

New Scenery after the Storm

In-Stat Conference, Phoenix, 1999

Invited Talk

Commentary

The great semiconductor recession which began in 1996 lasted to 98, and finally ceased in 99. It was like a storm and caused structural changes in the semiconductor industry. Some executives in this field were forced to leave the post in the semiconductor operation to take the responsibility of the poor financial performance. I was one of those, and was moved from semiconductor side to corporate R&D group of Hitachi at the time of this speech.

Big changes were taking place after the storm in the market structure, product portfolio, and business models. The management people were searching for the new direction.

In this speech, I talked about the major factors which caused this recession by focusing on the price erosion due to overinvestment. I proposed a concept of “magnitude of recession” by analyzing big recessions in the past as well, and showed an opinion that “the semiconductor market is unpredictable”. The bullish mentality, which was named “95 mentality” was one of major factors which led to the overinvestment (see page 8 for more details).

A discussion was made on the new scenery after the storm in four areas; product portfolio, market structure, regional shift, and manufacturing. It was noted that “nothing is on the simple extrapolation of the past”.

At the time of this speech, several cities in the world were putting their efforts to develop hi-tech industry. These activities were introduced as “Post Silicon Valley”.

In the future prospects, digital consumer products would become core segments of electronics which contribute to the spread of Nomadic lifestyle. Among other things, language technology would provide big market opportunity.

New Scenery after the Storm

Dr. Tsugio Makimoto
Board of Director
Corporate Chief Technologist
Hitachi, Ltd.

At the time of this speech, I was with R&D Group of Hitachi as Corporate Chief Technologist, moving from Semiconductor side. (Please refer to Episode 17 of Exhibit 1 for reasons of the movement). In this speech, I talked about several changes after the great semiconductor recession from 1996 to 1998, including market structure and product portfolio.



RAM

**Dynamic boom is gone with the storm
... and new scenery is developing.**

Where is the industry going?

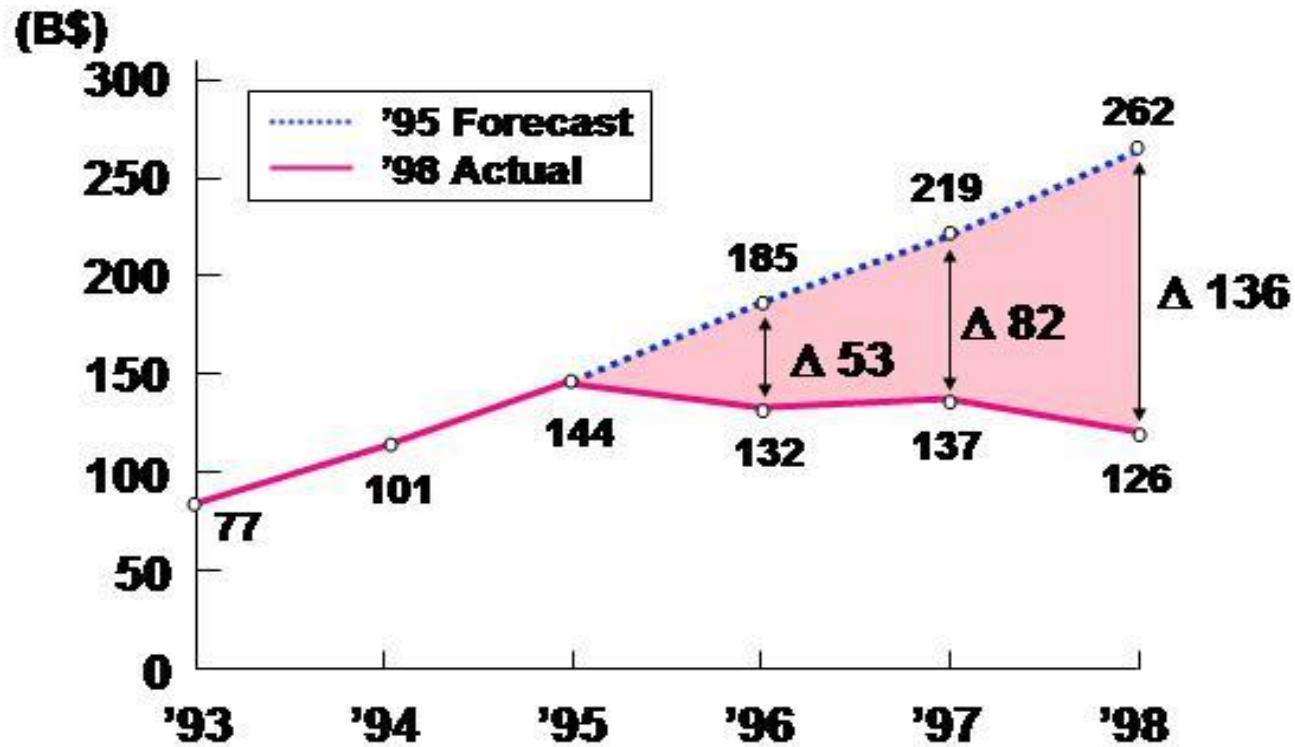


1

1995 was the boom year of the semiconductor industry thanks to the strong DRAM market. But the boom was over and it was followed by the great recession which lasted for three years. It reminded us of the famous movie "Gone with the wind".

- ◆
- **The Semiconductor Storm**
- **New Scenery 1: Shift in Product Segment**
- **New Scenery 2: Shift in Market Structure**
- **New Scenery 3: Shift in Geographical Market**
- **New Scenery 4: Shift in Manufacturing Fields**
- **Emerging Post Silicon Valleys**
- **Future Outlook**

The Magnitude of the Storm

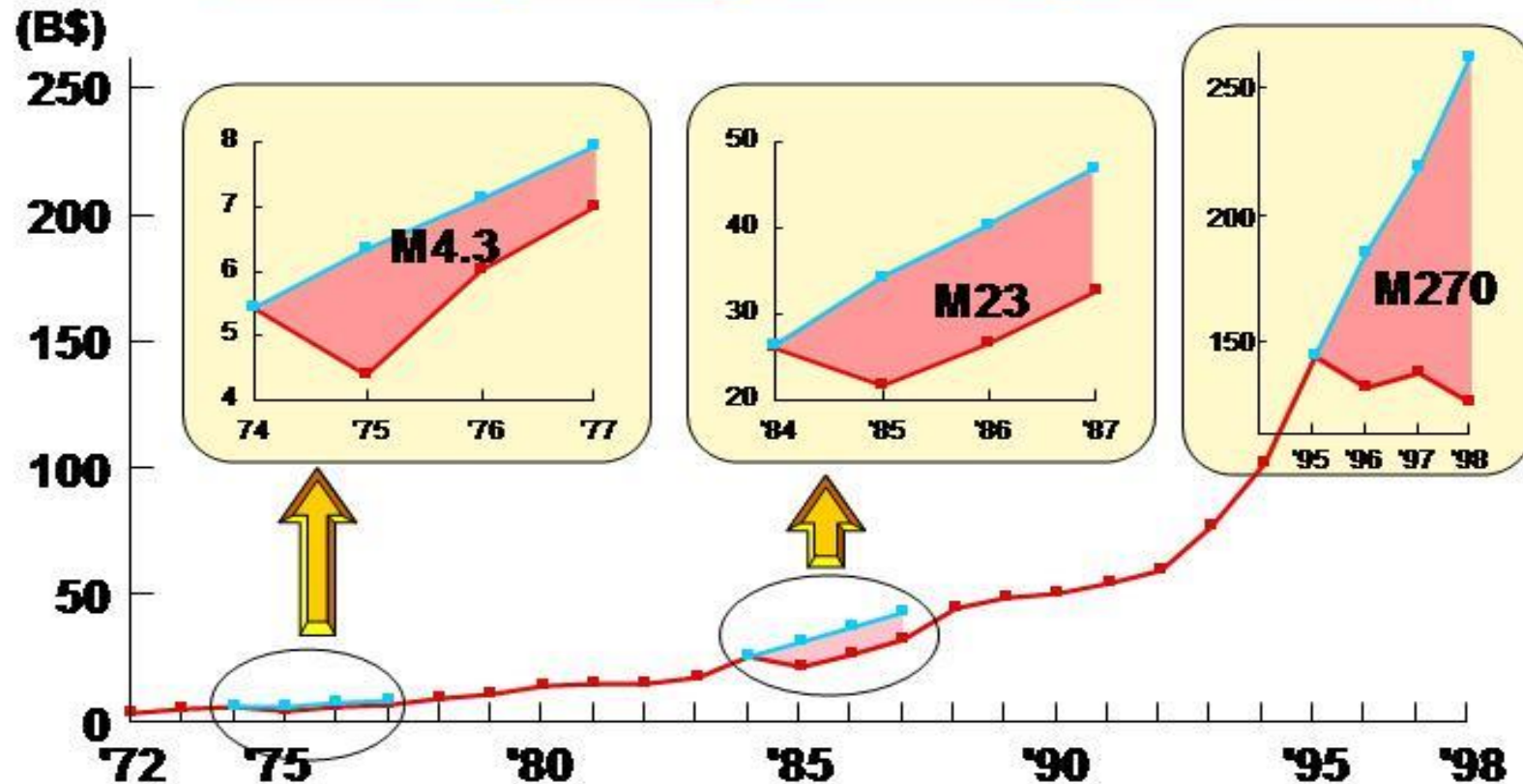


Source: WSTS

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The figure shows comparison of the forecasted and actual semiconductor market. The deviation between the two is shown by the red zone. It was intended to propose a way to define the magnitude of the recession, by adding deviation for three years. This figure corresponds to the "lost market" in three years. The period of three years was chosen since investment planning was normally based on three year forecast.

Comparing the Magnitude



Source: DataQuest & WSTS

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We have experienced three big recessions in the past. The figure compares the magnitude “M” for three cases. The 1975 recession was caused by the oil crisis with $M=4.3$. The 85 recession was triggered by the oversupply of DRAM with $M=23$, and the 96 recession was also caused by the DRAM slump with $M=270$. Based on this analysis, the recession of this time was the worst in the semiconductor history. It leads to the lesson that the semiconductor market is unpredictable.

Major Factors Affecting the Latest Dip

Supply Side:

- **After effect of '95 mentality**
- **“Shrink shock”**

Demand Side:

- **Shift to low-end PC**
- **Weak economies in Japan/Asia**

Four factors are shown here which affected the latest recession; two from supply side and two from demand side. “95 mentality” will be described in the next slide. Shrink shock was the impact of chip shrink which resulted in the sharp increase of supply. Demand from PC decreased partly due to shift to low-end side. The Asian Financial Crisis began in 1997, which caused weak economies.

Review of the '95 Mentality

- **Market to exceed 200B\$ in '97, going to 330B\$ by the year 2000.**
- **No silicon cycle within this decade.**
- **400 new fabs required by 2000.**
- **Severe shortage of engineers and capital for investment. etc**

The bullish mentality was widely shared in the semiconductor industry in 1995 due to the strong demand, which can be called the 95 mentality. Most of semiconductor people did not doubt the above statements, and competed in investment. It was a kind of mass psychology shared among semiconductor community.

Murphy's Law of Golf

Golf

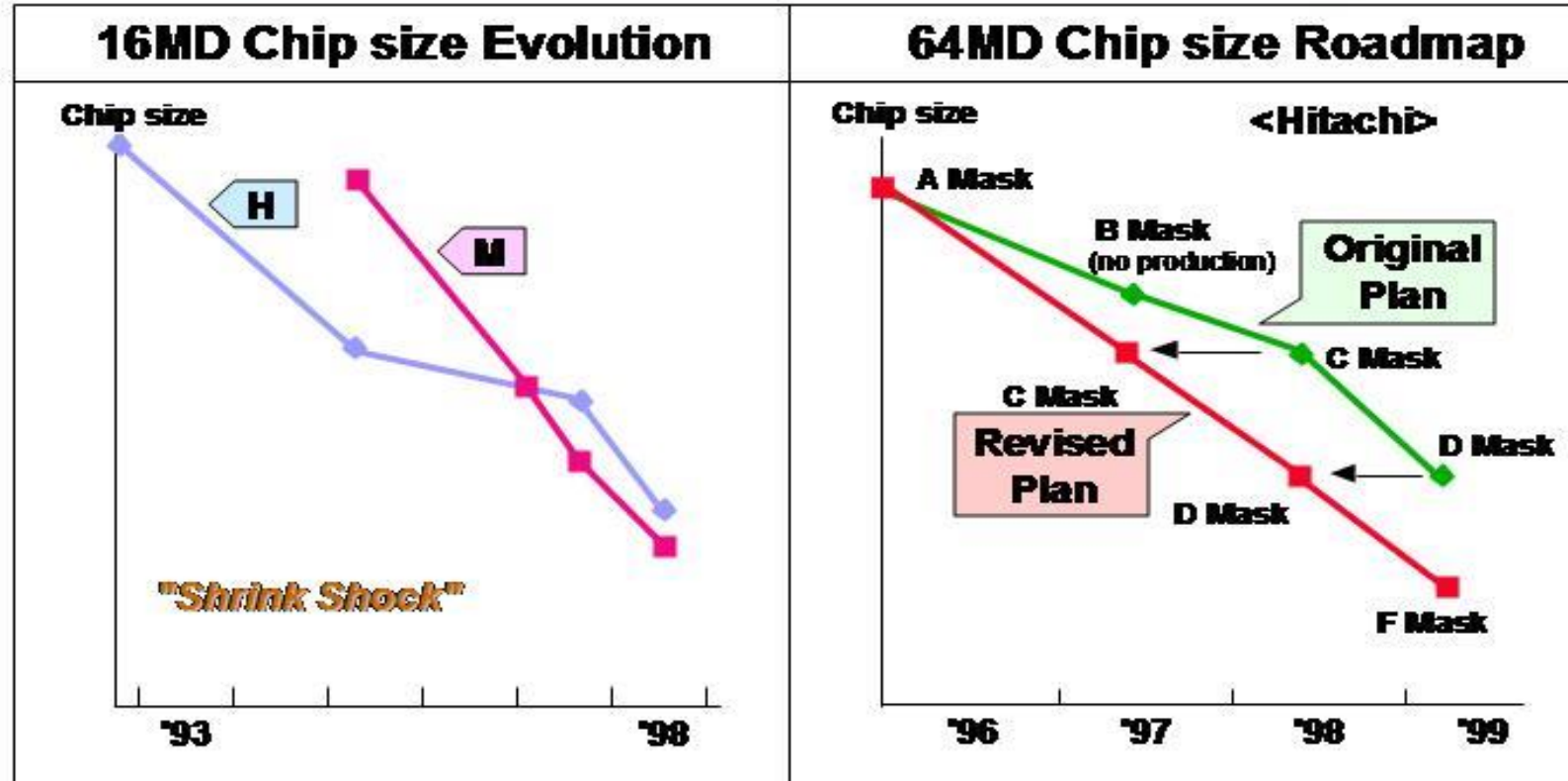
If we learn from our mistakes, then *golfers* are the most learned people on earth.

Semiconductor

If we learn from our mistakes, then *semiconductor people* are the most learned people on earth.

When the market is strong semiconductor people tend to believe that the situation would continue towards the future, but nothing can last for the infinite time. This is the lesson we learned from the latest recession.

Impact of the Shrink Shock

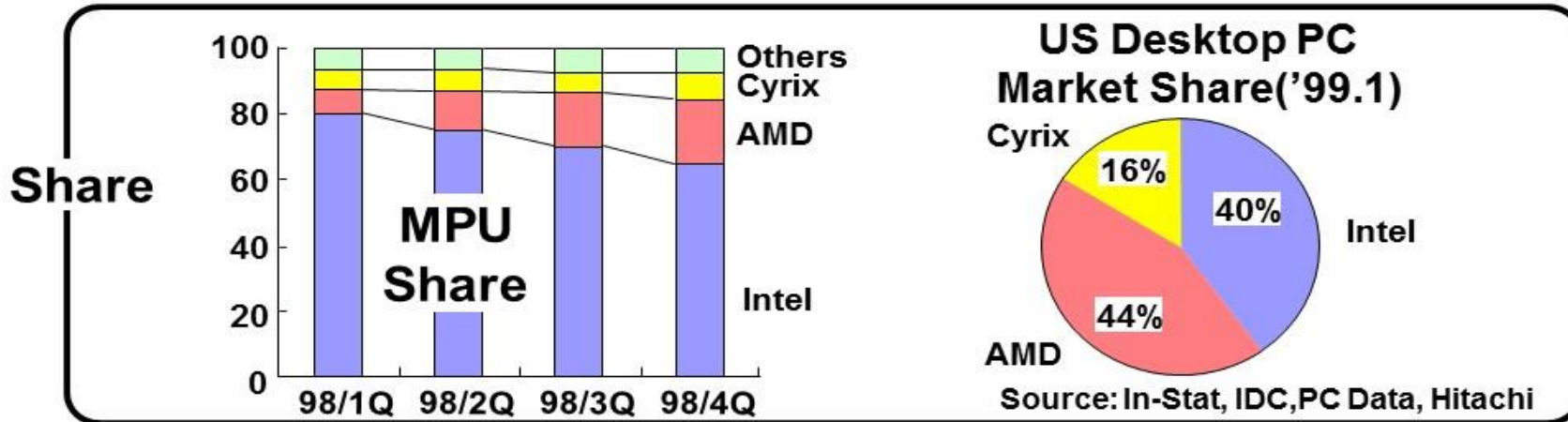
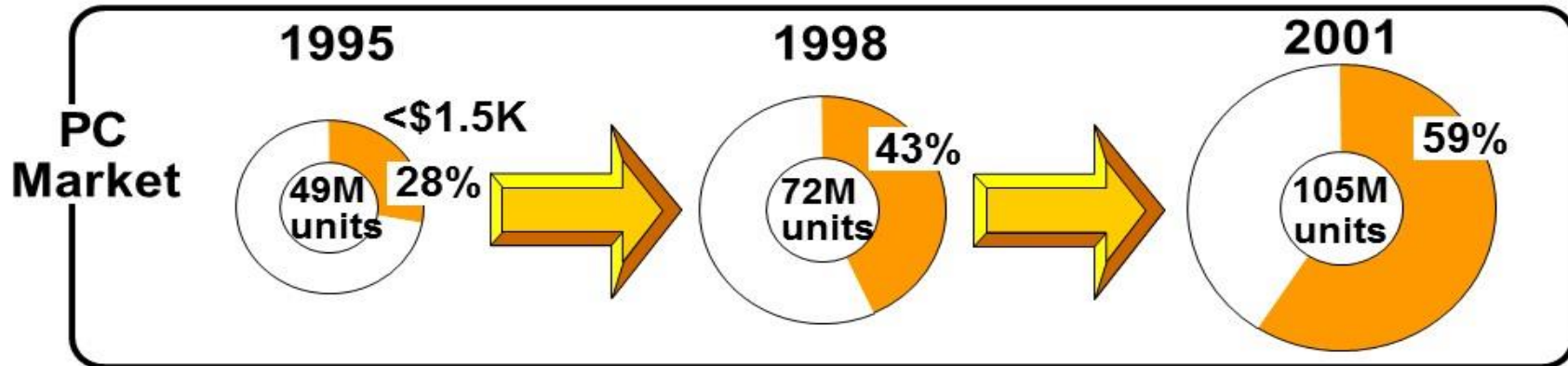


Source: IDC, Hitachi

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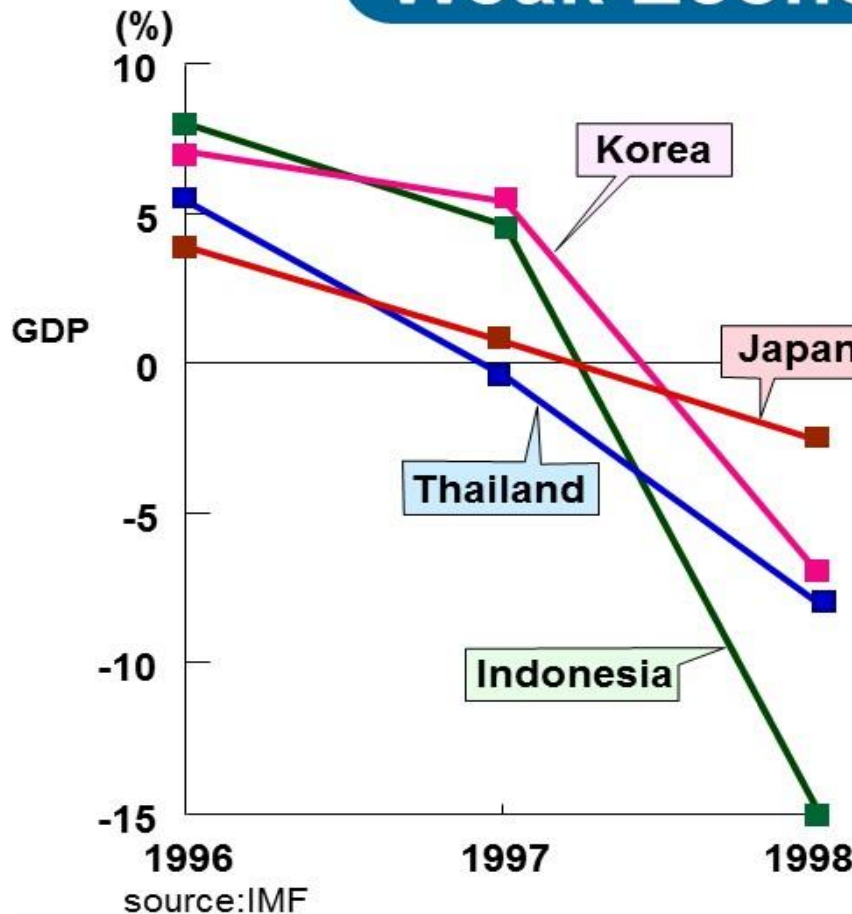
Japanese makers were initially leading in the 16M DRAM generation, but Micron introduced the shrink version of the device, and it was a great surprise. All the suppliers started to develop shrink version not only for 16M generation but also for 64M generation, and it resulted in "oversupply without investment" further causing the price erosion of DRAM.

Low End Shift of PC Market



The low end PC is priced at \$1500 or less. It was 28% in 1995, but increased to 43% in 1998, and it is expected to further increase to 59% in 2001. Although the PC units increase the DRAM consumption does not increase in proportion. This is one of reasons for the demand-supply imbalance resulting in the price erosion.

Weak Economies in Asia



WORLD ECONOMY

STARTING OVER: The crisis nations no longer fight the IMF — and are beginning to dismantle the old system of crony capitalism. BY TONY EMERSON

ASIA'S AGONY

THE LINEUP OUTSIDE THE OFFICE OF GLENN YUSUF, chairman of the Indonesian Bank Restructuring Agency, reads like a Who Was Who of Indonesian business. Each day the defeated tycoons arrive, handing over deeds to office blocks, factories, cruise ships, even shrimp farms, to settle subsidized loans to their failing banks. Fighting to stay afloat, the tycoons say they've handed over \$20 billion worth of collateral (though Yusuf says it's more like \$9 billion). Yet 40 banks have been closed or seized by the IBRA so far, and the agency has just begun its work — under orders of the International

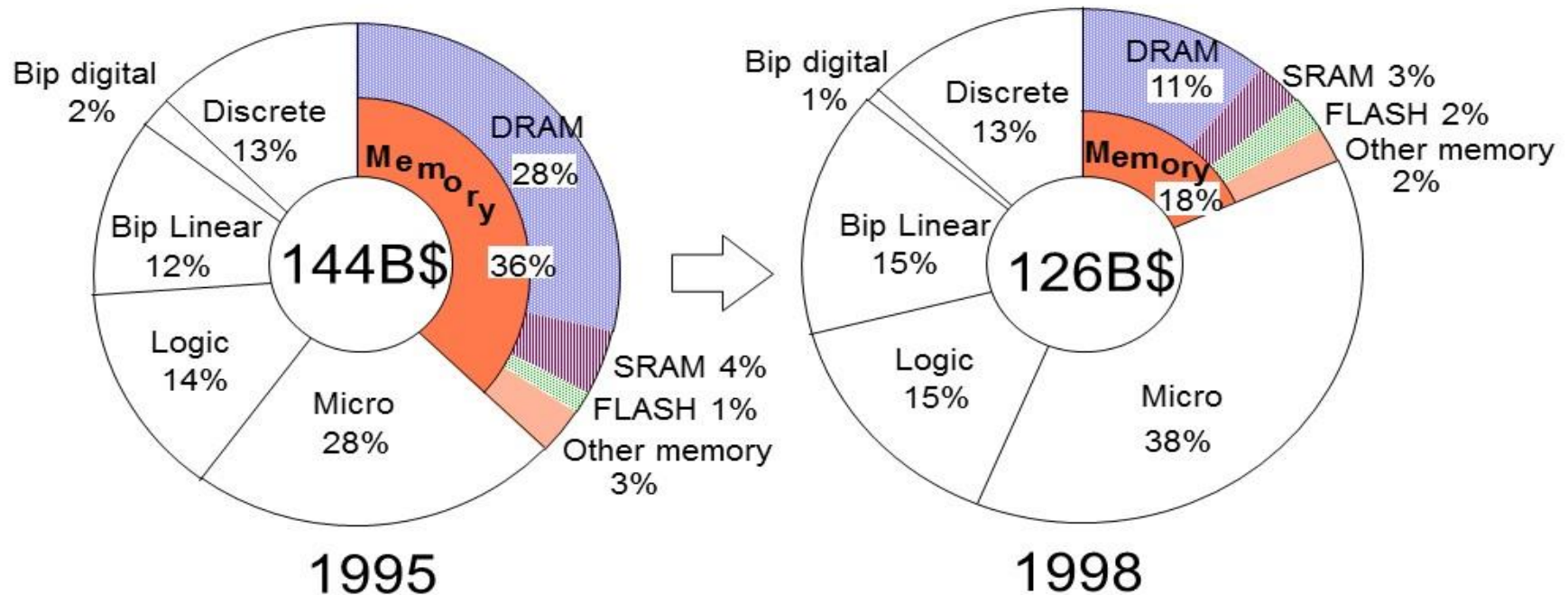


NEWSWEEK OCTOBER 12, 1998

This is cited from NEWSWEEK article on December 12, 1998, titled "ASIA'S AGONY". GDP of four major countries are shown, all of which became negative value in 1998. The Korean economy was forced to be under the control of IMF. It was one of backgrounds for the latest semiconductor slump.

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Shift of Product Portfolio - Memory Market Shrinks -



Source: WSTS

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The figures show changes in product portfolio for 1995, before the storm, and 1998, after the storm. The biggest change is the drastic decrease of memory from 36% to 18%, primarily due to the DRAM slump. Only flash memory increased from 1% to 2%. On the contrary, logic devices including microprocessors jumped from 32% to 53% symbolizing the drastic change in the product portfolio.

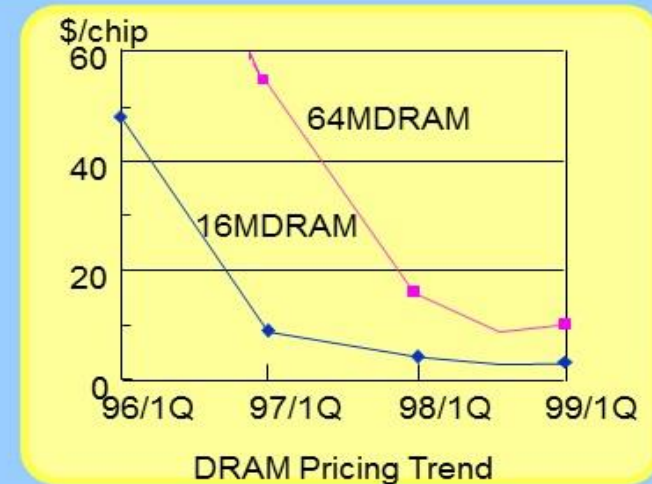
Psychological State of DRAM Makers

Hamlet:

To be, or not to be:
that is the question:

DRAM Makers:

To stay, or not stay in DRAM business:
that is the question:

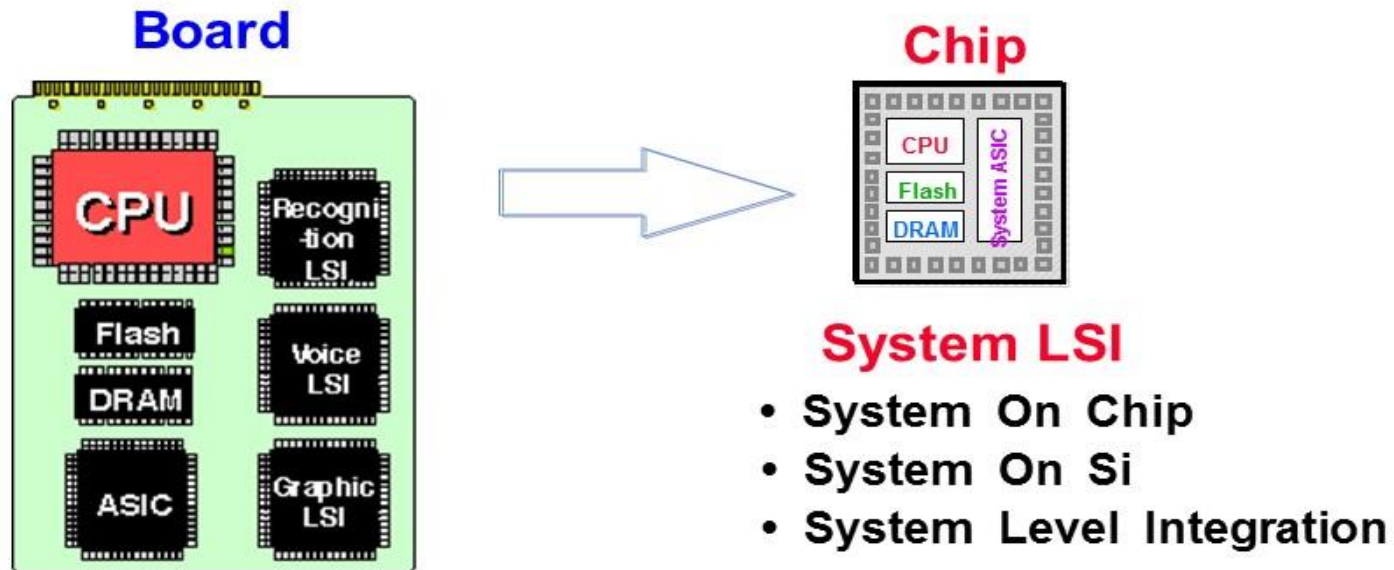


The figure on the right shows price trend for 16M and 64M DRAM. 16M price dropped from \$50 in 1Q/95 to \$3 in 1Q/99, or 17 to 1. The 64M price dropped from \$55 in 1Q/97 to \$10 in 1Q/99, or 6 to 1. DRAM makers seriously asked themselves, "to stay or not to stay in DRAM business".

In Japan, only Elpida remained as a DRAM company after the storm, but it was eventually bought by Micron.

System LSI

Paradigm Shift from Board to Chip



Thanks to the increase in the integration density, chips on board, such as CPU, DRAM, Flash memory, graphics LSI, and speech LSI, can be integrated on a chip as shown above. This is system LSI and called SoC or System Level Integration. This is the new big trend towards the future.

Backgrounds for System LSI

System Needs

- Emergence of Digital Consumer Applications
- Higher Performance / Low Cost
- Lower Power for Portability

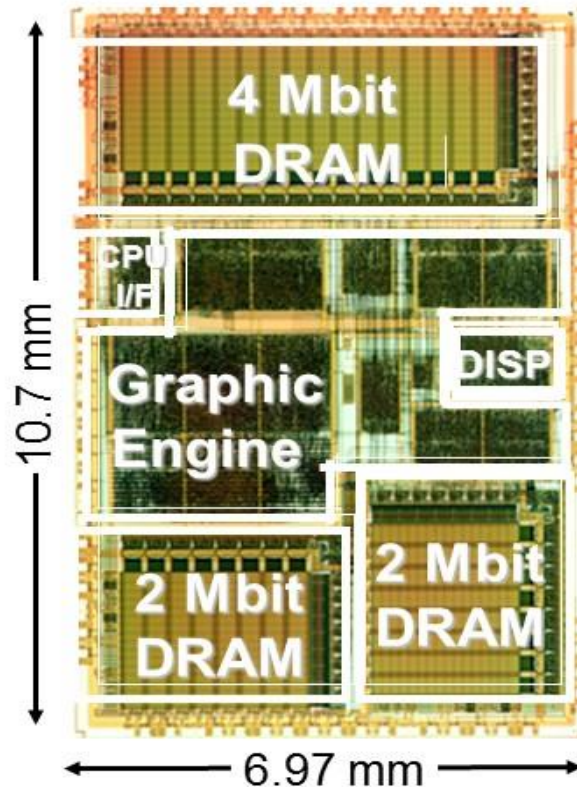
Technology Seeds

- Deep Sub-micron Process
- Millions of Gates on Chips
- IP Cores Accumulated
- Progress of EDA Tools

This shows backgrounds for System LSI from the viewpoints of both system needs and technology seeds.

Advantages of System LSI

— Case Study : 3-D Graphic Engine



- **Performance**
: 4 [48 → 192 bit bus width]
- **Power**
: 1/ 5 [2.5 → 0.5 W]
- **Chip Counts**
: 1/ 4 [4 → 1 Chip]
- **Total Pin Counts**
: 1/ 3 [318 → 100 pin]

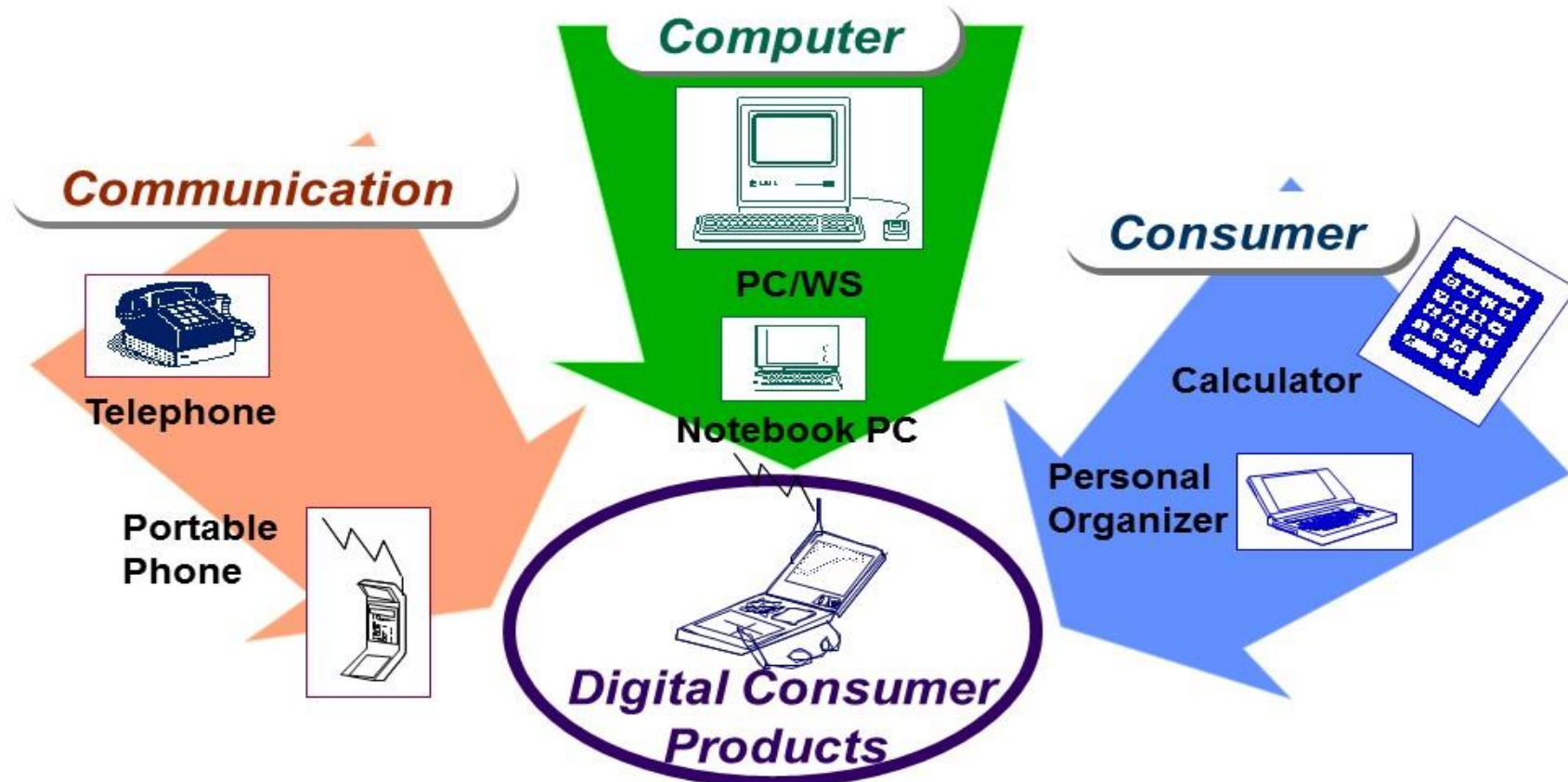
16

The chip above is an example of system LSI for 3D graphic engine. In comparison with the system on board, performance increased 4 times, while power decreased to 1/5, number of chips to 1/4, and total pin counts to 1/3. Overall effects are drastic improvement in price/performance ratio, smaller size, and longer battery life.



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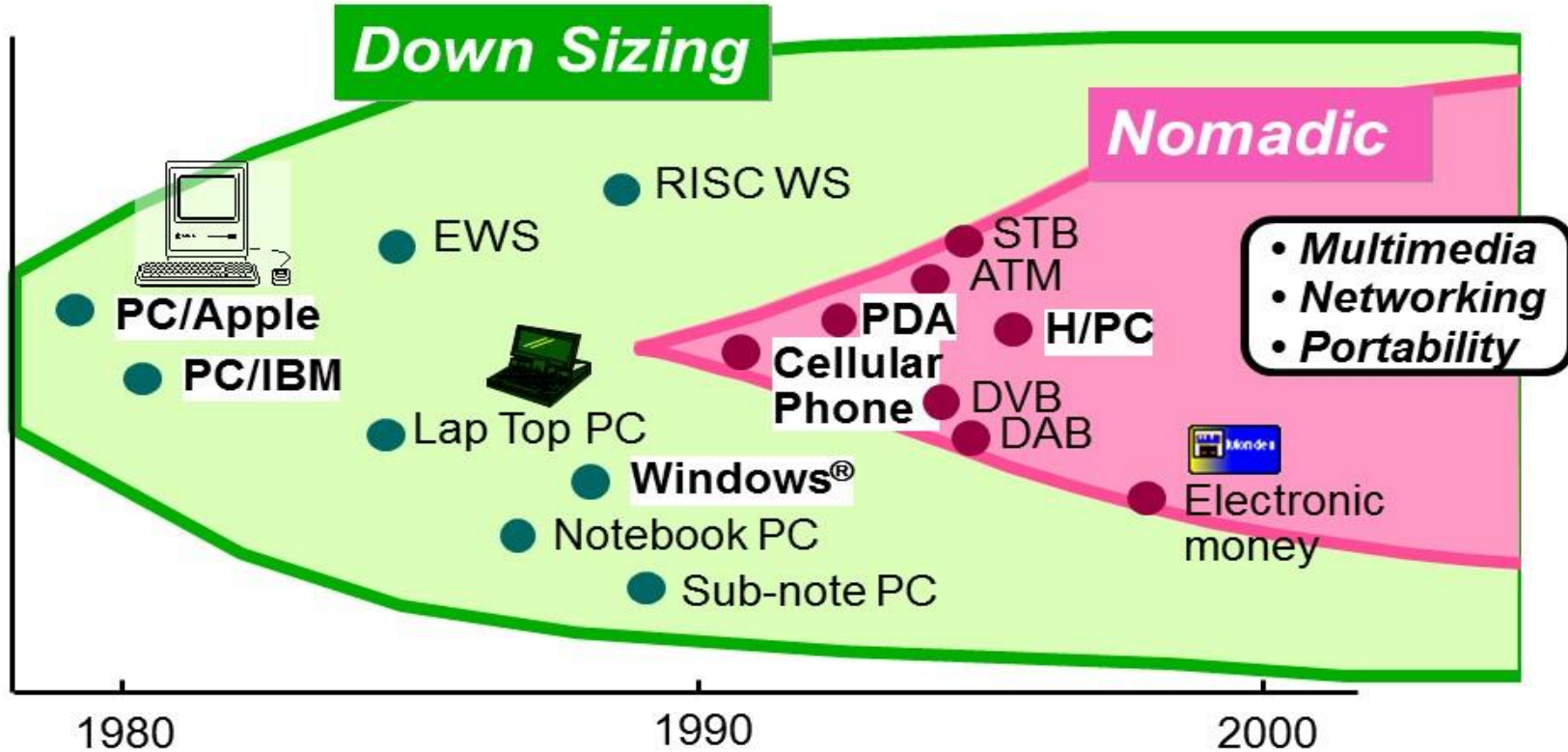
Emerging Digital Consumer Market



18

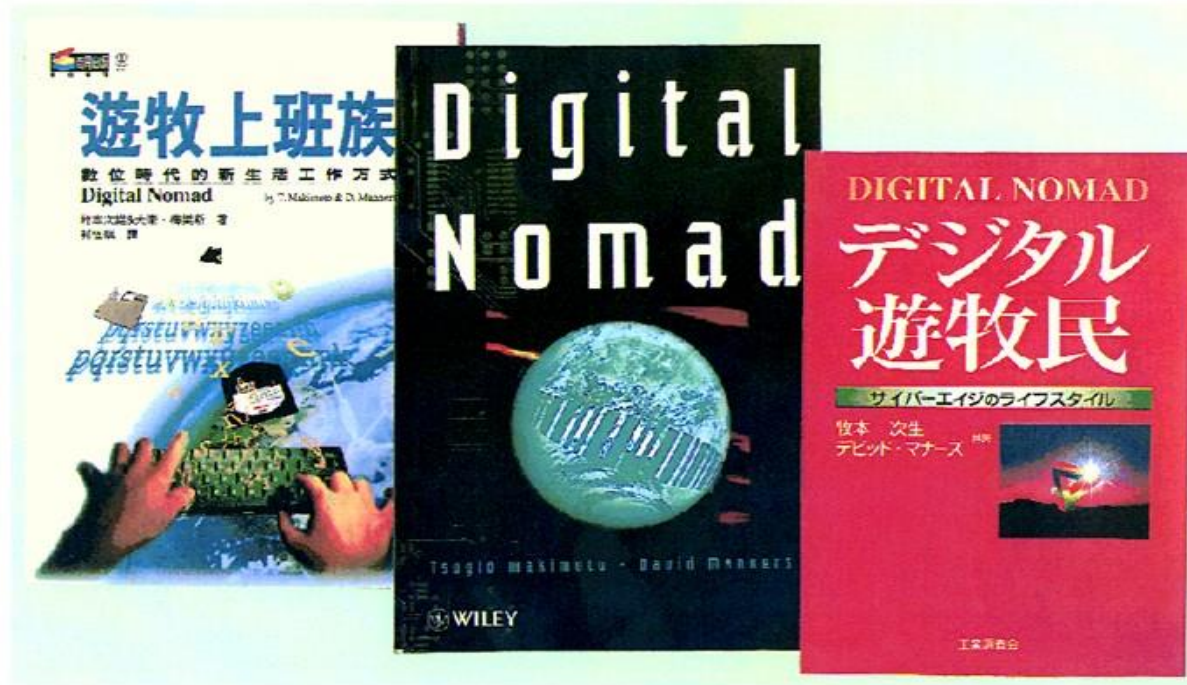
Traditional products in consumer, computer, and communication markets will gradually converge on “digital consumer products” with the progress of digital technology together with downsizing of electronic equipment. This trend will be further enhanced by the progress of semiconductor technology. Digital consumer products will become the core segment of electronics market.

Mega Trends



The figure shows the shift of megatrends; from downsizing trend created by the PC to nomadic trend created by digital consumer products. Core products of this trend are portable, intelligent terminals such as PDA and H/PC (Hand Held PC). H/PC's OS is Windows CE newly developed by Microsoft, which made a debut at Comdex 1996.

Digital Nomad



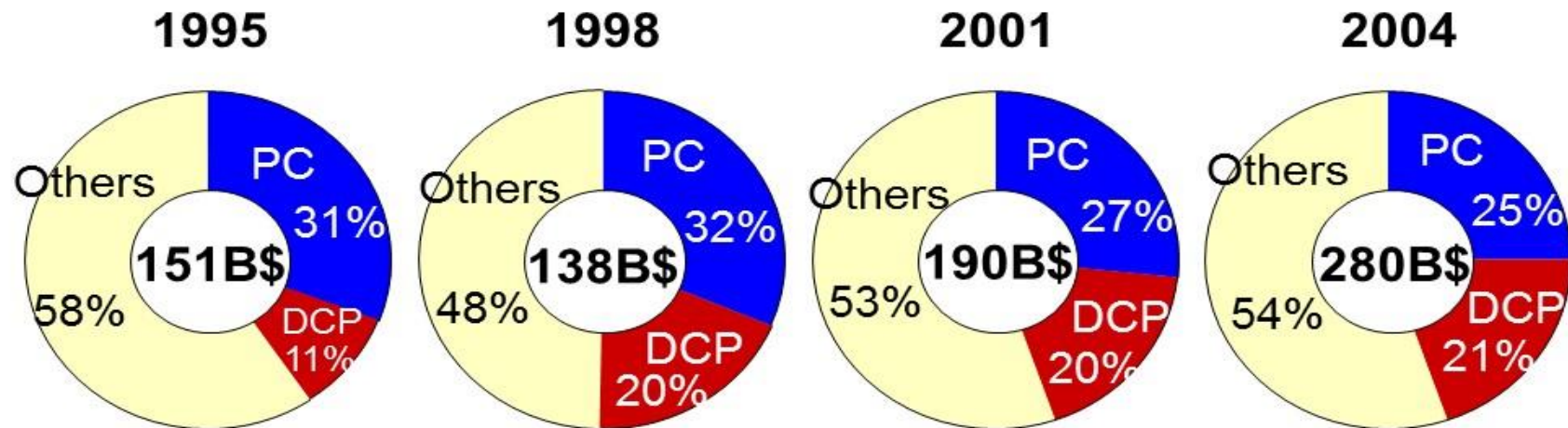
TOP-SELLING 5 IT/MANAGEMENT BOOKS IN SCOTLAND

1. On the Firing Line -Gil Amelio
"My 500 Days at Apple"
2. Digerati - John Brockman
"Encounters with the Cyber Elite"
3. Digital Nomad - Tsugio Makimoto
& David Manners
4. Unleashing the Killer App-
Larry Downes & Chunka Mui
"Digital Strategies for Market
Dominance"
5. Digital Enterprise - Key Henning
"How Digitization is Redefining
Business"

(Source: insider technology '98)

I made a first speech at In-Stat Conference in 1994 regarding the advent of the Nomadic Age. Following this speech, a book titled "Digital Nomad" was published by Makimoto and Manners in 1997. This book was once ranked the third place of top-selling IT/Management books in Scotland, as shown in the table on the right. Although various books on the subject of Digital Nomad have been published so far, our book seems to be the oldest and the most original of these kinds.

Application-wise Trends — Emerging Post PC Market —



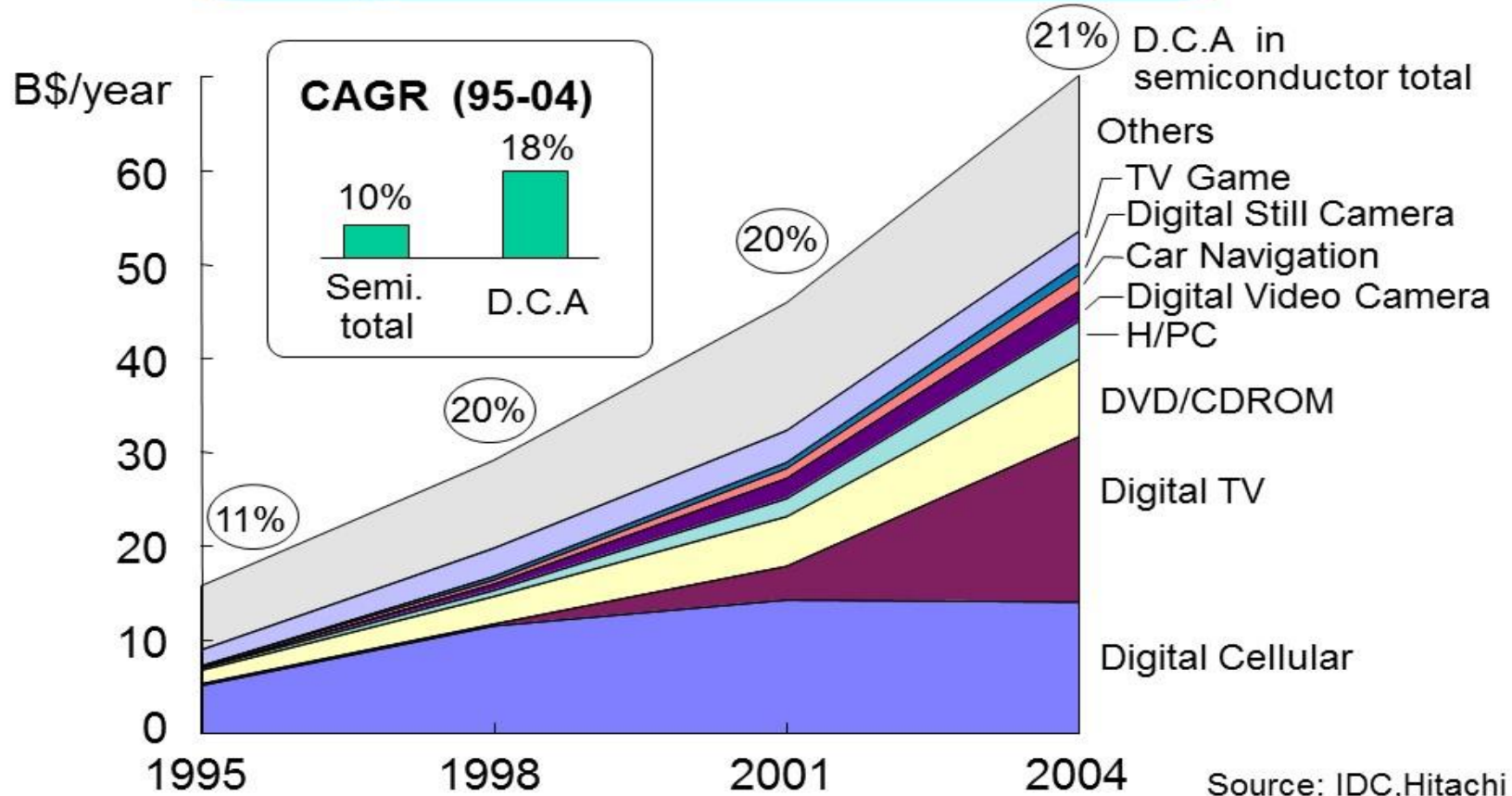
DCP: Digital Consumer Product

Source: IDC, Hitachi

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The figure shows the changing trend of application market from 1995 to 2004. Initially, the PC market was the largest segment sharing 31% in 95, but it gradually declined to 25% in 04. On the other hand, Digital Consumer Product started from 11% in 95 and increased to 21% in 04. This segment is positioned as post PC segment.

Digital Consumer Market

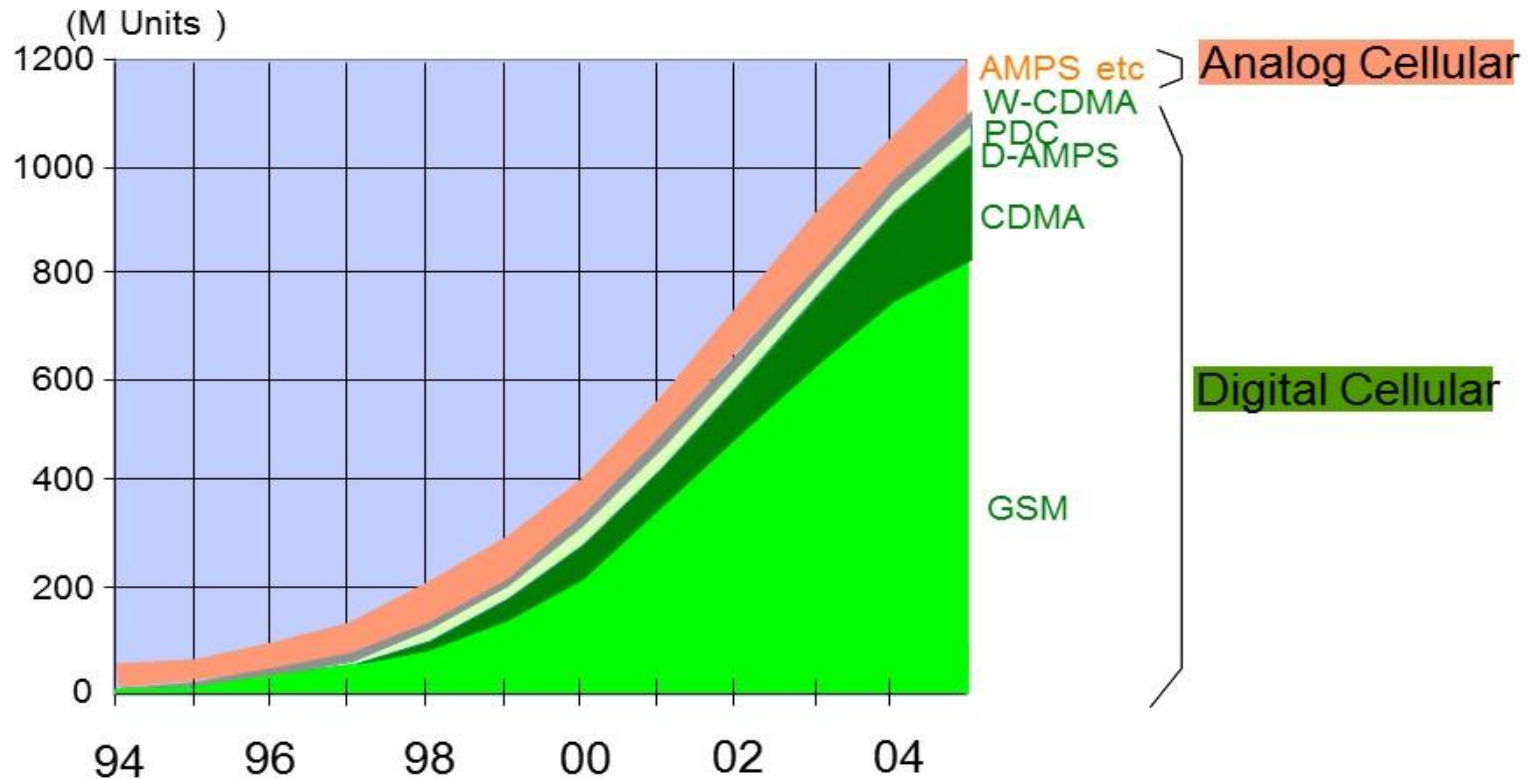


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This figure shows the trend of digital consumer products. CAGR in this period for total semiconductor market is forecasted as 10%, while CAGR for digital consumer segment is 18%. It is expected that cellphone is the core product up to 01, and digital TV will lead the trend thereafter. A variety of products are emerging like DVD, H/PC, digital video camera, digital camera, and game machine.

World-wide Cellular Subscriber Forecast

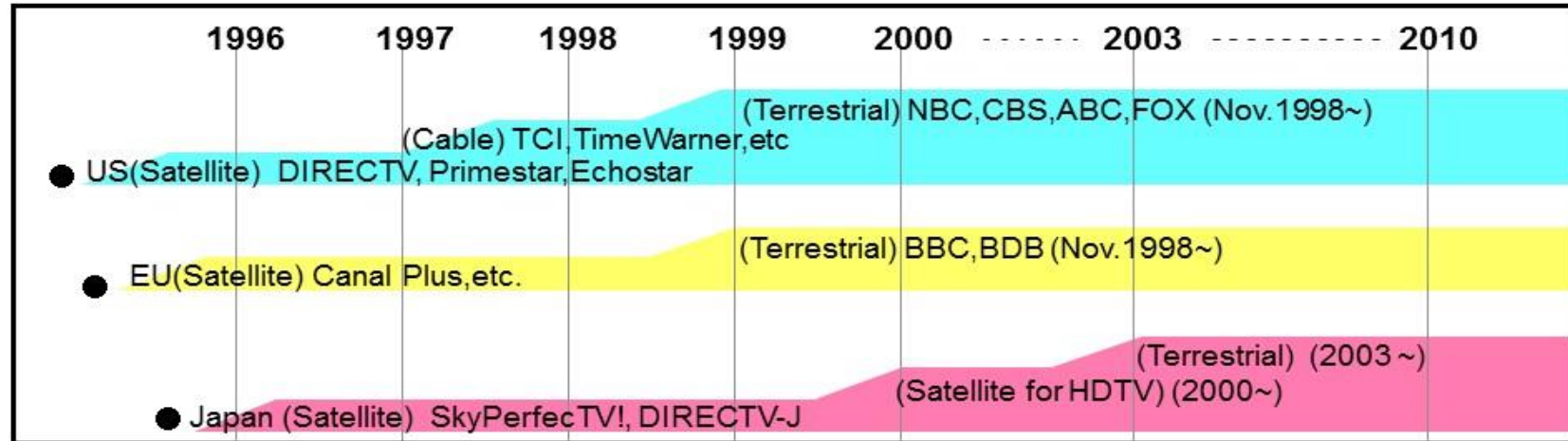
Digital Subscriber Growth By System



23

The figure shows the forecast of subscribers for 10 years from 1994. Although the Analog cellular was the largest in 1994, there will be no growth from there, and digital cellular will gain the momentum. Among various formats, GSM is the largest and expected to reach 800M subscribers in 05, followed by CDMA with 200M. PDC is a format peculiar to Japan, and is already showing a sign of "Galapagos phenomenon" at this time.

Digital Broadcasting Service Trend



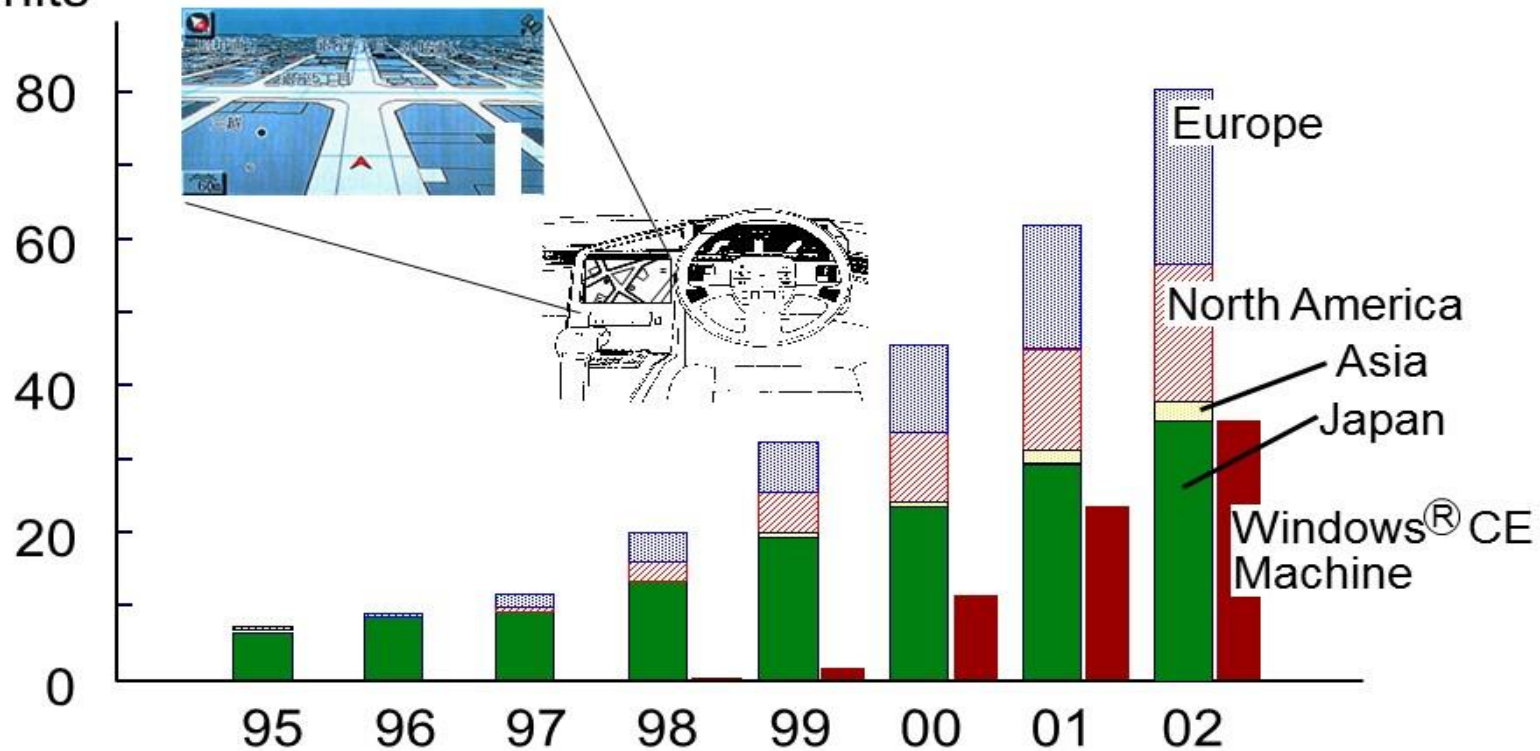
< Standardization of Format >

Aspect ratio	pixel		Frame frequency			
	Horizontal	Vertical	60P	60I	30P	24P
16:9	1920	1080		●	●	●
	1280	720	●		●	●
	704	480	●	●	●	●
4:3	704	480	●	●	●	●
	640	480	●	●	●	●

The figure shows the trend of digital broadcasting services in US, Europe, and Japan. Satellite services were already in service by 96. Terrestrial services started in 99 in US and Europe, and it is planned to start in 03 in Japan. The Table shown below summarizes standardization of pixel size and frame frequency.

Market of Car Navigation Systems

M units



25

Car navigation services started in Japan. There has been a big needs in Japan because roads are complex and addresses are not easily found: Necessity is the mother of invention. At the time of this speech, 20M systems were already in use in Japan, being majority of global market. However, it is expected that US and Europe market will grow faster. It is to be noted that Windows CE will rapidly grow as main OS of the system.

New Generation TV Game Machine

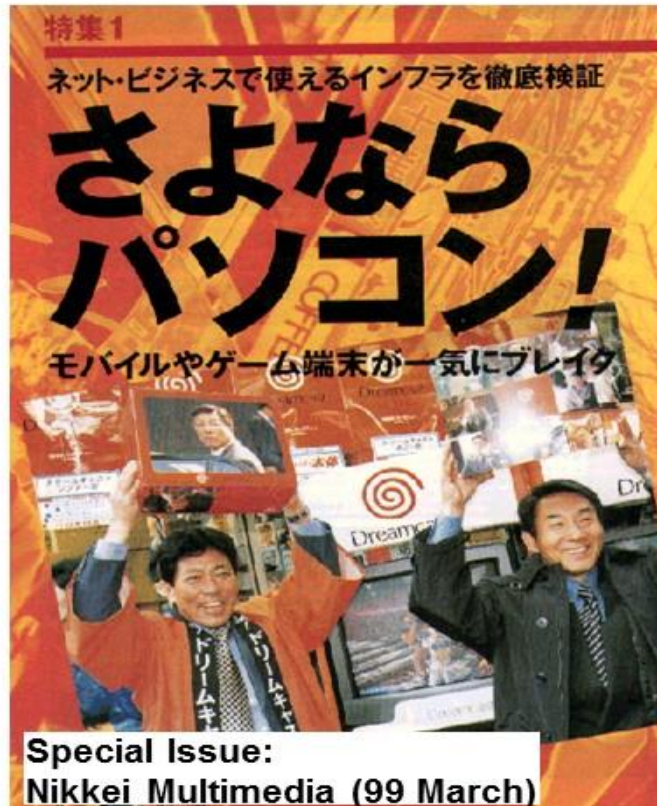
Company	Sony	SEGA	Nintendo
Game Machine	PlayStation 2™	Dreamcast™	NINTENDO64
CPU	128bit/Toshiba	128bit/Hitachi	64bit/NEC
Memory(MB)	32	16	4
Performance (k Polygons/sec)	75,000	3,000	200 (estimated)
Device	DVD/CD-ROM	CD-ROM	ROM cartridge
time of introduction	end / '99	end / '98	'96 middle
			

Source: Nikkei Shimbun, etc

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At the time of the speech, game market was mostly shared by Sony, Sega, and Nintendo of Japan. Nintendo introduced the new generation first followed by Sega and Sony. However, the latter machines had higher performance in terms of polygons/sec. Sega machine was 15 times, and Sony machine was 400 times of Nintendo machine, thanks to CPU performance and memory capacity. Sony's PlayStation made a "break", and game machine became a big semiconductor market.

Good-bye PC



Potential New Information Appliances after PC

- Internet TV
- Internet Telephone
- Internet PC
- Portable Information Terminal with wireless Function
- Portable Homepage Access Terminal
- Next Generation Portable Phone
- Wearable PC
- Next Generation TV Game
- Computer-equipped Car

Source: Nikkei Shimbun (99 March)

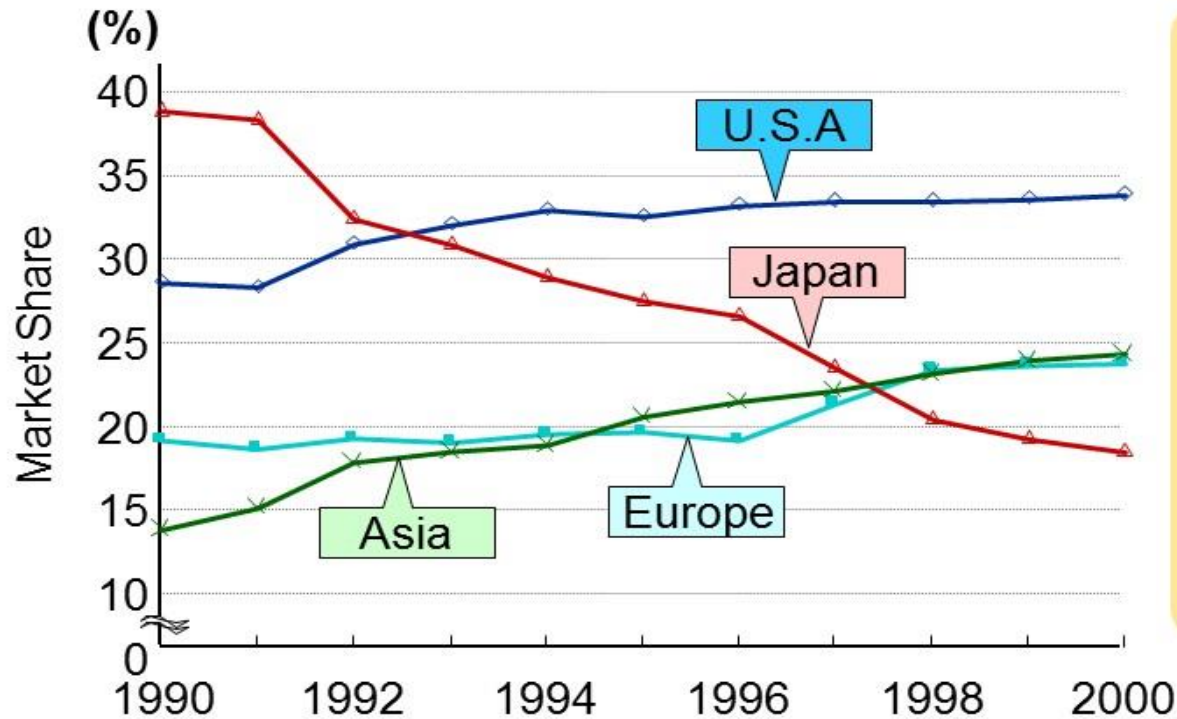
27

The figure shows the cover of Nikkei Multimedia, a special issue on the subject of "Good-bye PC". The age of the PC is over, and mobile device, game machine and so on will become new drivers of our industry. The picture was taken at the time when Sega's game machine, Dreamcast, was introduced to the market. In the table on the right are potential devices after PC. These devices have been realized in 10 years, and today they are converged on a smartphone.

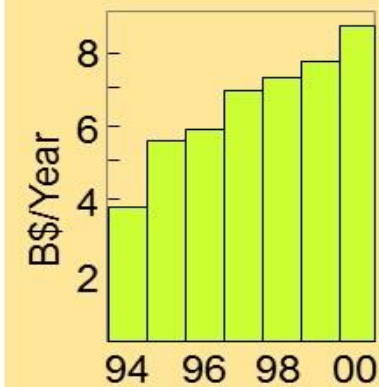


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Geographical Trends — Japanese Market Shrinks —



94-00 CAGR: 15%



Growing Chinese Market

Source: WSTS, Hitachi

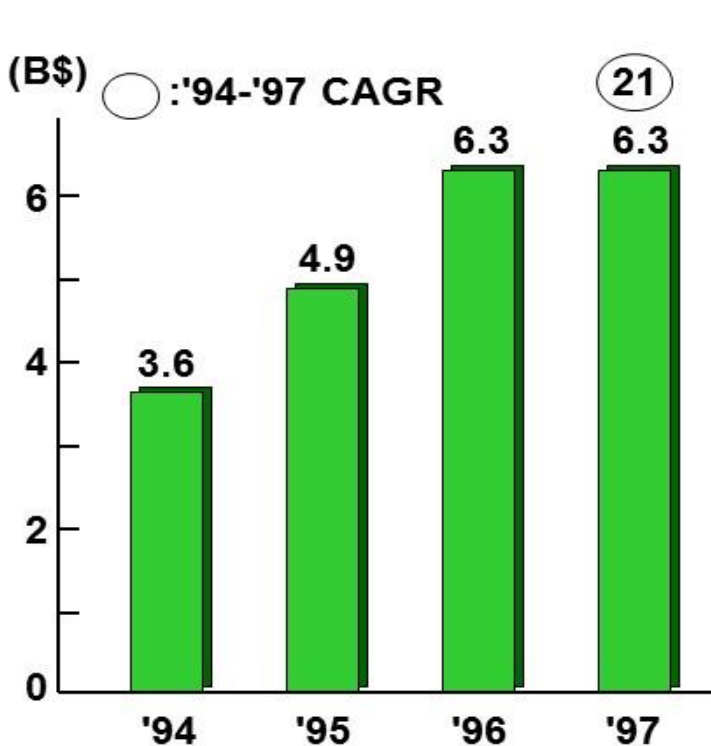
29

At the time of this speech, regional market structure was under drastic change. Especially notable was the shrink of Japanese market which accounted for nearly 40% in 1990 decreased to half in 2000, and became the smallest market. On the contrary, Asian market grew sharply with Chinese market growing 15% annually as shown in the figure on the right. This trend continued since then and Asian market became the largest in the world as of today.



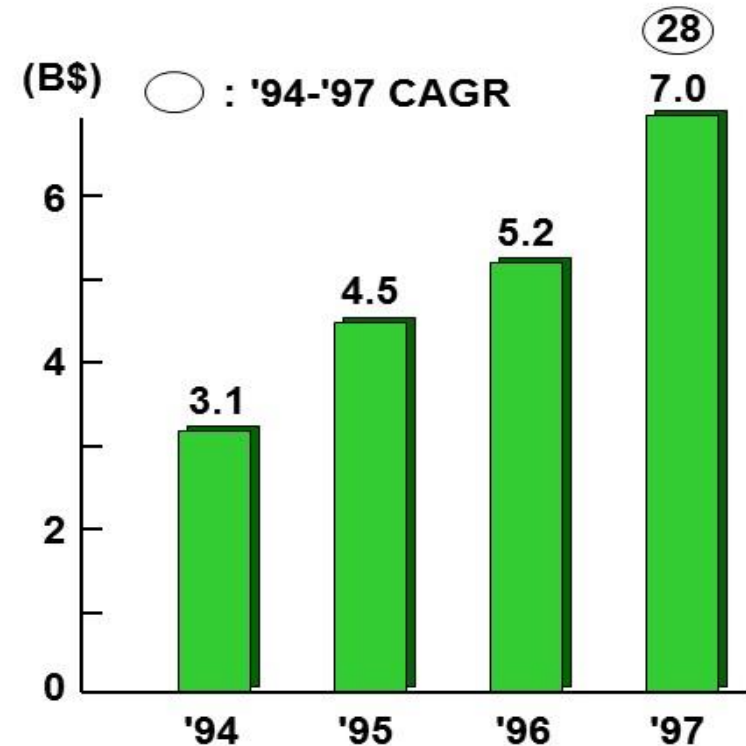
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Growth of Fabless and Foundry



Shipment of Fabless Maker

Source: FSA



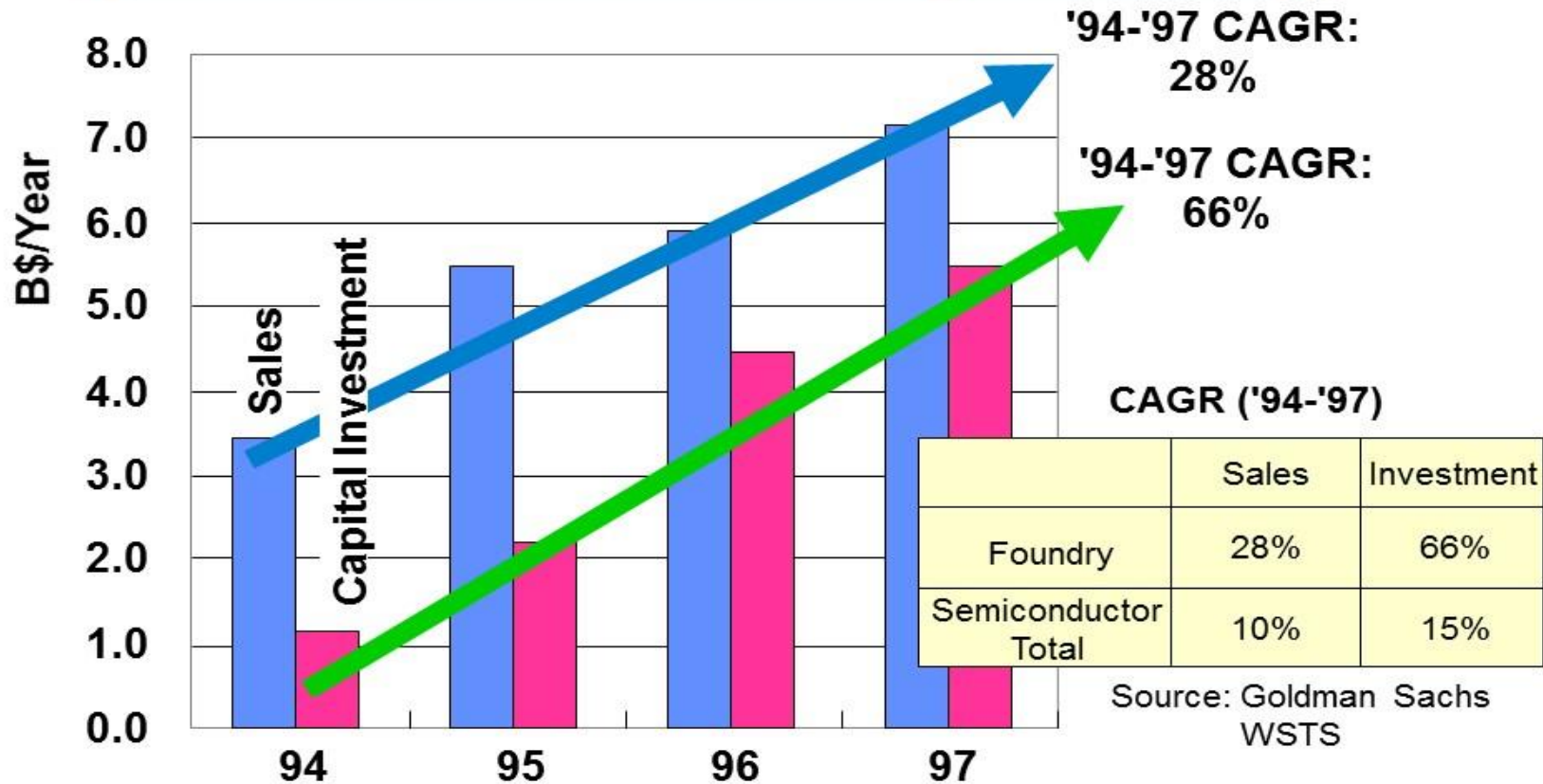
Output from Silicon Foundry

Source: Electronic Journal

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Since the mid 1990s, fabless and foundry businesses have made remarkable progress. While the CAGR of the semiconductor total was 10%, CAGRs of fabless and foundry was 21% and 28% respectively. A big change has begun in the semiconductor business model from vertical integration model to horizontal division model.

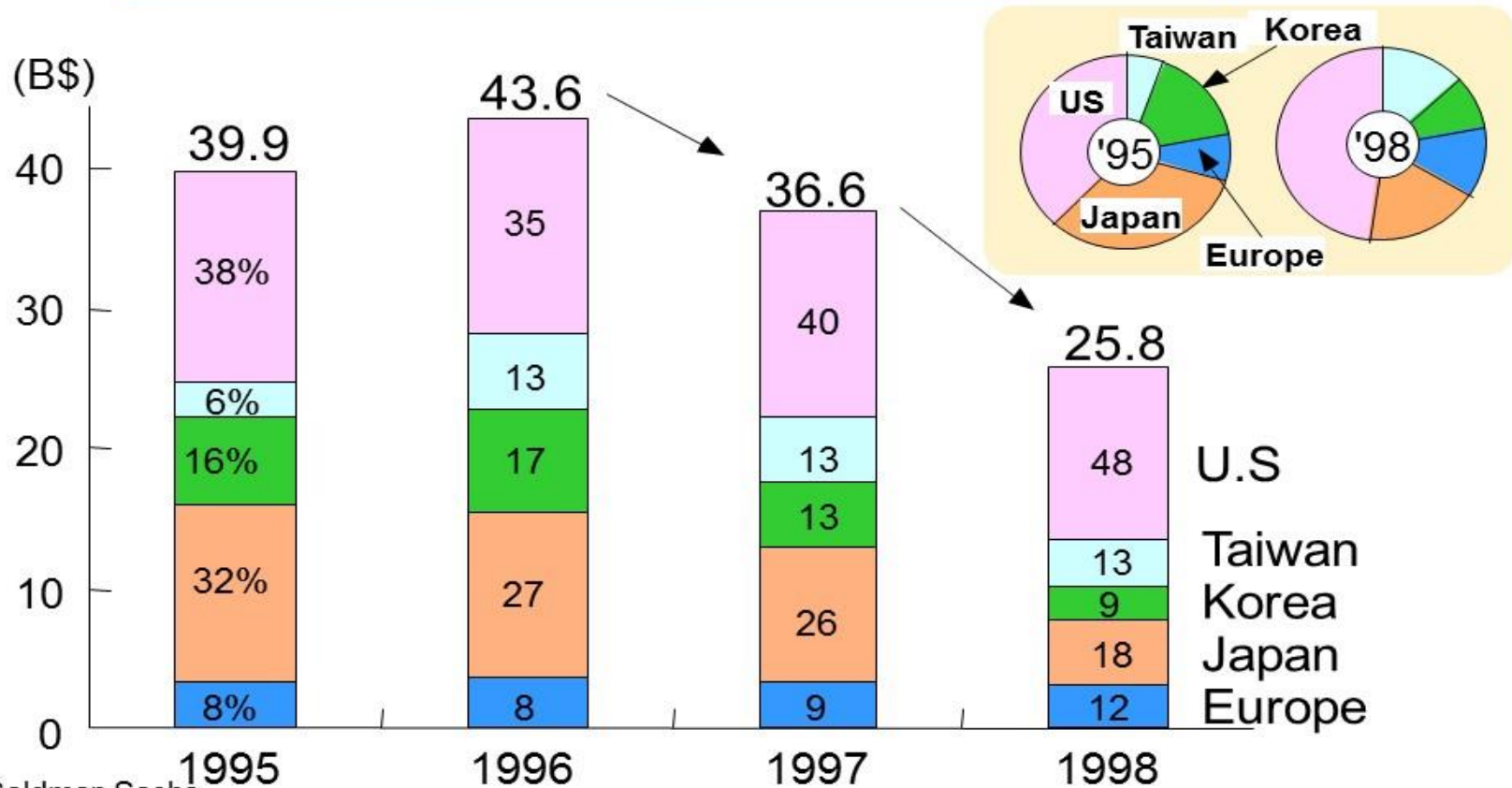
Trend of Investment by Foundry



Source: Electronic Journal, Hitachi

The figure shows the rapid progress of foundry business; CAGR of sales was 28% from 94 to 97 while CAGR of investment for the same period was 66% which indicates the strong willingness for investment. In 1997, sales was 7B\$ and the Investment was 5.5B\$. In the same period of 94 to 97, CAGRs of sales and investment of semiconductor total were 10% and 15% respectively.

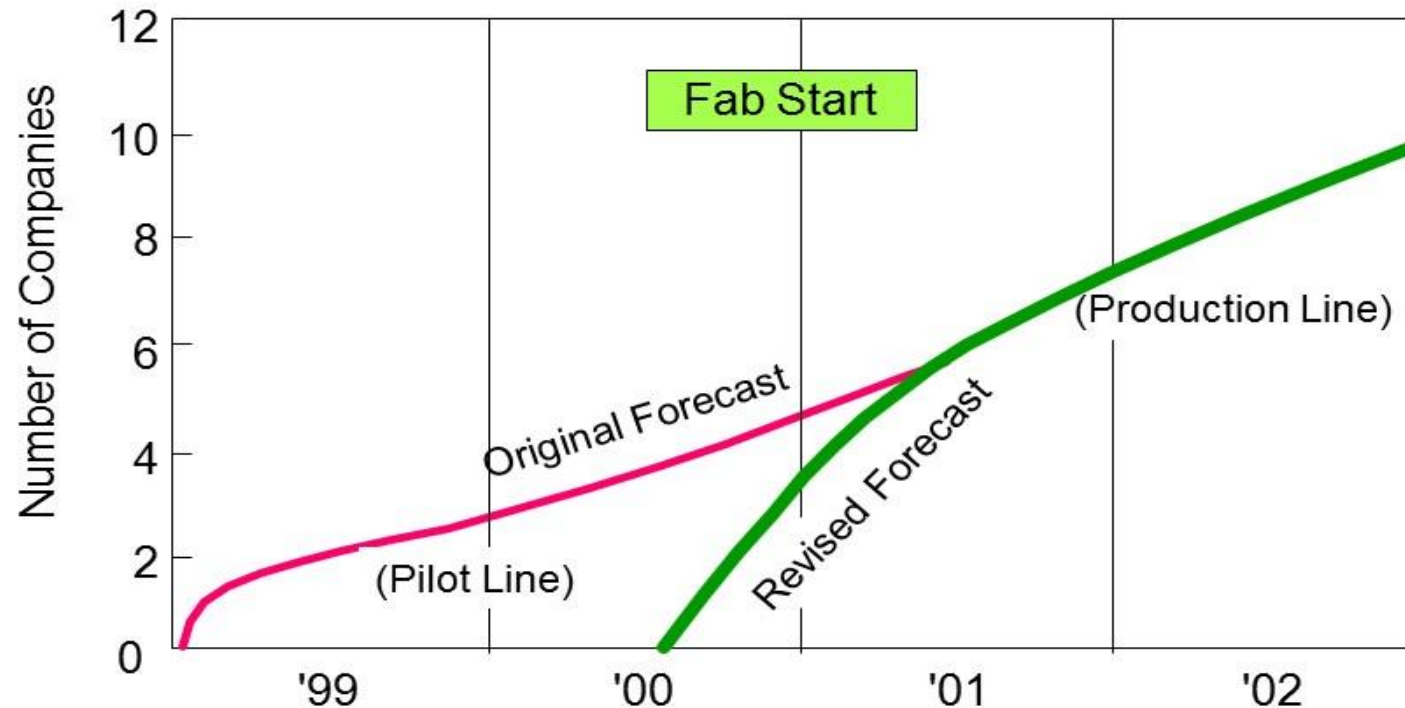
Capital Investment Trend



Source: Goldman Sachs

The bar graph shows the trend of investment from 95 to 98. Although the investment slightly increased from 95 to 96, it was followed by the drastic decrease afterwards. Two pie charts at top right show regional percentage of investment for 95 and 98. It is noted that Japan and Korea, DRAM centric countries, decreased the percentage, while US (Miro & Logic centric) and Taiwan (Foundry centric) increased the percentage.

When will 300-mm Fab Start?

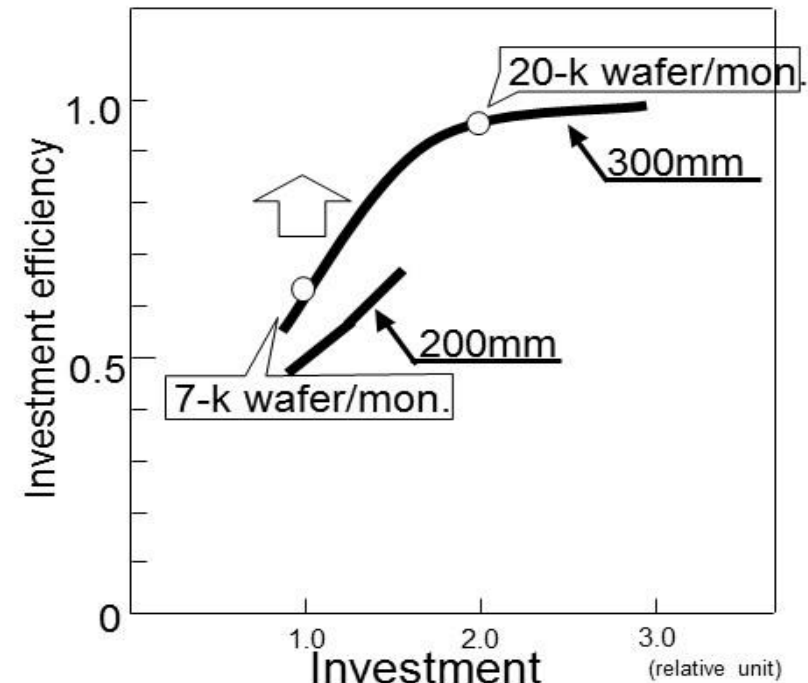
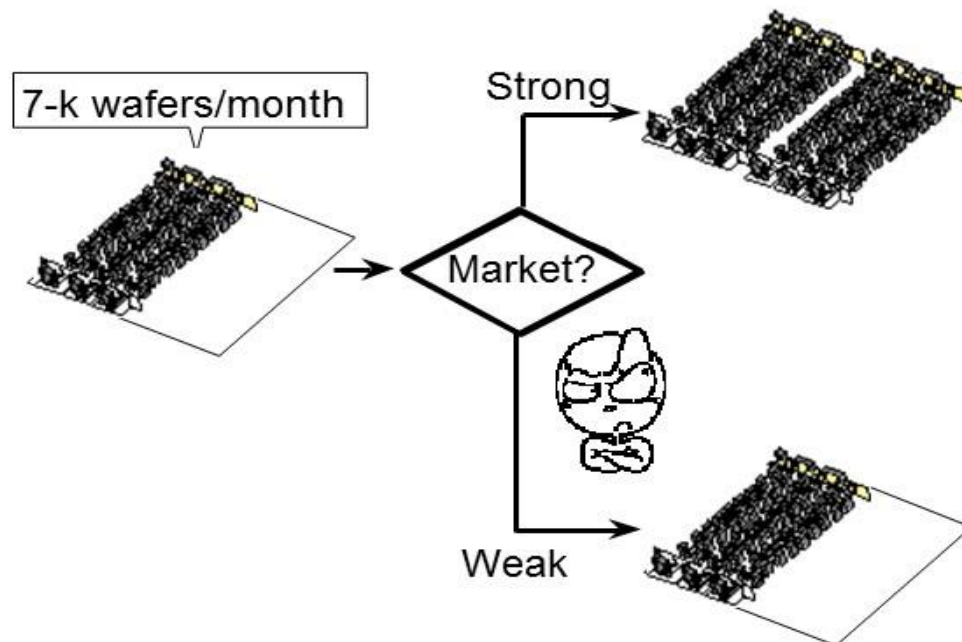


Source: Selete

34

The figure shows a forecast of number of companies which will start 300mm fab. Up to now, it was expected that pilot production would start from early 1999, but the current forecast, at the time of this speech, is that it will start from the mid 2000.

Flexible Fab



Condition:
 Product: 256M DRAM
 300/200-mm wafer area ratio: 2.35

35

A flexible fab is an idea which copes with the lesson that semiconductor market is unpredictable. The fab is designed to increase its capacity in the incremental step of 7K wafers per month instead of starting full operation of 20K wafers from the beginning. The capacity will be added in accordance with the market demand. The investment efficiency is lower than the case of full operation of 300mm fab, but it is higher than the case of 200mm fab.



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Emerging Post Silicon Valleys

BUSINESS

Across America and around the world, hot spots are challenging Silicon Valley.

Where to find the new jobs, the new wealth and the sheer fun of the Information Age today. **BY STEVEN LEVY**

The Hot New Tech Cities

- Austin, Texas
- Salt Lake City, Utah
- Bangalore, India
- Seattle, Washington
- Boston, Massachusetts
- Singapore
- Cambridge, England
- Sophie-Antipolis, France
- Helsinki, Finland
- Tel Aviv, Israel

► **Attracting Talent**

Jennifer Bealford opened a...
Coffees inside in Tower of Babel,
Wino, with its easy being and
room for young residents to rise.

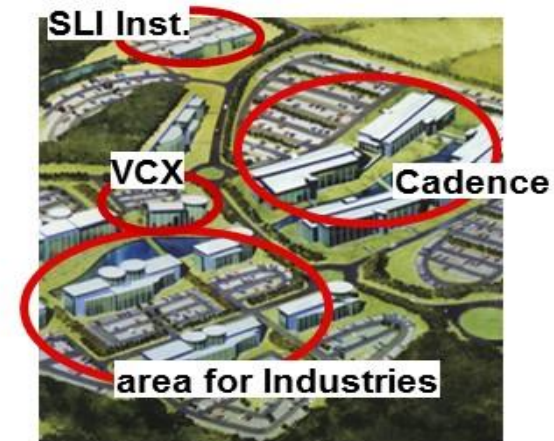
CAN ANY PLACE EVER HOPE to match the awesome success of Silicon Valley? To answer the question, venture capitalist Joe Schoendorf leads a visitor to the roof of 418 University Avenue in Palo Al...

U.S	E.U	Asia
<ul style="list-style-type: none"> • Austin • Boston • Seattle etc. 	<ul style="list-style-type: none"> • Cambridge • Helsinki • Tel Aviv etc. 	<ul style="list-style-type: none"> • Singapore • Bangalore • Hsinchu

Post Silicon Valleys are emerging around the world targeting to become high-tech centers. This is the new movement in search of employment and wealth which are created in the information age. New high-tech cities in US, Europe, and Asia are shown in the table above.

System LSI Design Base / ALBA Center

- Joint project of Government, Universities and Private Companies
 - 150M\$ support from UK and Scottish Government
- Project Details
 - System LSI Institute.
 - VCX: organization of IP exchange
 - Design service of IP and system LSI
 - Create 5000 designing Jobs in 5 years
- Education
 - Change of Curriculum at Universities
 - Offering MS-level course for System LSI design



400 km² (98 Acers)

38

This is an example of high-tech city Livingstone in Scotland targeting to become post-silicon valley. A joint project among industry, government, and universities is going on with the support of 150M\$ from Scottish government. Increase of 5000 employment is expected by System LSI institute, IP exchange, and design service, etc. MS-level course for system LSI design is offered jointly by regional universities.

Synchrotron in Singapore



- Synchrotron :Helios 2 (Oxford Instruments)
- 20 X-Ray Beams:
10 for Academic use
10 for Industrial use
- Building:
50 m: diameter
9 m: height

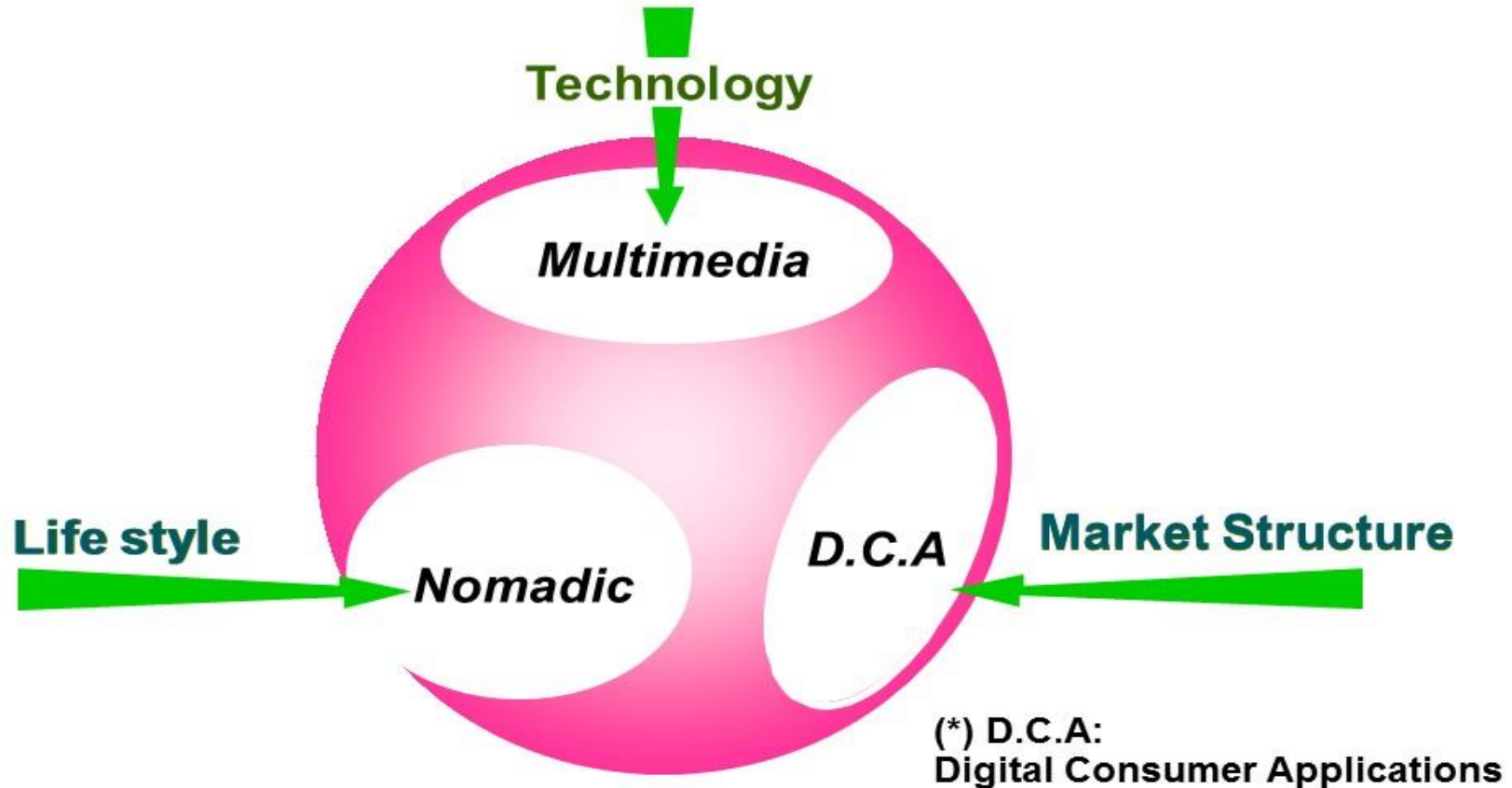
39

Singapore is another example of post silicon valley. Its symbolic project is a synchrotron which is being built to support research and industrial activities. Helios 2 of Oxford Instruments is equipped with 20 X-ray beams; 10 for research and 10 for industry. The building under construction is 50m around, and 9m high.



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- **New Scenery 1: Shift in Product Segment**
- **New Scenery 2: Shift in Market Structure**
- **New Scenery 3: Shift in Geographical Market**
- **New Scenery 4: Shift in Manufacturing Fields**
- **Emerging Post Silicon Valleys**
- **Future Outlook**

Vision of the Future



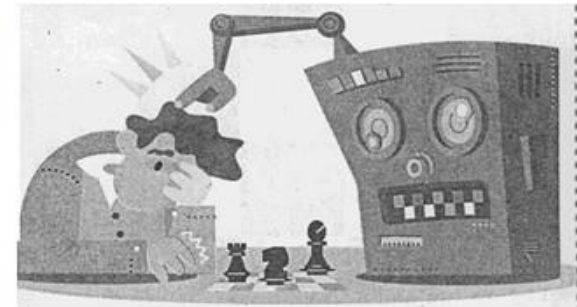
41

This shows a future trend of electronics seen from three angles. In terms of technology, digitalization of information or “multimedia” will spread. Digital consumer applications will surely form important market segment. Portability of information terminal will create nomadic life style, and people are likely to be freed from the constraint of time and location.

Computer vs. Human

When will computer intelligence win the human intelligence?

	Current Winner	Year of Computer winning
★ Checker	Computer	1994
★ Othello	Computer	1997
★ Chess	Computer	1997
★ Shogi	Human	2020?
★ Go	Human	2050?



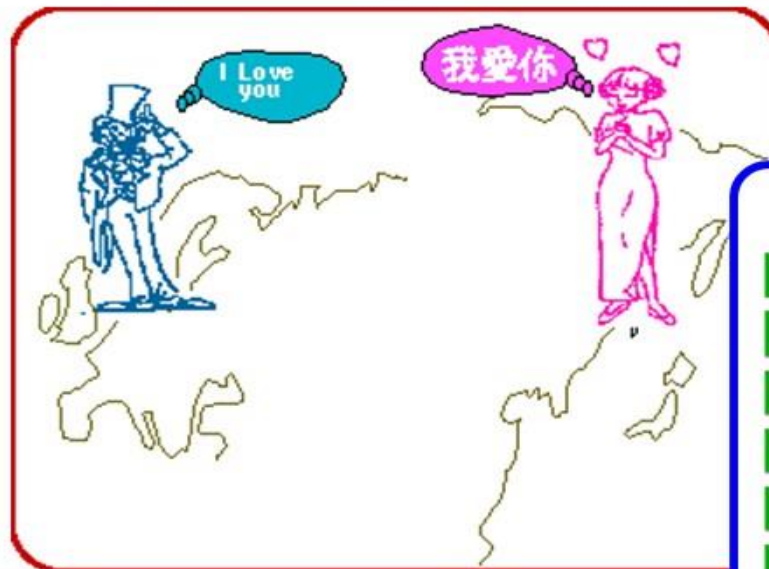
Source: '98.5.17 Asahi Shimbun

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The table shows the competition between computer and human intelligence for various games. At the time of this speech, computer has already become the winner for Checker, Othello, and Chess. As of today, forecast for Shogi and Go proved to be big mistakes, since computer already became winner in 2013 for Shogi, and in 2016 for Go. AI has made much faster progress than was expected, and "Singularity" will come in 2045.

Challenging the Language Barrier

New business potential is opening.



SPEECH TECHNOLOGY IS THE NEXT BIG THING WILL IT PUT A PC IN EVERY HOME?

LET'S TALK!

...off line at each T.J. Watson Research Center in Hawthorne, N.Y., and the excitement is palpable. Since the 1960s, scientists here have been struggling—Henry Higgins-like—to get computers to talk with humans. Several powerful programs recognize what people say with 90% accuracy. Unfortunately, not one has made it to market with a jury of consumers. One notable exception is the program developed by the late Dr. William S. Gray. It transforms spoken sentences into text on a screen and lets users open up a word processing program by voice command. But at Watson, no one seems content with this feat. Instead, scientists are scrambling to perfect the next generation of speech technology, which will

color, cylinders, and tape systems on a wall-size display merely by gesturing and speaking to the screen. With these prototypes, IBM is taking a giant step toward a long-cherished ideal of computer scientists and will less the world over: machines that understand "natural language"—meaning sentences as people actually speak them, unconstrained by special vocabu-

Special Report

lary or context. Computers have been listening to humans and transcribing what they say for years. Since the 1960s, a host of startups, including Karnewell Applied Intelligence and Dragon Systems Inc., have sold spe-

Special Report Business Week / Feb 23, 1998

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This is cited from Special Report of Business Week (Feb. 23, 1998) on "Let's Talk". It was emphasized that "speech technology is the next big thing". An expectation was that language barrier would be overcome thanks to portable electronic interpreters. Although such a time is surely approaching but still it is an unfinished dream as of today. A lot of efforts are being put in this technology in the preparation for the Tokyo Olympic Games in 2020.