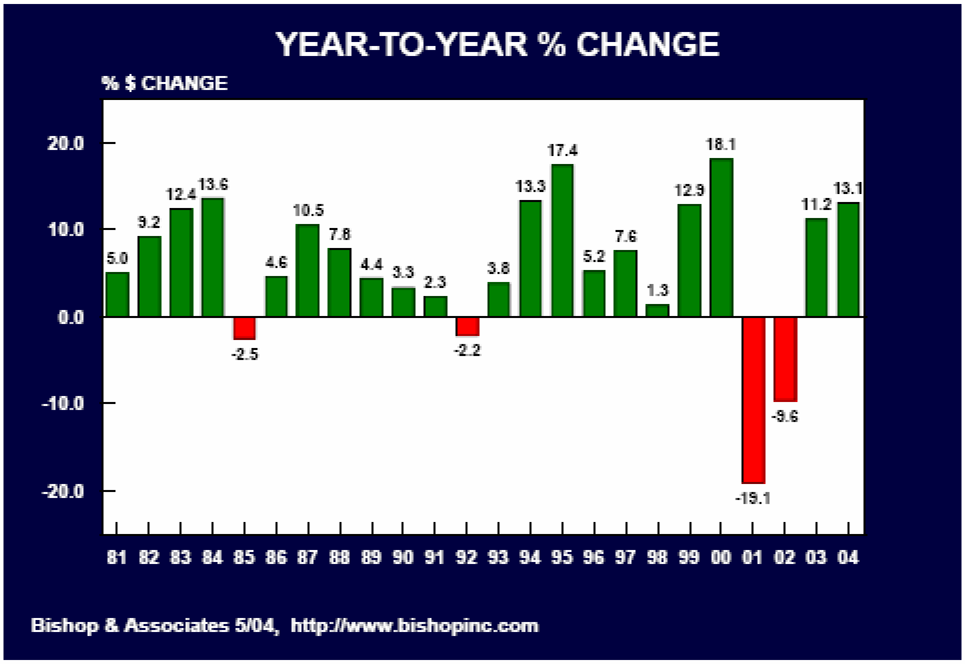

Figure 19 – World Connector Market

Electronic Equipment

Japan and the USA collect and publish monthly electronic equipment data by type. Figure 20 depicts Japan's equipment information in a "stacked bar" format. Notice the strong seasonality within the year and also the general annual decline since 2000. Japan has outsourced production of much of its "lower tech" equipment to SE Asia to reduce costs.

While the Taiwan government does not collect and publish monthly equipment data, all publicly traded Taiwanese companies must report complete financial information on a monthly basis. Figure 21 gives composite monthly revenues of 7 large Taiwan OEM/ODM companies. Notice the strong pre-Christmas peaks - related to consumer related products including computers and mobile phones.

Figure 22 contains U.S electronic equipment orders and shipments on a monthly basis. Orders are clearly much more volatile. They seem to drive domestic PCB orders. U.S. electronic equipment shipments have been growing since the mid-2002 trough (unlike Japan's ongoing post 2000 decline). The large order "spike" in September and October was due to huge, non-recurring defense communications orders.

Figure 23 shows inventories by stage of production for U.S. electronic equipment producers. Notice that post-2000 raw material inventories were extremely large but that they have now finally been reduced to pre-2000 levels. It is no wonder that component suppliers' sales plunged post-2000 – considering their customers' hefty inventory levels!

Figure 24 provides composite revenues, net income and inventories for 6 large global telecom/datacom companies. Growth finally resumed in mid-2003 in the hard-hit communications sector.

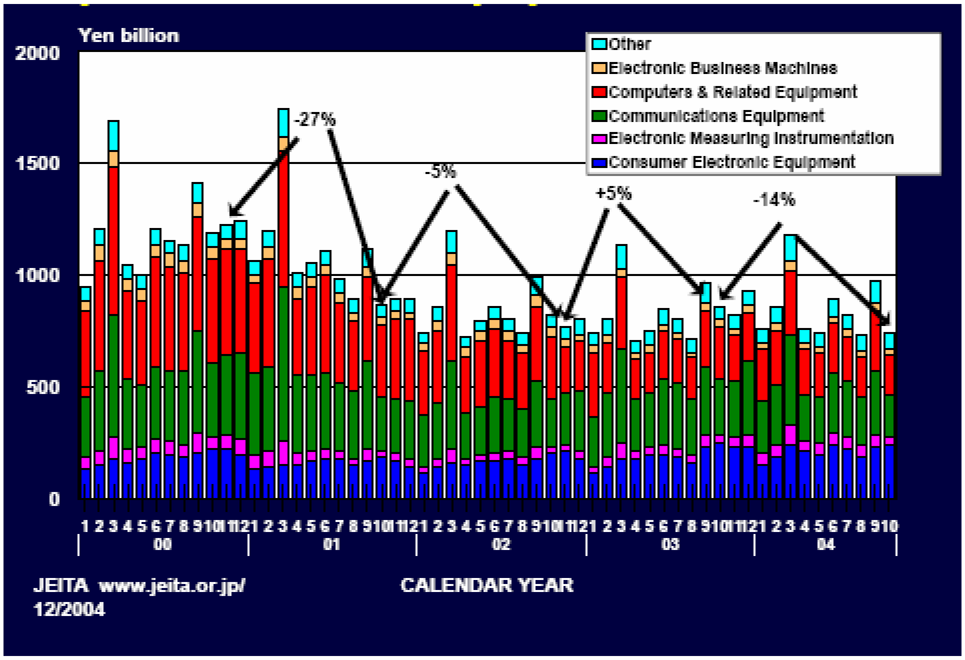

Figure 20 – Japan Electronic Equipment Production

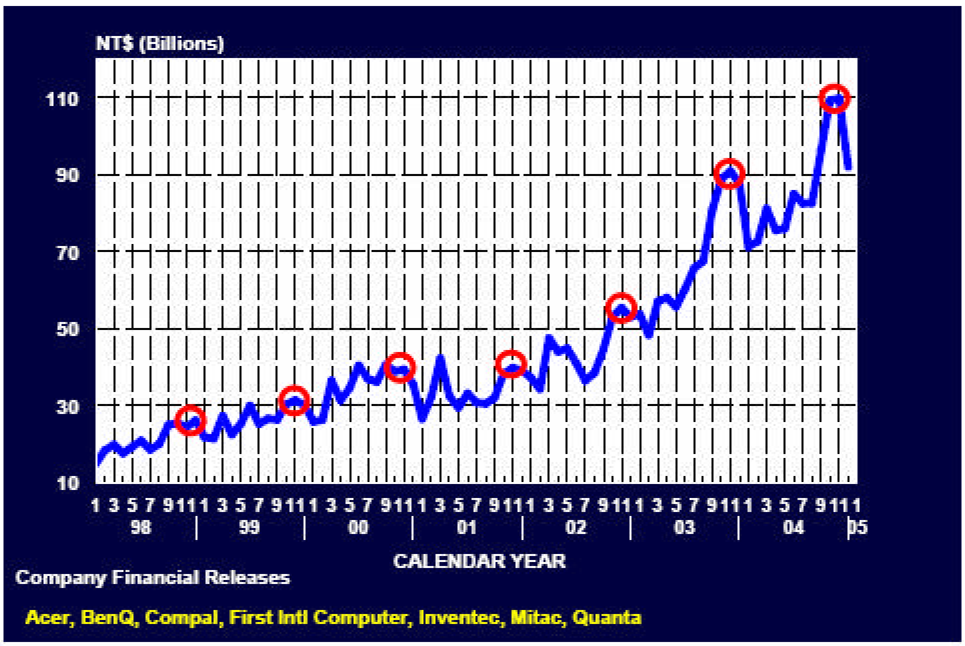

Figure 21 – Taiwan Electronic Equipment/ODM Manufacturers Sales Composite of 7 Large Manufacturers

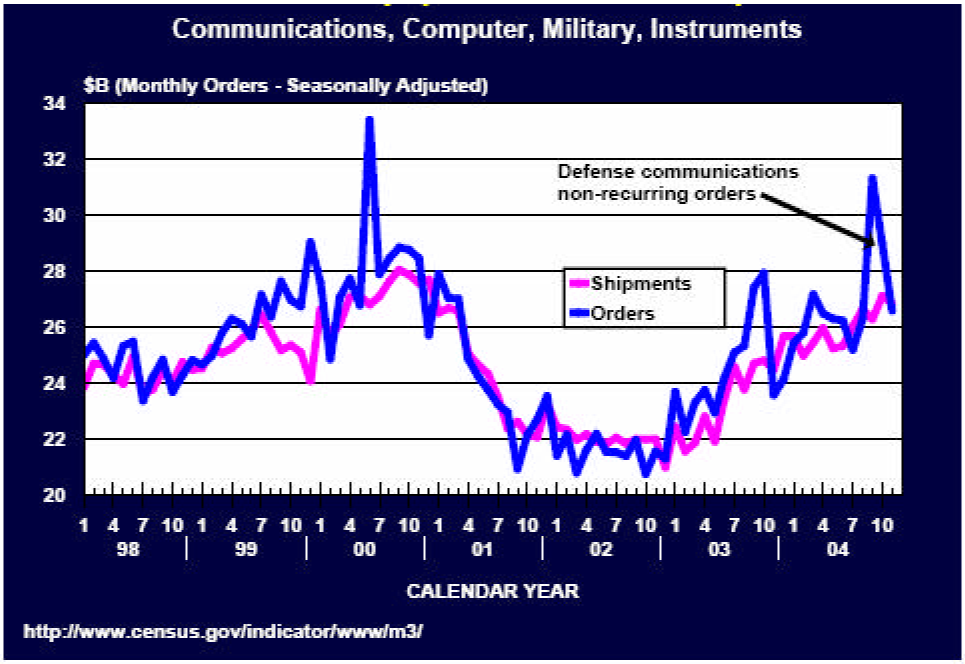

Figure 22 – US Electronic Equipment Orders and Shipments

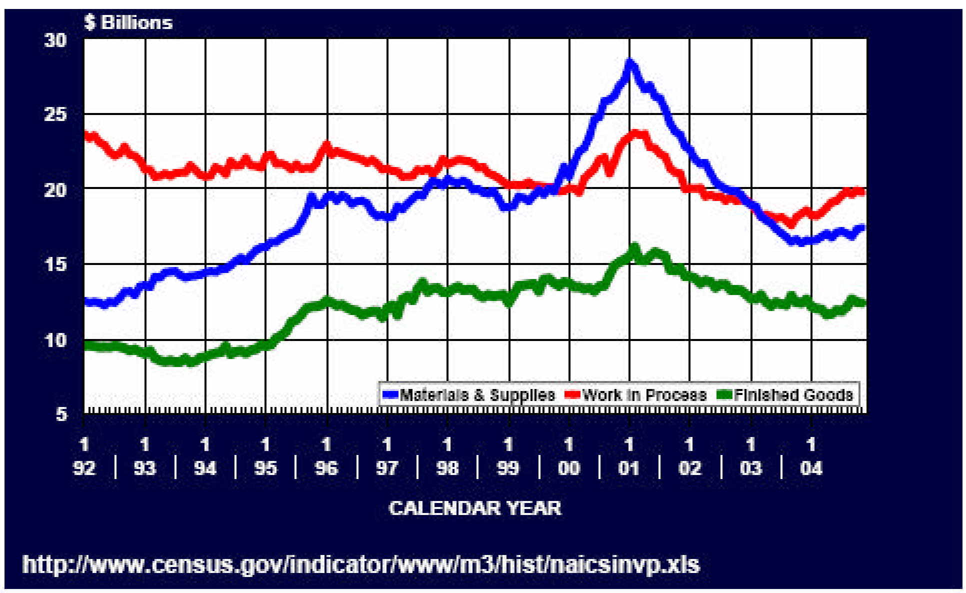

Figure 23 – Value of US "computers and Electronic Products" Inventories by Stage of Fabrication

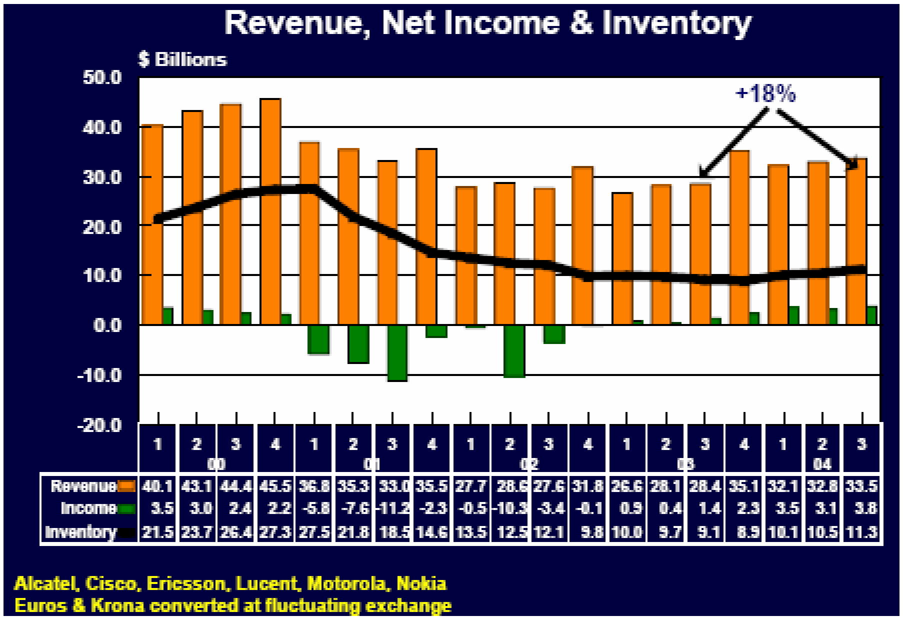

Figure 24 – Large "Communications" Equipment Suppliers Composite of 6 Public Companies

EMS & ODM Companies

Figure 25 is a composite of 12 large global EMS companies. Financial information is reported at fluctuating exchange rates. The strong euro vs. the US $ helped to amplify the +18% dollar-denominated revenue growth in 3Q'04 vs. 3Q'03.

Taiwan-based companies dominate almost 90% of the world's personal computer motherboard supply. Although the companies contributing to Figure 26 are Taiwan based, much of their production is in Mainland China. Notice the recurring, annual pre-holiday sales peaks. After the Christmas season motherboard plant utilization drops and these companies focus on winning new orders to fill their factories – often using "price" as an incentive. Seasonal fluctuations in bare motherboard demand play havoc with PCB materials demand.

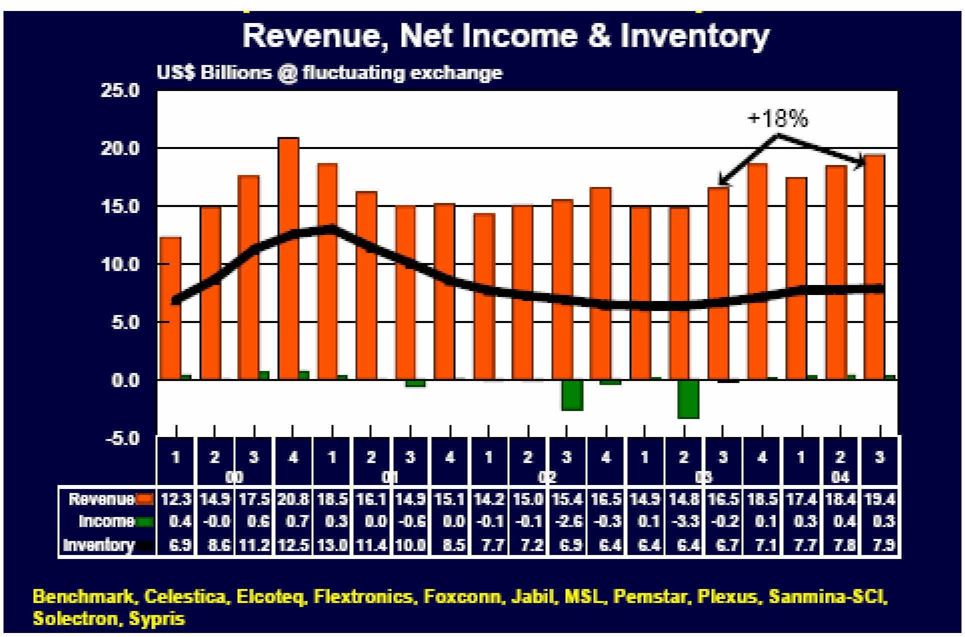

Figure 25 – Large EMS Providers Composite of 12 Public Companies

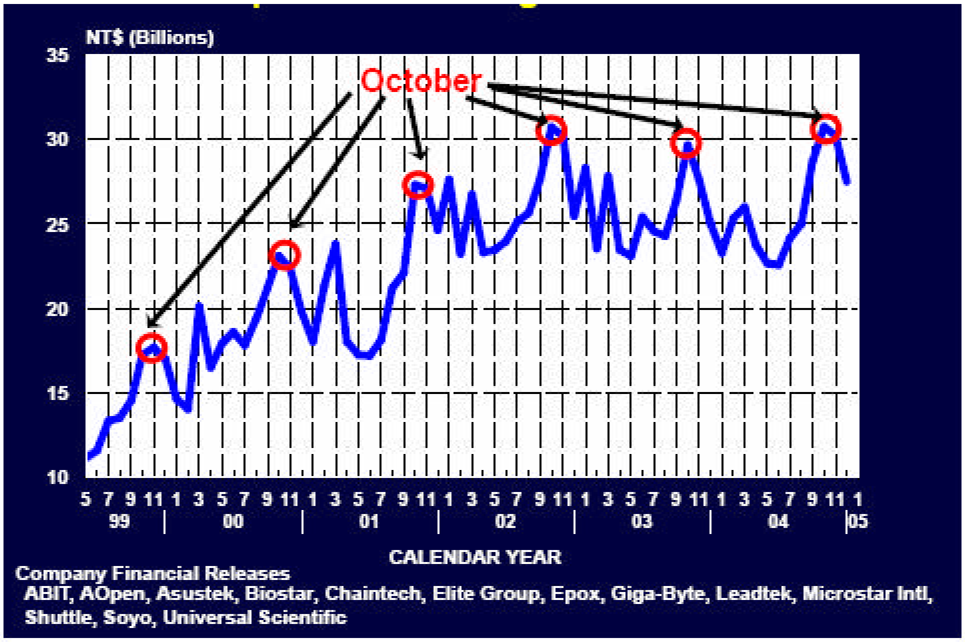

Figure 26 – Taiwan Motherboard Vendor Sales Composite of 13 Large Manufacturers

Printed Circuits

Not surprisingly European and N. American PCB production has suffered post-2000 due to the competitive impact of China, Taiwan, S. Korea and other "low cost" countries. European production peaked in 2000, Figure 27, and has been relatively flat ever since. Germany remains the largest producer, Figure 28.

In Europe Germany, France and the UK trade associations collect monthly book/bill data although in some cases it is only available to local membership. The Germany-based VdL/ZVEI trade group does make its book/bill available, Figure 29, although not its actual order and shipment data.

Combining all of Asia (thanks to Dr. Hayao Nakahara and Ed Henderson) and with the help of strong growth in China, S. Korea and Taiwan, it is estimated that the overall Asian region produced about 75% of the world's printed circuit boards. After a global slowing in 2005/2006 Asian, growth is forecasted to resume in 2007(Figure 30). However the China expansion will continue even through the 2005/2006 world slowdown.

Japan's monthly PCB shipments Figure 31 are published on a publicly accessible Japanese language website. It appears that although Japan was the world's largest PCB producer in 2003, its printed circuit growth flattened in 2004.

Figure 32 shows historic Japanese 12/12 growth. After an expansion in early 2004 the growth rate dropped mid-year.

Because Taiwan's publicly traded PCB producers report their financials monthly it is possible to track local growth. Bearing in mind that much of the product sales reported by "Taiwan" companies was actually produced in Mainland China, Figure 33 must be considered as a composite of the combined Taiwan/China sales for 8 large manufacturers.

N. America has moved from its historical #1 global PCB share position, to only about a 15% share today. Figure 34 shows N. America's annual PCB sales from 1980. Figure 35 depicts quarterly rigid and flex shipments for N. America. The massive drop off in 2001 can be attributed to the implosion of telecom (N. America's pre-2001 demand driver) the shift in PCB manufacturing to China and price degradation in the local market due to overcapacity, EMS buying power and "low cost" Asian PCB pricing competition.

Figure 36 shows monthly N. American rigid PCB orders and shipments – on a $ index basis where an average month of 2001 = 1000. This information is from the IPC's monthly statistical survey.

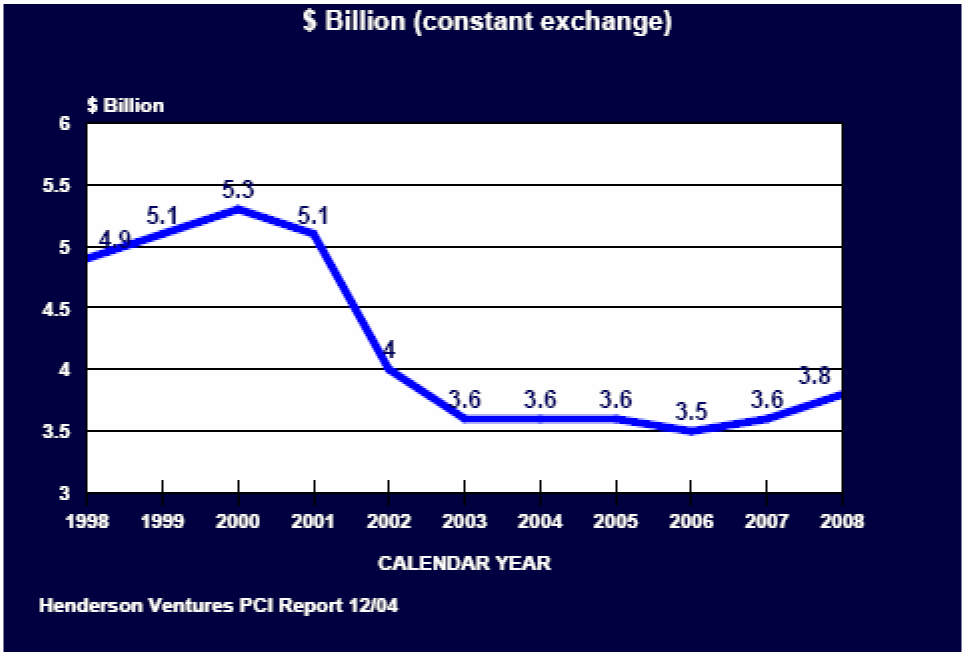

Figure 27 – PCB Production in Europe

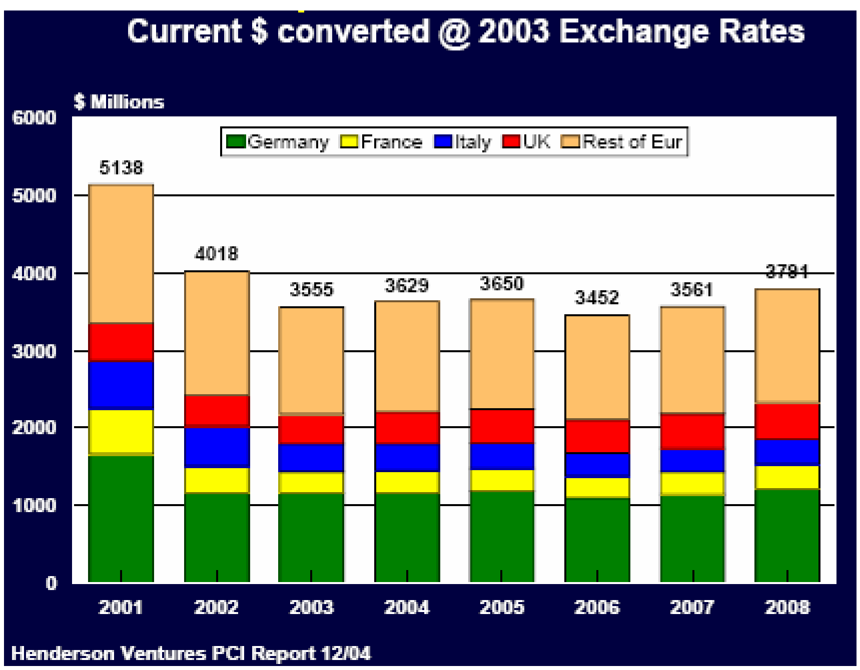

Figure 28 – European PCB Production

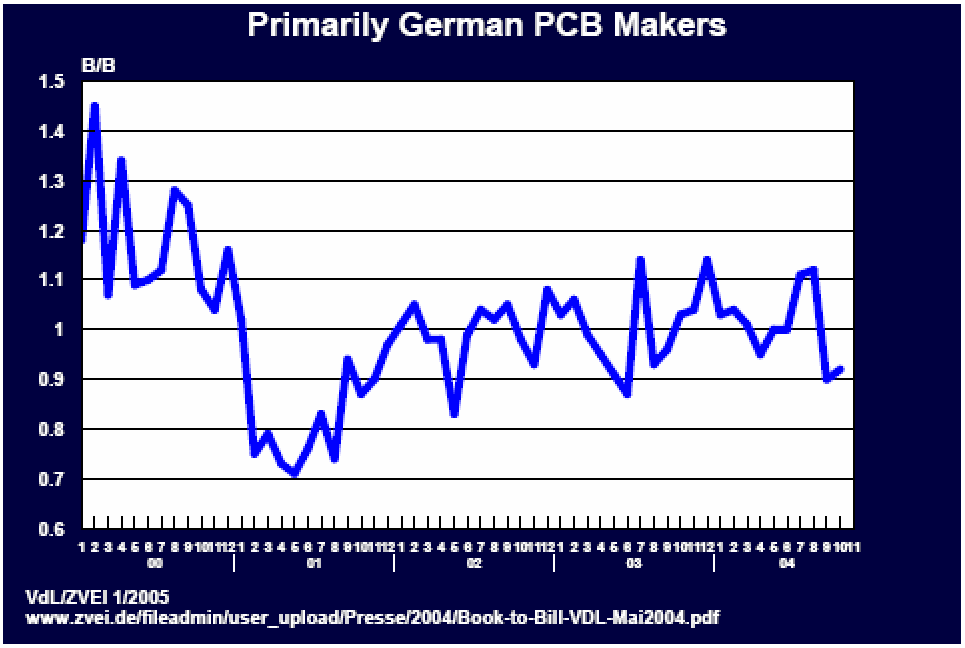

Figure 29 – PCB Book/Bill – VdL/ZVeI

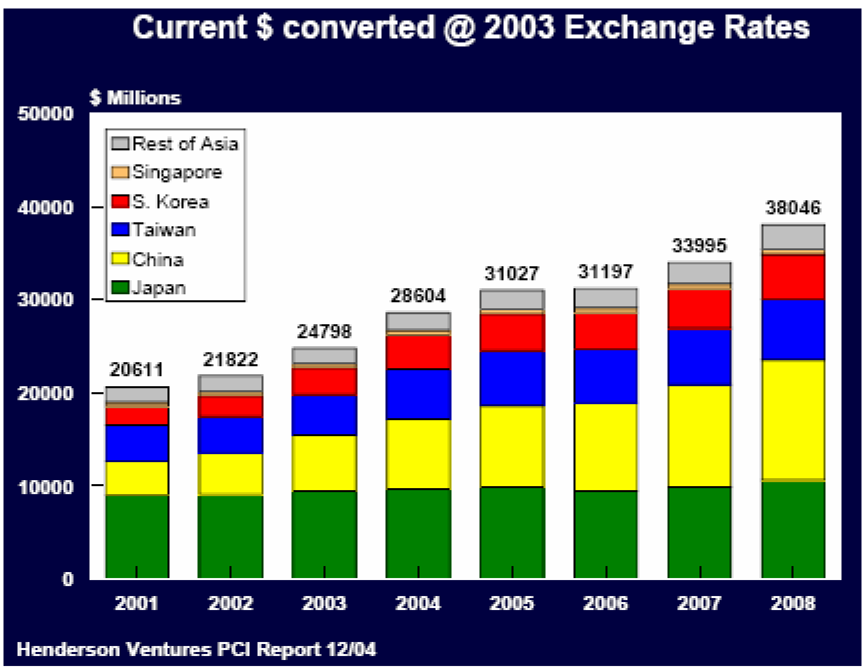

Figure 30 – Asian PCB Production

Figure 31 – Japan PCB Shipments

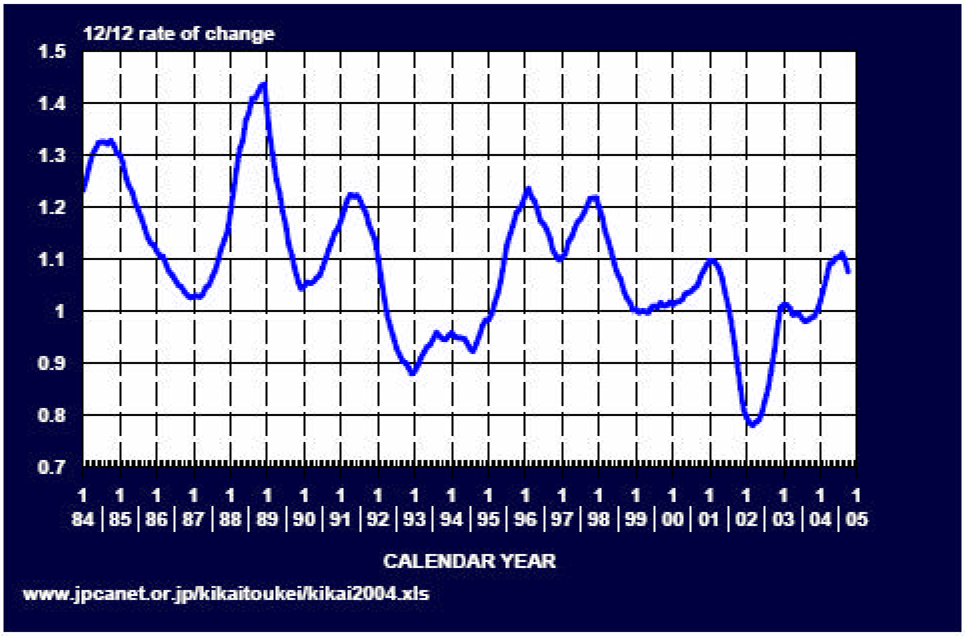

Figure 32 – Japan PCB Shipments

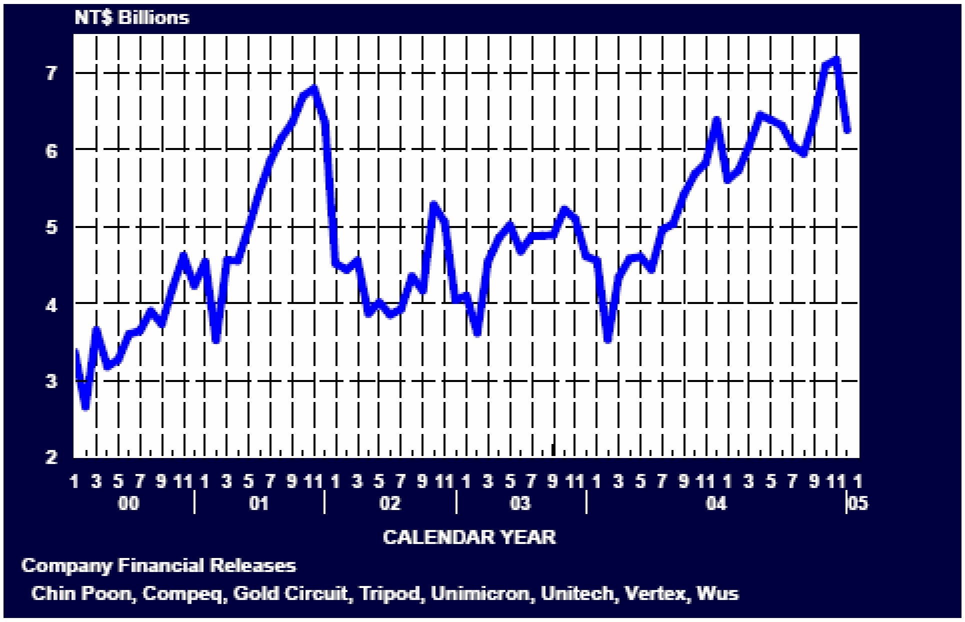

Figure 33 – Taiwan Rigid PCB Shipments Composite of 8 Large Manufacturers

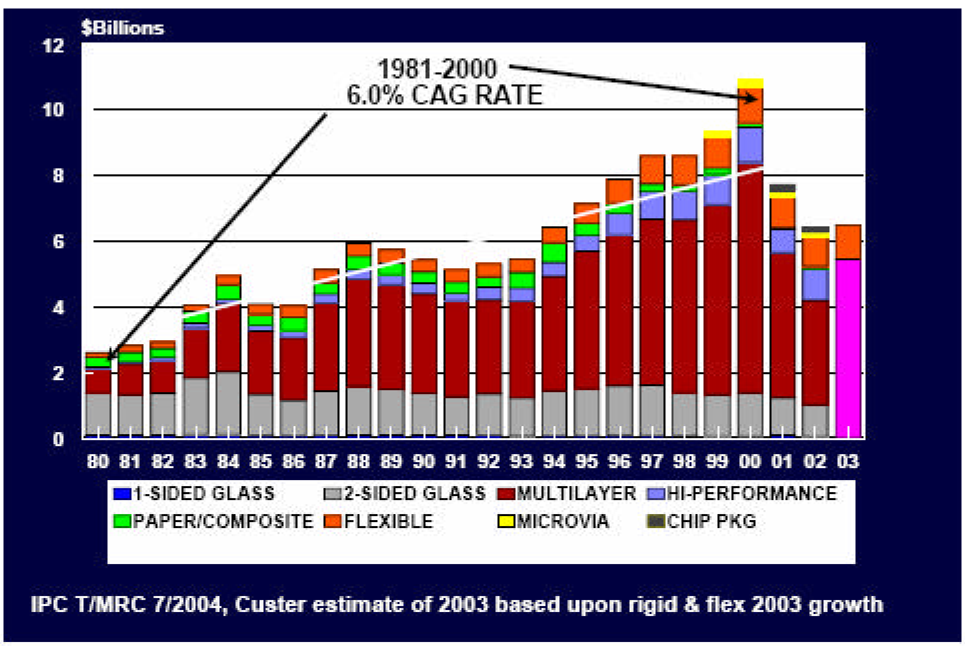

Figure 34 – North American PCB Shipments

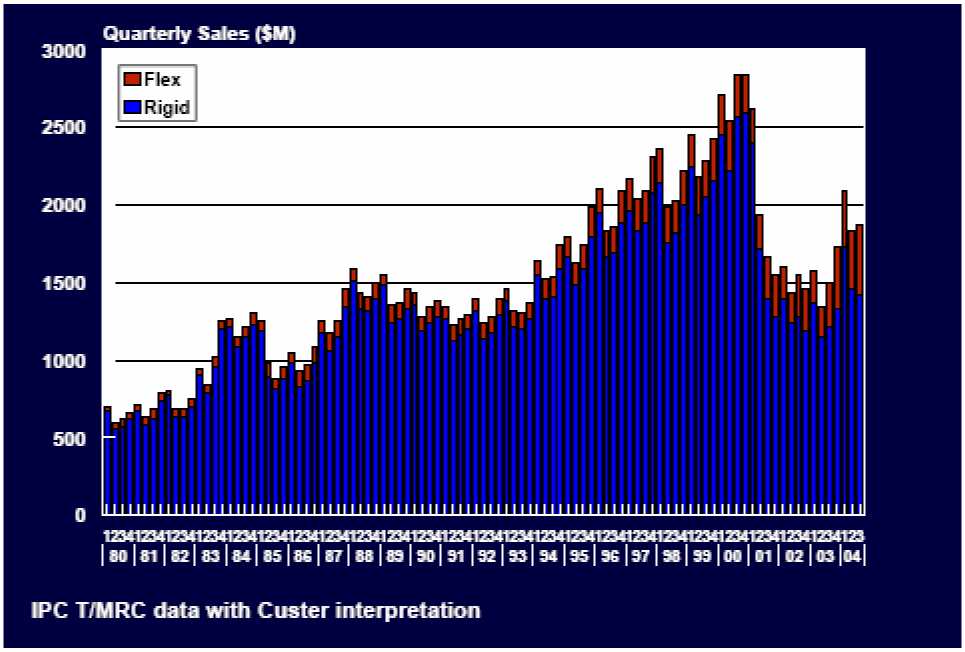

Figure 35 – North American Total PCB Shipments

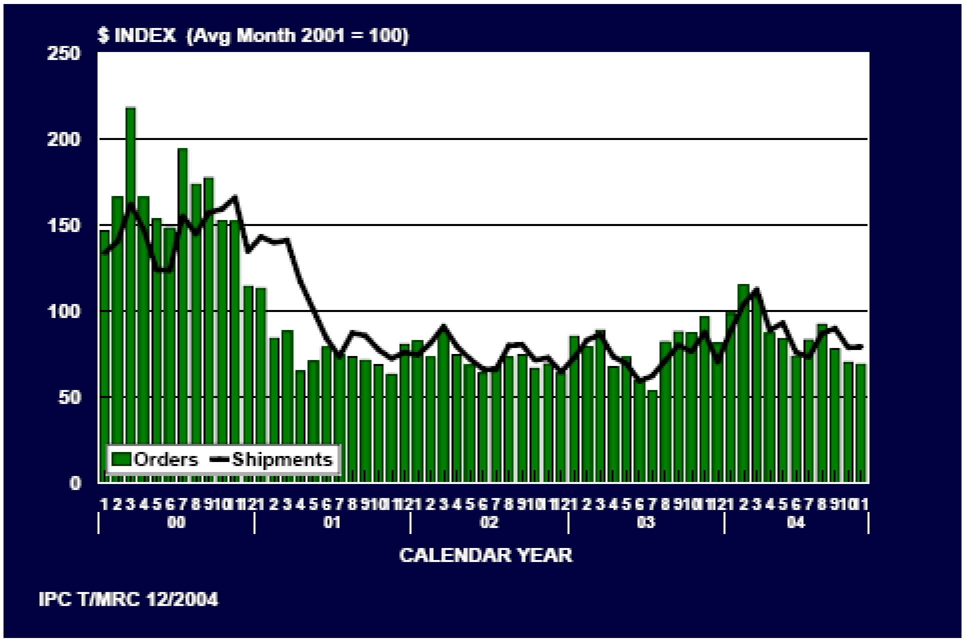

Figure 36 – US Rigid PCB Orders and Shipments

PCB Materials & Process/Test Equipment

At least 6 Taiwan laminate manufacturers report their financials publicly. Figure 37 contains composite monthly sales of these companies. Unfortunately few (other than Park Electrochemicals) laminate manufacturers outside of Taiwan report their data. Since many PCB material companies (DuPont, Hitachi, Rohm and Haas, Cookson) have multiple product lines it is not possible to easily track their PCB material sales.

However through the IPC statistical survey initiatives, global process material suppliers are reporting their data to the IPC under secrecy for subsequent consolidation and analysis. Presently the results are only shared among the reporting companies and the data collection has been relatively short term.

As this “materials” data collection process matures, hopefully summary data will be shared with industry observers.

Figure 38 contains composite sales of 6 “public” PCB process & test equipment vendors. Unfortunately this also includes sales to other (higher growth) companion industries (flat panel displays) but this composite does provide an indication of industry trends.

Figure 37 – Taiwan Rigid laminate Vendors Composite of 6 large Manufacturers

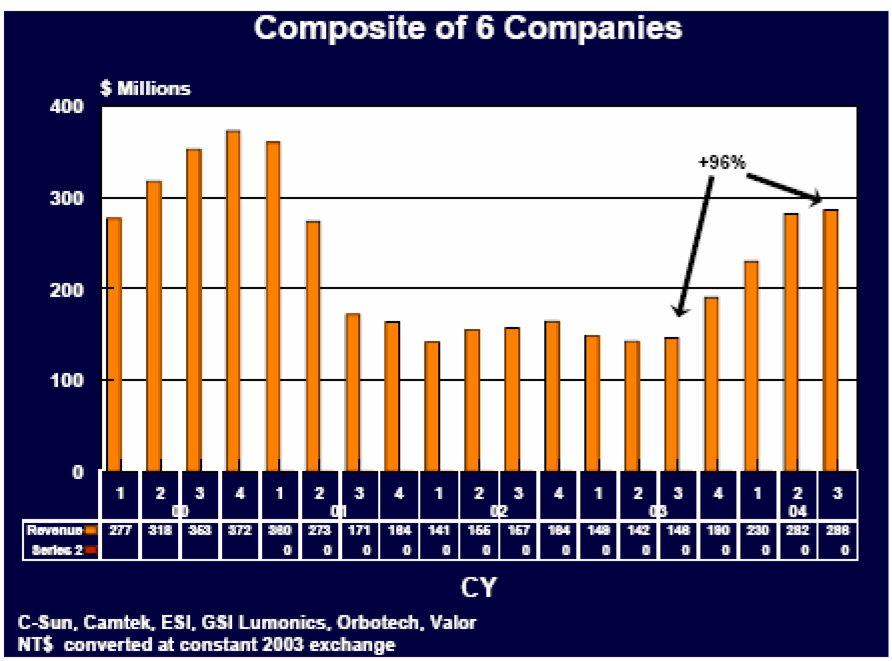

Figure 38 – PCB Process Equipment Related Suppliers

“Food Chain” Relationships

Cross-industry growth comparisons are possible. Figure 39 compares the N. American rigid PCB and SEMI semiconductor equipment book/bill ratios. The correlation is quite good.

Taiwan's laminate and rigid PCB makers' monthly revenues also "fit" well, Figure 40. Note that laminate sales have recently been "leading" PCB sales lower. Unfortunately at present we do not have composite Taiwan laminate prior to 2003 so we can not examine the correlation during the 2000 "bubble" and the subsequent downturn.

Figure 41 is informative. It shows the 3/12 growth of finished U. S. electronic equipment versus both rigid PCBs and PCB process equipment shipments. It is clear that managing a PCB process equipment company is most challenging – with "booming" demand during periods of industry growth and massive sales declines in the downturn.

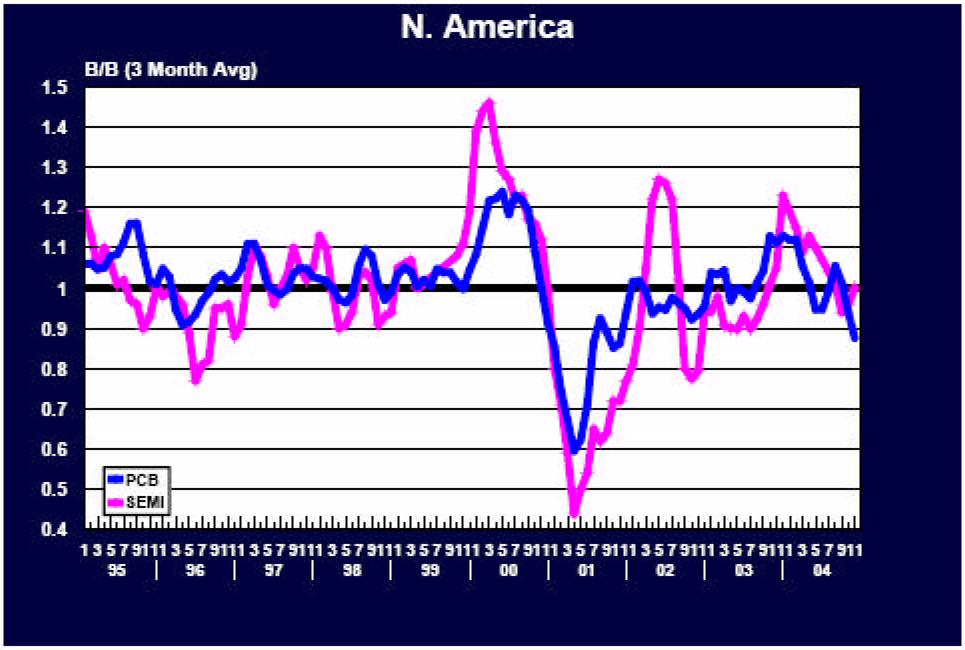

Figure 39 – Rigid PCB vs. Semi Book/Bill

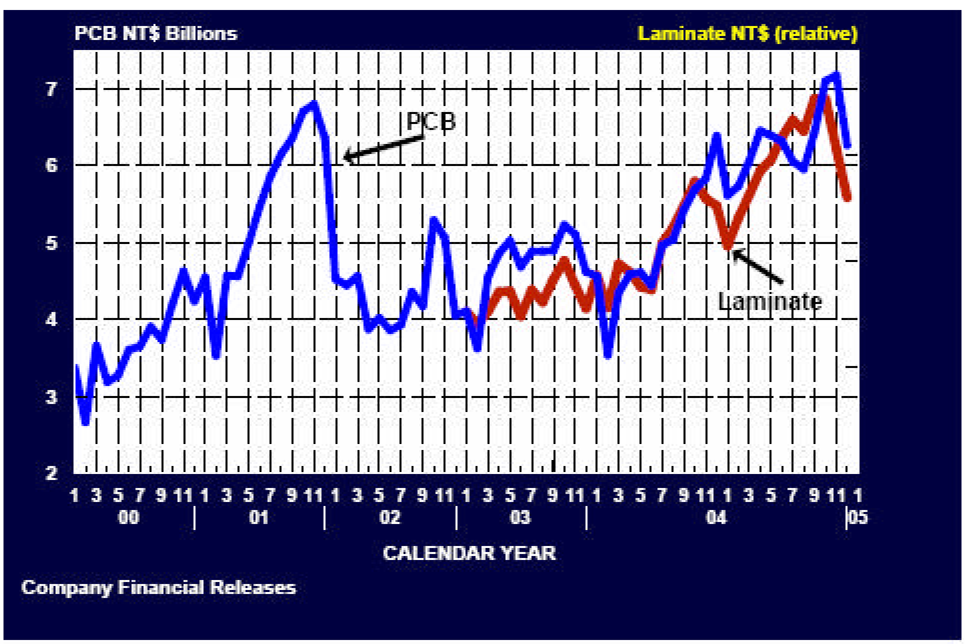

Figure 40 – Taiwan Rigid PCB vs. Laminate Shipments Composite of Large Manufacturers

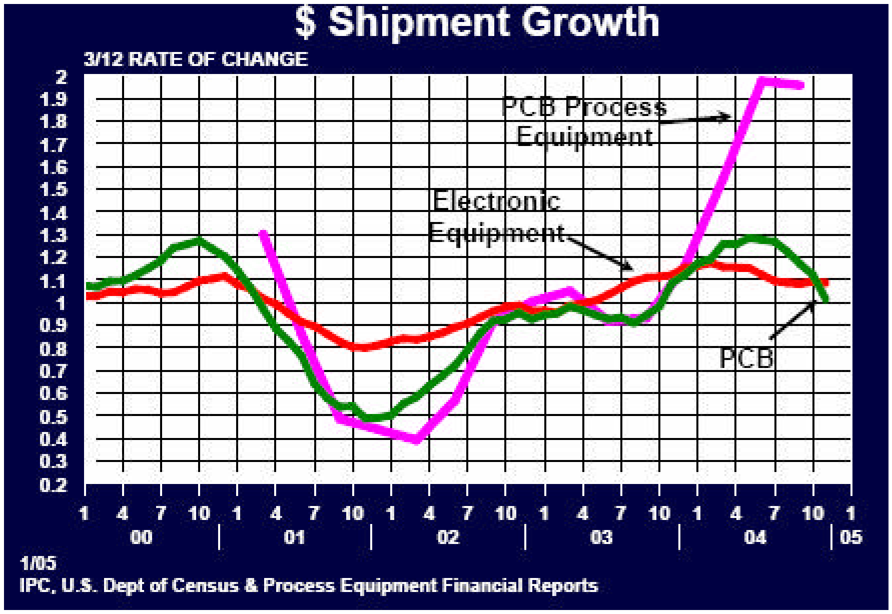

Figure 41 – US Electronic Equipment, North American Rigid PCBs and PCB Process Equipment

World PCB Shipment Model
Although monthly PCB shipment information is only collected by a few countries, there is certainly a "demand" for a monthly world sales model.

Using these assumptions:
- Europe monthly PCB growth = N. America monthly PCB growth (from IPC)
- Japanese & N. America PCB growth from JPCA & IPC data
- Taiwan/China growth based upon Figure 33 (8 large company composite)
- Rest of Asia (excluding Japan) growth = Taiwan/China composite Figure 32
- Data scaled to match Henderson Ventures PCI report annual country PCB shipment totals Figure 50 (Chart 64)

Based upon these assumptions and data sources, Figure 42 shows the synthesized world PCB sales model. It will continue to be refined as more global data becomes available.

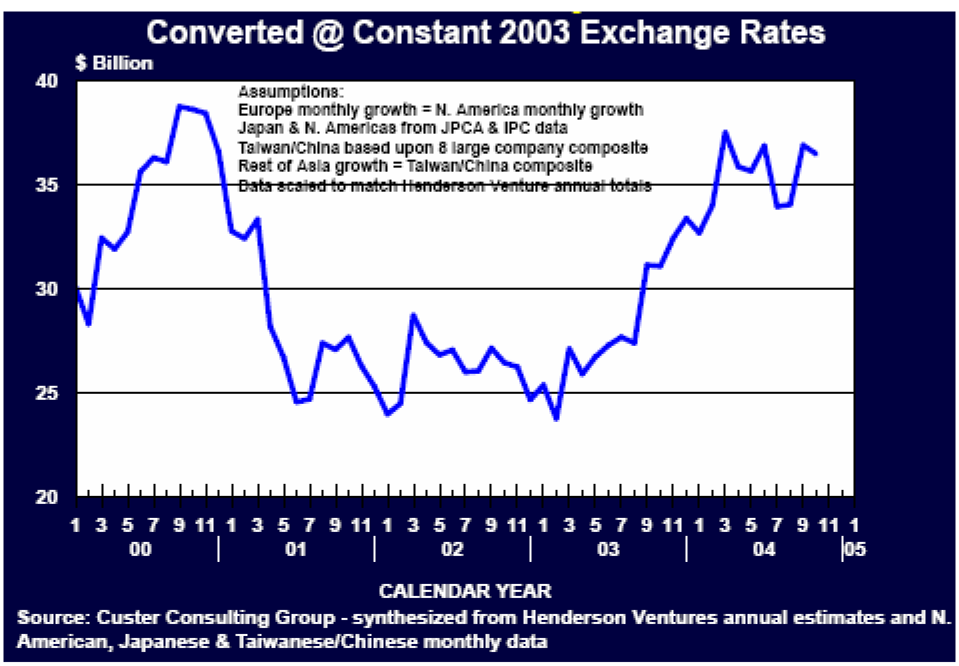

Figure 42 – World PCB Shipments

Leading Indicators

Leading indicators can be useful in forecasting future market growth. These indicators include the:

- reciprocal of interest rates
- Conference Board’s composite indicator
- ratio of finished electronic equipment inventories/orders
- other “related” industry time series.

Taiwan’s chip foundries respond rapidly to changing semiconductor business conditions. Figure 43 compares a sales composite of the two largest chip foundries to global semiconductor sales. Beginning in October 2004 the foundries monthly revenues turned down. Figure 44 compares U.S. electronic equipment orders to the Conference Board’s composite leading indicator.

Leading indicators can be useful in preparing 3 to 18 month forecasts. These resulting forecasts must always be judged in light of current industry events

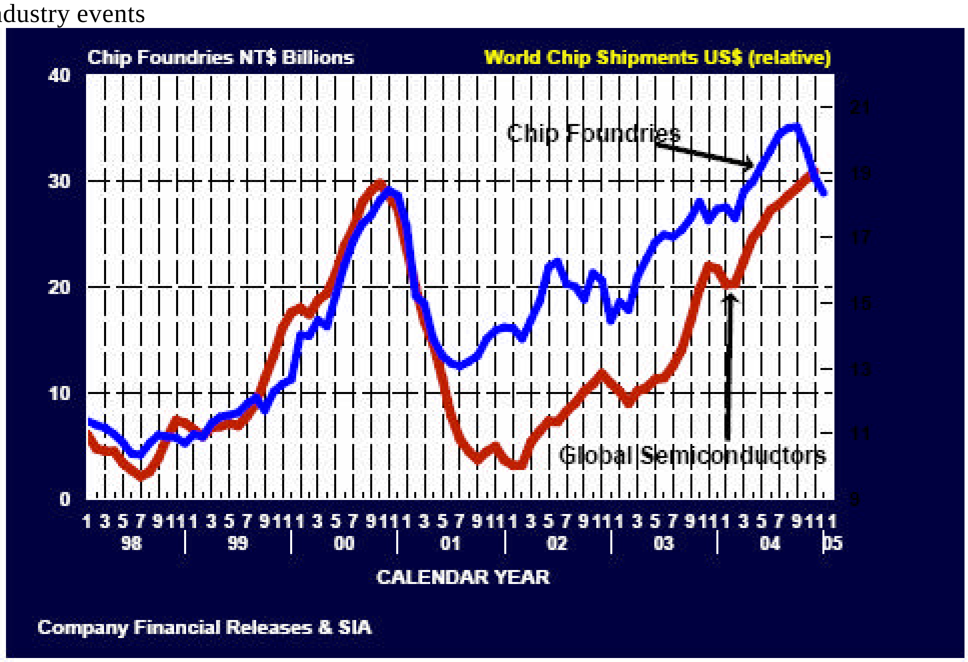

Figure 43 – Taiwan Chip Foundry Composite vs. Global Semiconductor Revenues

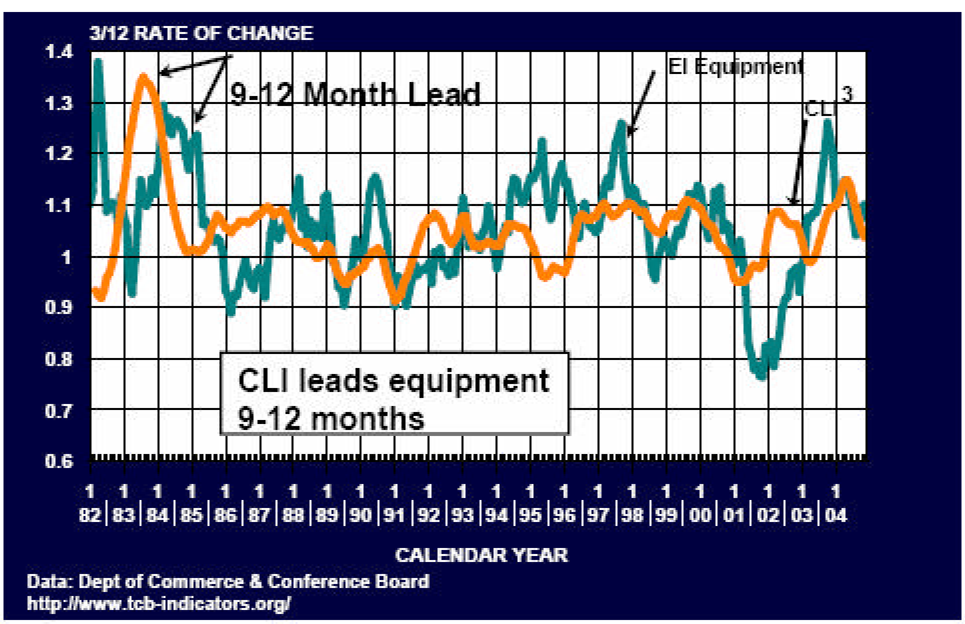

Figure 44 – US Electronic Equipment Orders vs. Conference Board Composite Leading Indicator

Forecasts
Figures 45-53 show forecasts from various industry sources are included in this paper:


Constant $ Growth Rates Converted @ Constant Exchange Rates

	2003	2004	2005	2006	2007
World	2.6	4.2	3.3	3.1	3.6
USA	3.0	4.4	3.3	2.9	3.3
W Europe	0.8	2.2	1.9	2.3	2.7
Japan	2.5	3.8	2.0	2.3	2.5
Four Tigers	2.8	5.8	4.4	4.3	5.5
China	9.1	9.1	7.5	7.7	8.0

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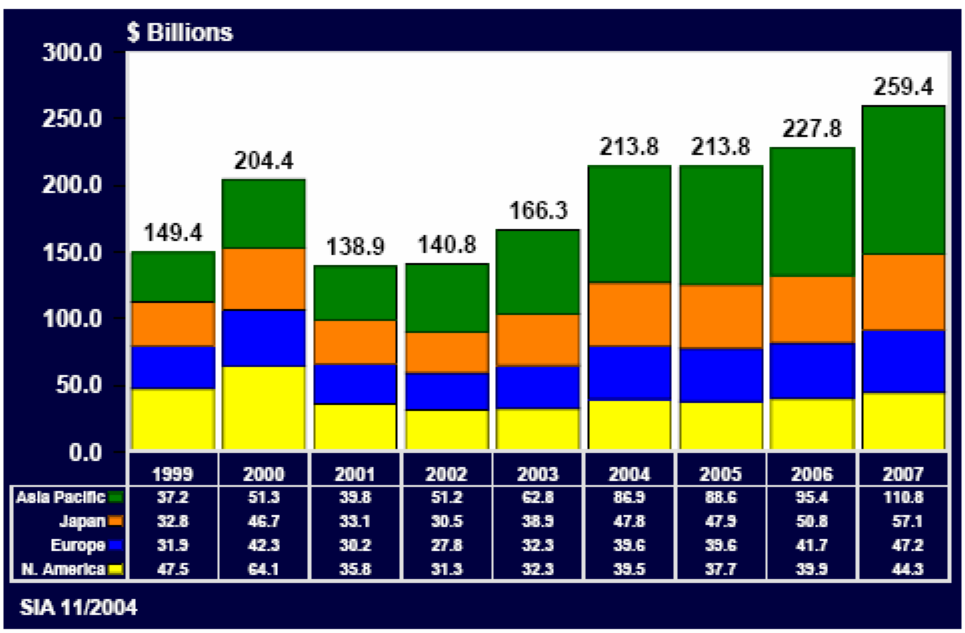
www.hendersonventures.com

Figure 45 - GDP Growth; World & also by Area, 2003 to 2007



	1999	2000	2001	2002	2003	2004	2005	2006	2007
Asia Pacific	37.2	51.3	39.8	51.2	62.8	86.9	88.6	95.4	110.8
Japan	32.8	46.7	33.1	30.5	38.9	47.8	47.9	50.8	57.1
Europe	31.9	42.3	30.2	27.8	32.3	39.6	39.6	41.7	47.2
N. America	47.5	64.1	35.8	31.3	32.3	39.5	37.7	39.9	44.3

Figure 46 – World Semiconductor by Area – 1999 to 2007

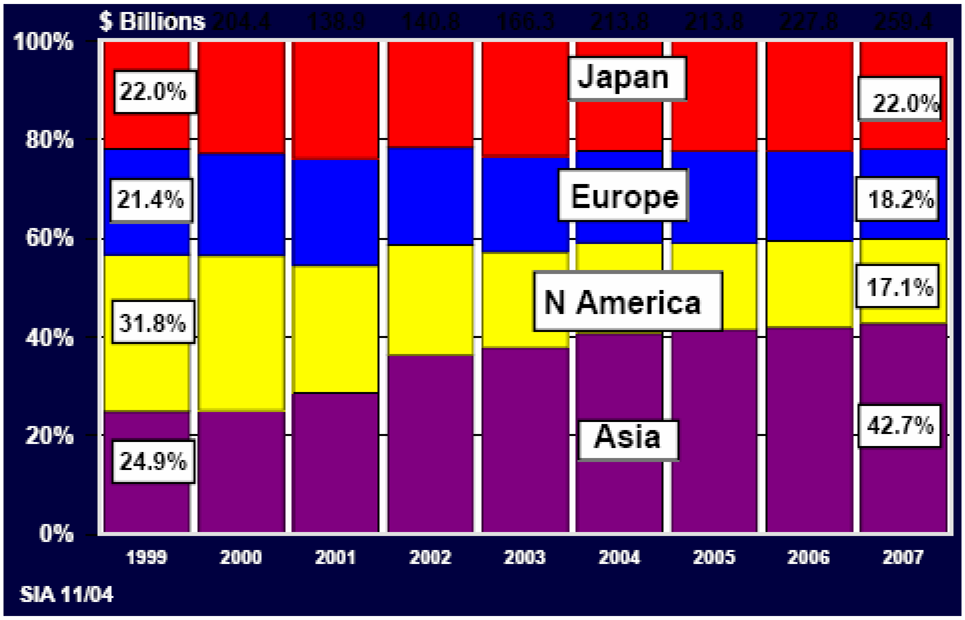
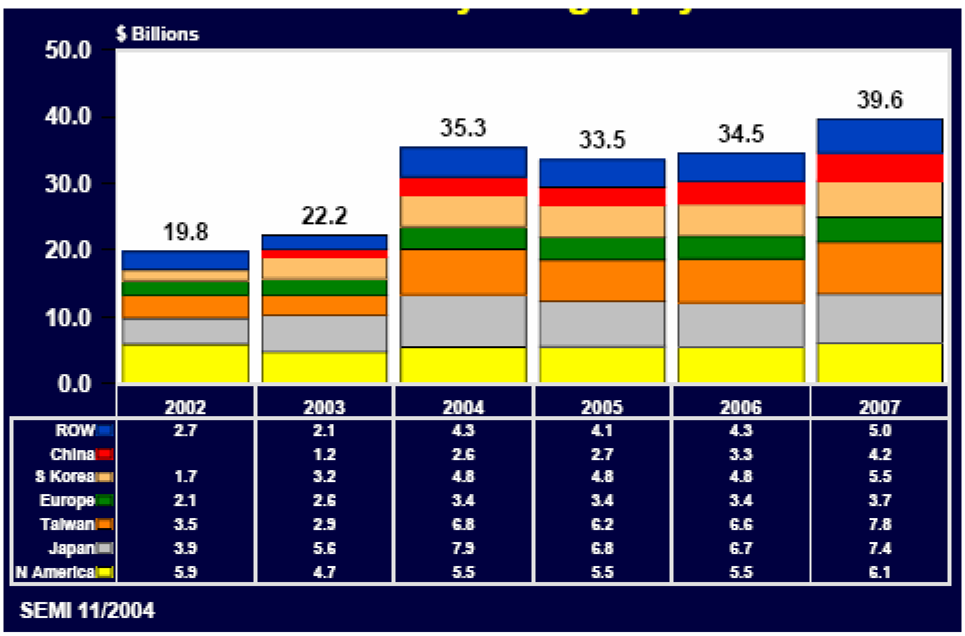
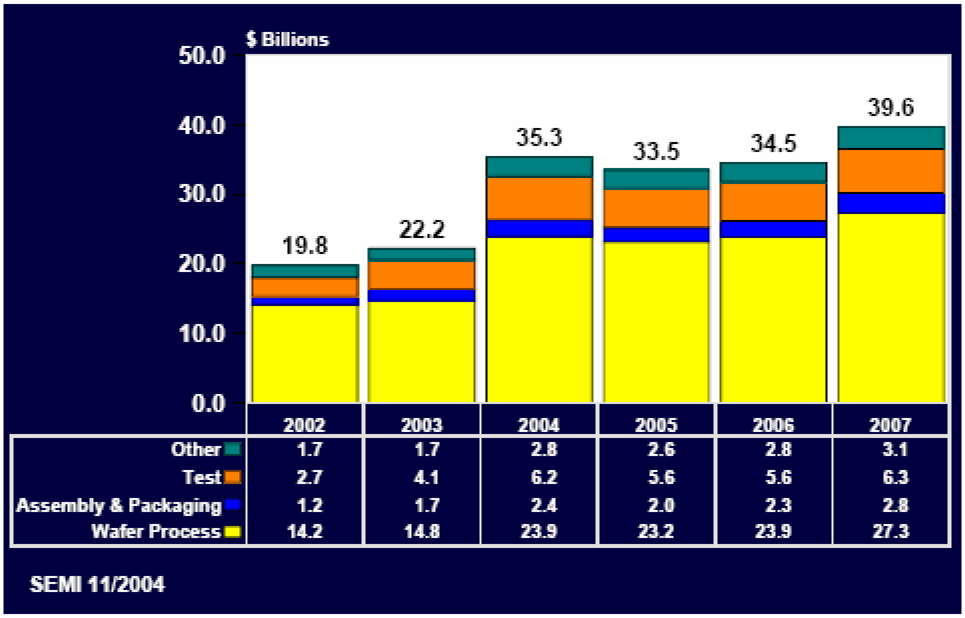


Figure 47 – World Semiconductor Market by Geography (100% bar) – 1999 to 2007



	2002	2003	2004	2005	2006	2007
ROW	2.7	2.1	4.3	4.1	4.3	5.0
China		1.2	2.6	2.7	3.3	4.2
S Korea	1.7	3.2	4.8	4.8	4.8	5.5
Europe	2.1	2.6	3.4	3.4	3.4	3.7
Taiwan	3.5	2.9	6.8	6.2	6.6	7.8
Japan	3.9	5.6	7.9	6.8	6.7	7.4
N America	5.9	4.7	5.5	5.5	5.5	6.1

Figure 48 – World Semiconductor Capital Equipment Market by Geography – 2002 to 2007



	2002	2003	2004	2005	2006	2007
Other	1.7	1.7	2.8	2.6	2.8	3.1
Test	2.7	4.1	6.2	5.6	5.6	6.3
Assembly & Packaging	1.2	1.7	2.4	2.0	2.3	2.8
Wafer Process	14.2	14.8	23.9	23.2	23.9	27.3

Figure 49 - World Semiconductor Capital Equipment Market by Equipment Segment – 2002 to 2007

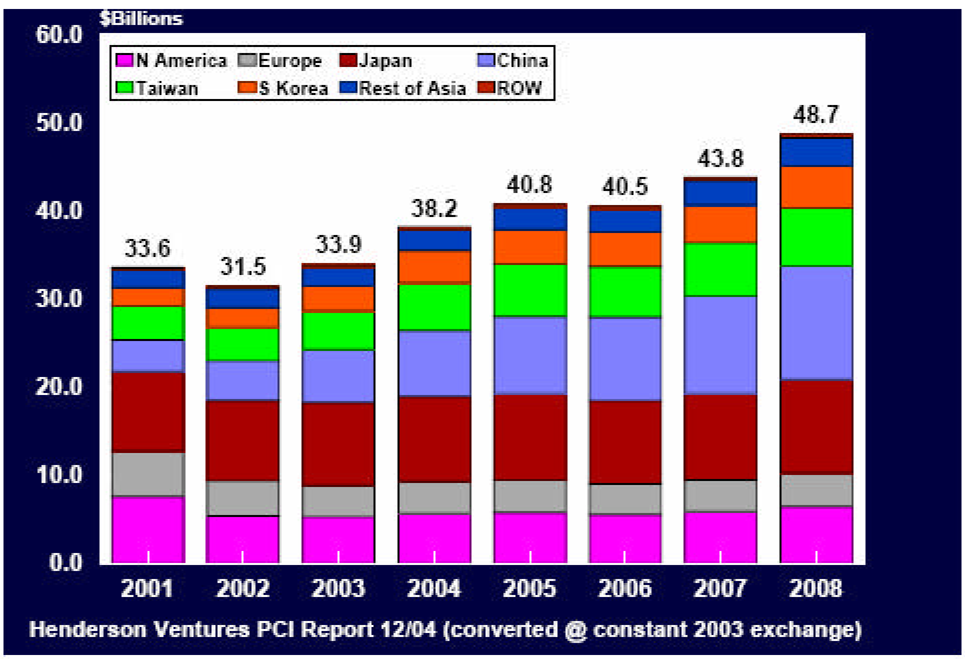
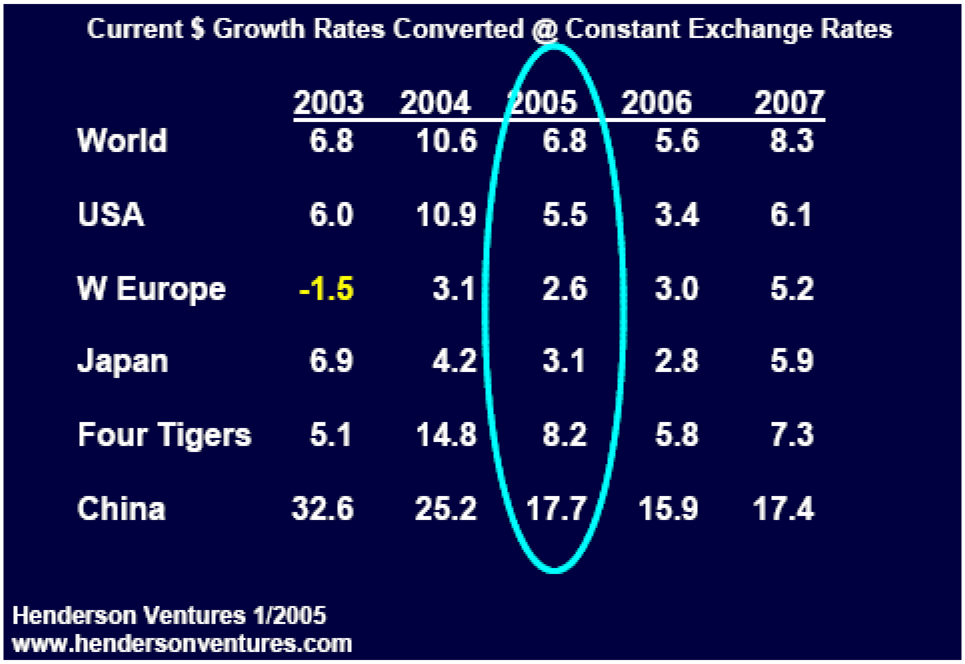


Figure 50 – World Rigid & Flex PCB Production by Major Country – 2001 to 2008



Current $ Growth Rates Converted @ Constant Exchange Rates

	2003	2004	2005	2006	2007
World	6.8	10.6	6.8	5.6	8.3
USA	6.0	10.9	5.5	3.4	6.1
W Europe	-1.5	3.1	2.6	3.0	5.2
Japan	6.9	4.2	3.1	2.8	5.9
Four Tigers	5.1	14.8	8.2	5.8	7.3
China	32.6	25.2	17.7	15.9	17.4

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www.hendersonventures.com

Figure 51 – Electronic Equipment Growth; World & also by Area, 2003 to 2007

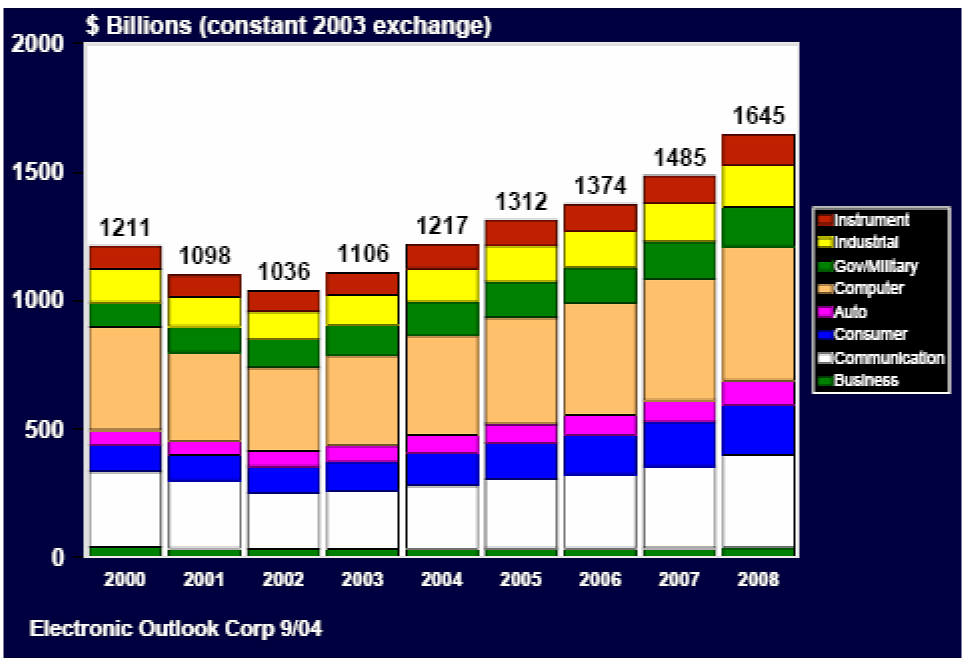

Figure 52 – World Electronic Equipment Production by Type – 2000 to 2008

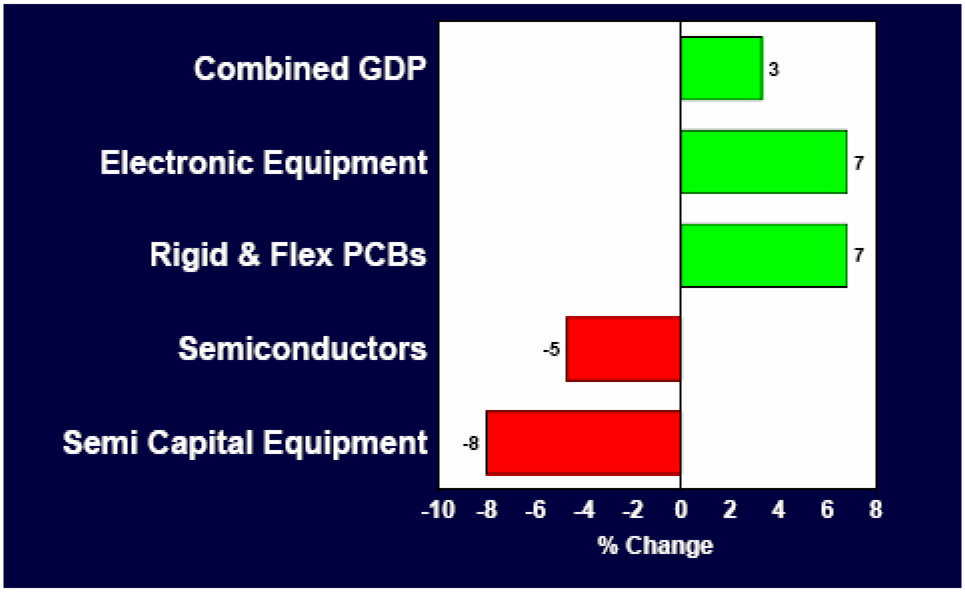

Figure 53 - Global "Electronic Food Chain" Outlook 2005 vs. 2004

Summary & Conclusions

- Business cycles are a "Fact of Life"
- Causes include excess ordering & inventory building in growth periods, poor management, economic climate changes and cataclysmic events
- Results include imprudent inventories, ill-timed capacity expansions, wild price & margin fluctuations and excess hiring followed by layoffs
- Lower levels of the supply chain grow more in good times and contract more in downturns. Process, test & understanding business cycles and exercising proper management discipline to avoid excess inventory, untimely capacity expansions, imprudent employment levels and reactionary pricing decisions is key corporate success

Reference

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Henderson Ventures - www.hendersonventures.com
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