

*Transformation of Semiconductor R&D*

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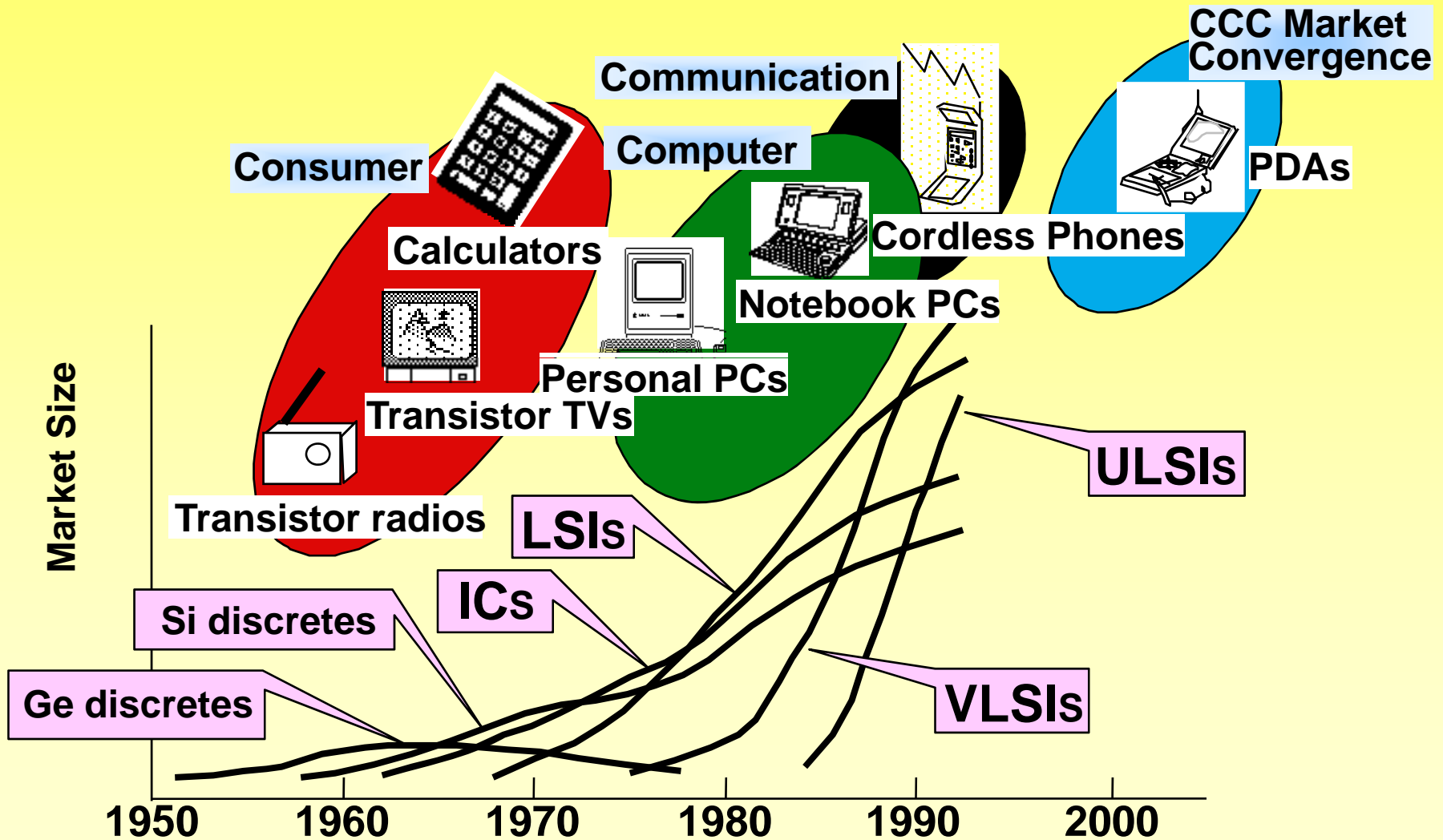
# OUTLINE

1. Semiconductor Industry – History , Technology , and Market
2. Industry Vicissitude – Historical Perspective of Semiconductor Industry
3. Transformation of Semiconductor Industry
4. Transformation of Semiconductor R&D
5. A Measure of R&D Effectiveness
6. R&D History at Hitachi CRL

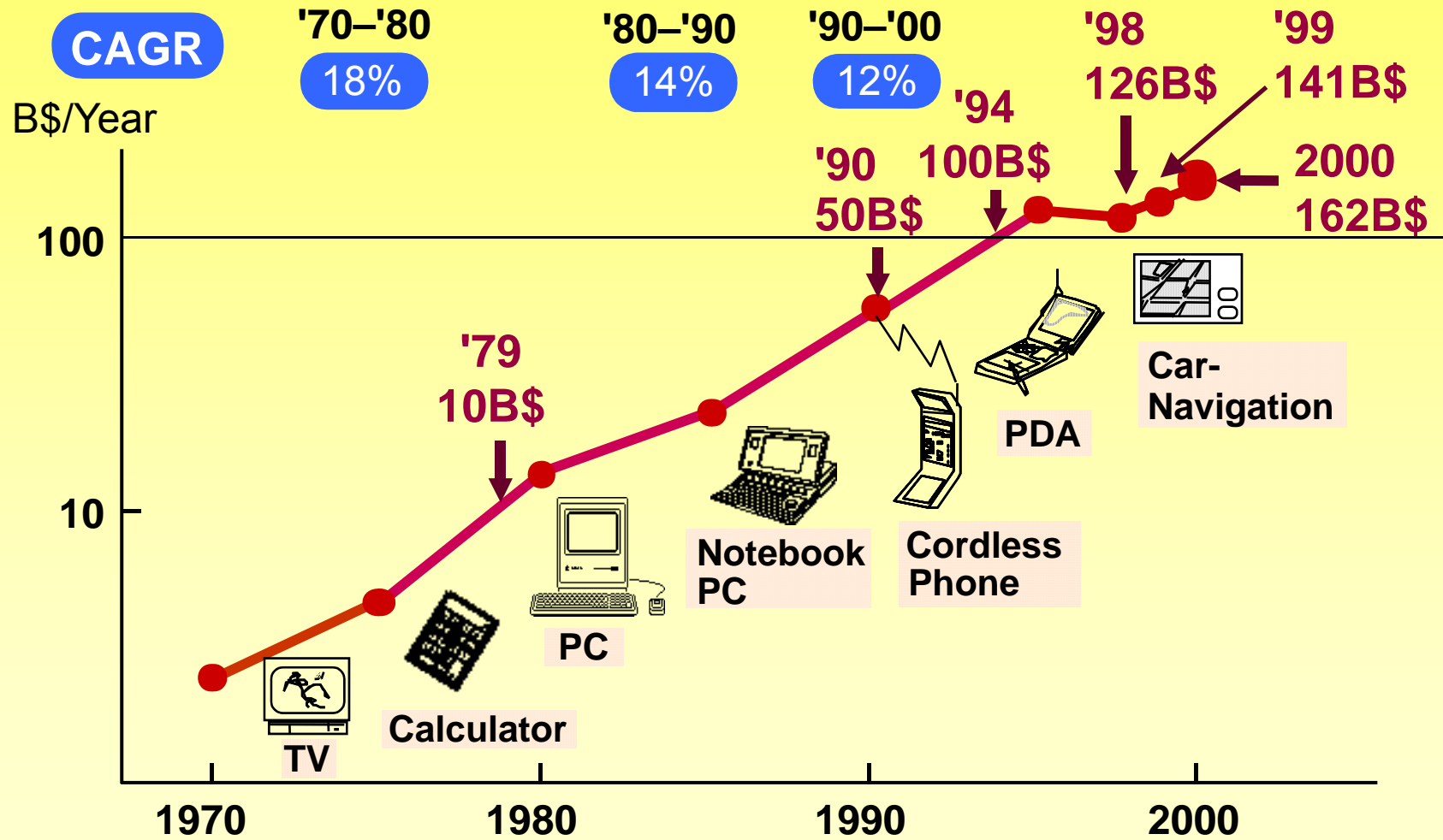
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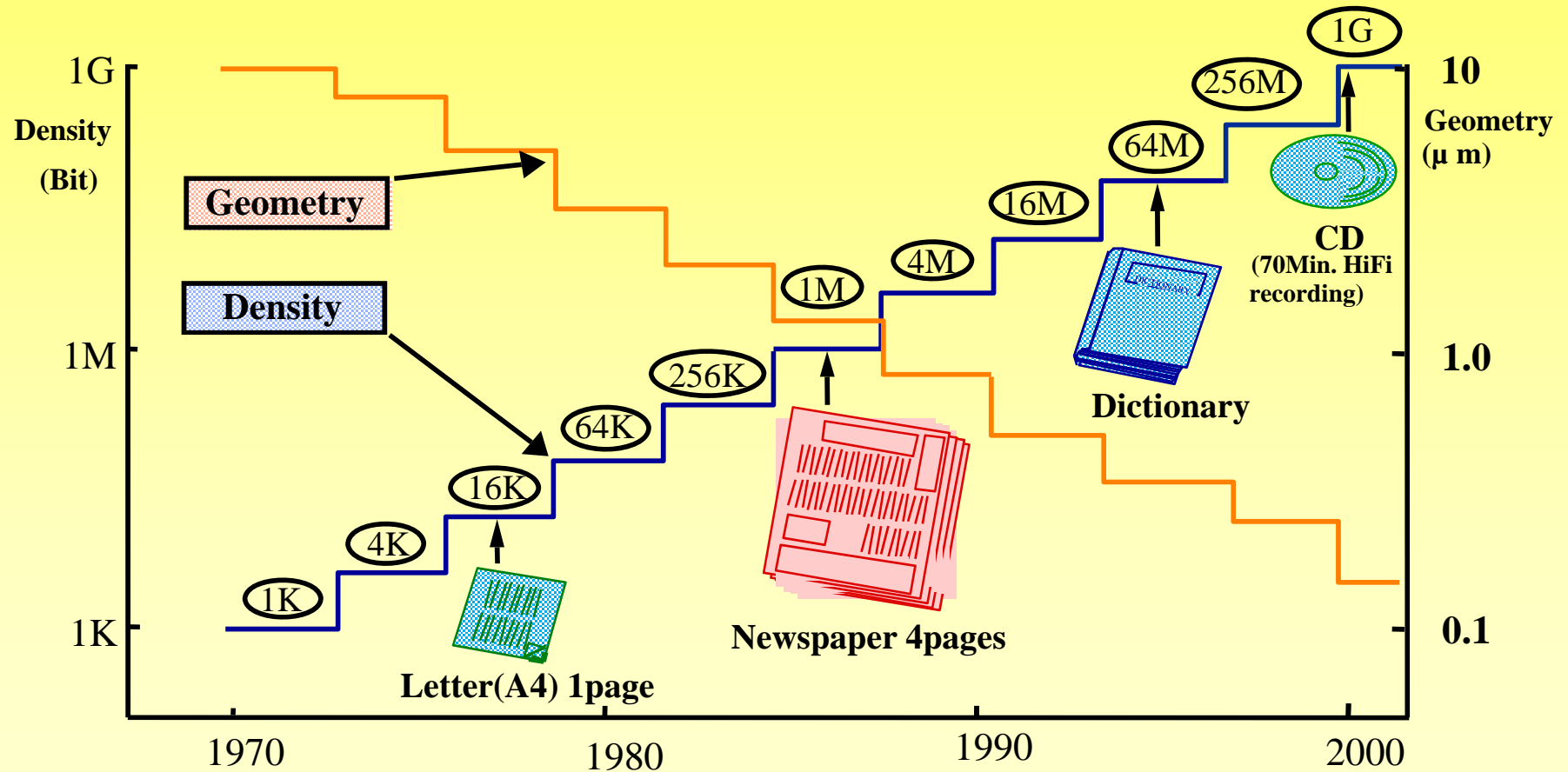
# The History



# The Market



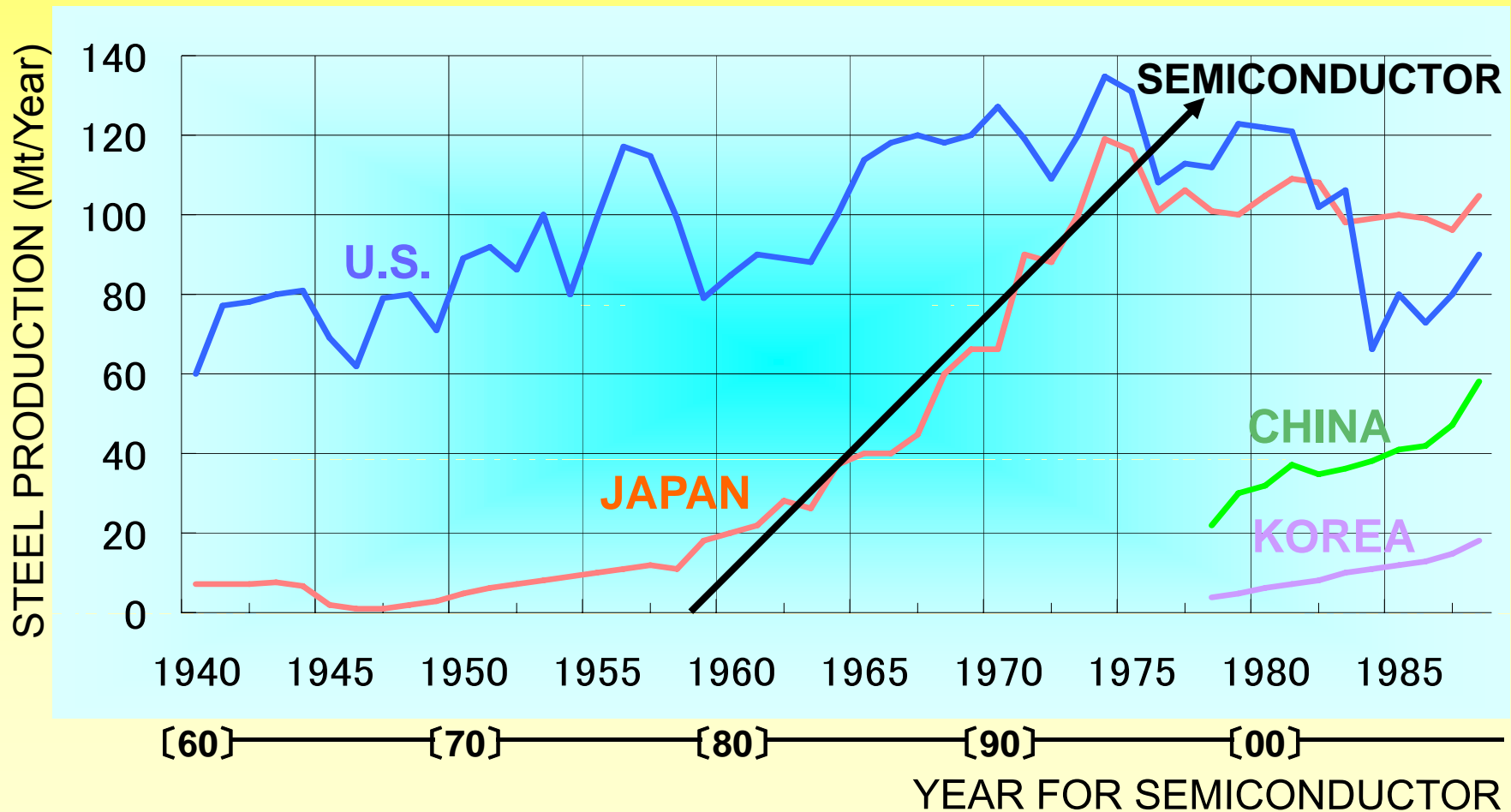
# The Technology



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# Semiconductor Market Compared to Steel Production





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# Semiconductor Industry Trend

	'70	'80	'90	'00
	10B\$	40B\$	150B\$	
Market	Develop	Grow	Mega Competition	Oligopoly
Infra-Structure (Equipment)	Scarce	Develop	Grow	Mega Competition
Application	Mainframe	PC	Communication Digital Consumer	
ASP(\$)	$10^6 \sim 10^5$	$10^4 \sim 10^3$	$10^4 \sim 10^3$	
Business Style	IDM	IDM	IDM, Fabless, Foundry	
R&D	CRL	CRL	?	
	Government-University-Industry Partnership		<i>To be discussed today!</i>	

# Market Trend

## Market Characteristics

1. Disappearance of Performance Oriented Segments  
(Mainframe Computer,...)

2. Downsizing  
(PC, HPA,...)

3. Multimedia Processing  
(Image, Voice)

## Effects on R&D

Density → Price per Bit

System-On-Chip  
Low Energy Architecture

CPU → DSP  
High Bandwidth  
(SDRAM, R-DRAM)

# Business Trend

## Business Characteristics

1. Huge Investment
2. Decrease of ROI
3. Silicon Cycle
4. New Market Entry  
by Specialization

## Effects on R&D

- Manufacturing System  
becomes Focus of study
- Alliance, Consortium
- Product Portfolio  
→ Segment Specialization  
(System Solution)
- Synergistic Technology  
as a new leverage

# Technology-Process and Device Technology R&D Direction

## 1. Commoditization of Process Technology

● Precompetitive Domain

● Consortium

● Technology for Differentiation

● New Materials

● Phase-Shift, OPC

2. Uncertainty of Post  
Optical Lithography

Semiconductor -Society-wide  
Cooperation for NGL

3. Low Cost Manufacturing

Large Diameter Wafer  
Processing

# Technology-Continued

## 4. Technology Maturity

- Acceleration of Miniaturization
- Multi-Value Storage and Logic
- Module Level Integration

Contributing factors for 4—times DRAM density increase in the '80s.

• Miniaturization	×	2.2
• Memory Cell Improvement	×	1.2
• Circuit Improvement	×	1.1
• Chip Size Increase	×	1.4

## 5. Nanometer Processing (Oxide Thickness < 3nm, Now!)

Atomic Layer Manipulation  
Selective Growth  
(Etching - free Process)

## 6. War with Invisible Defects

Molecular / Atomic Level Physics  
and Analysis

## 7. Wiring Material Limit (Cu)

Optoelectronics

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# R&D-Past, Present, and Future

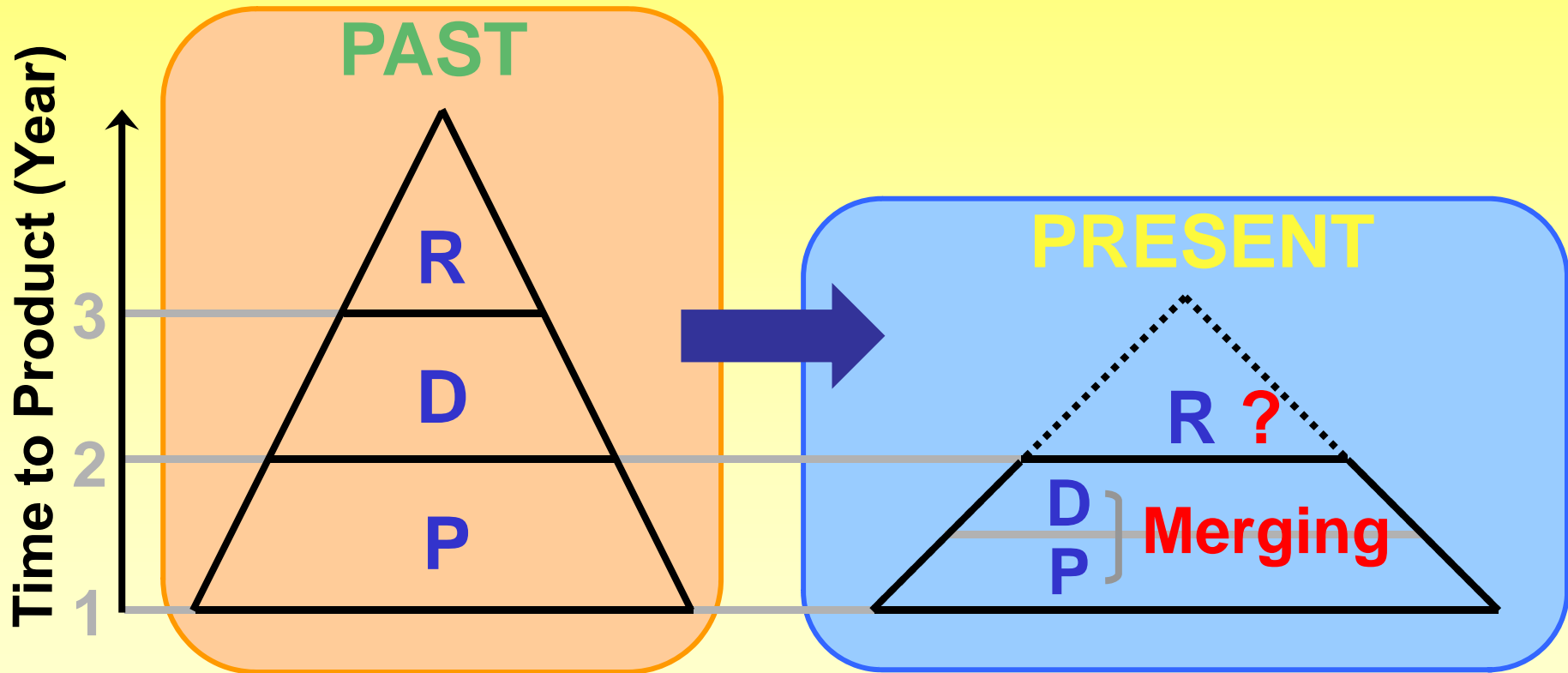
**Past:** Research(R), Development(D), and Production(P) were thought to be different, and separately conducted.

**Present:** Research Centers has been broken apart, and the distinction between D and P has been vanishing.

**Future:** How should we organize these three functions?



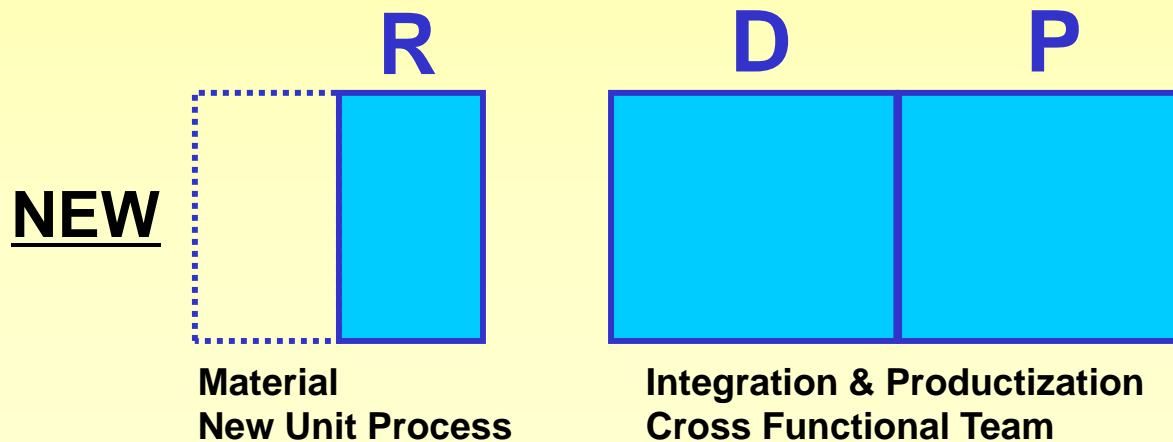
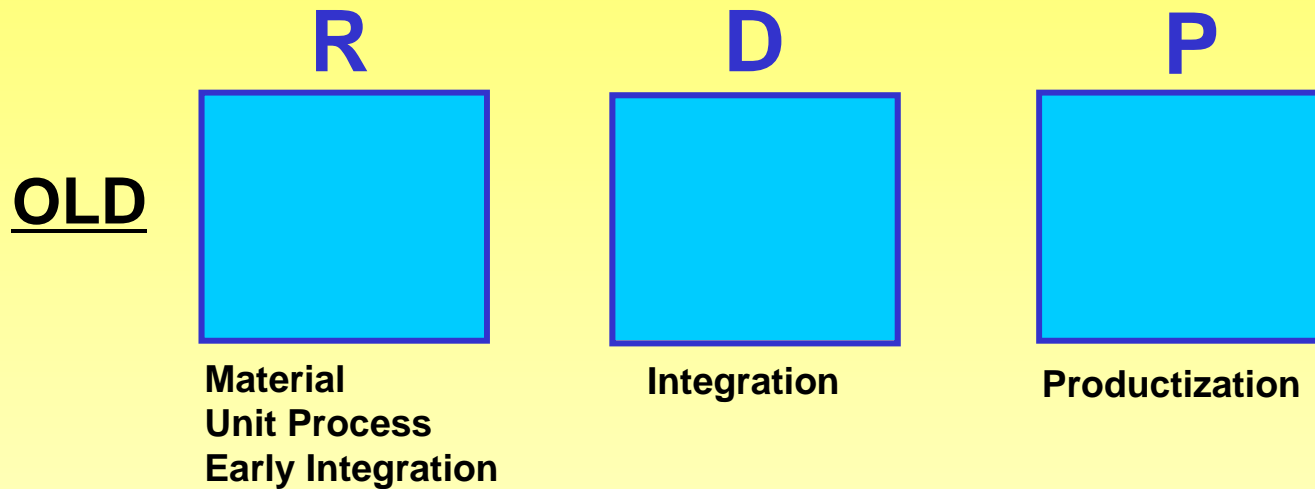
# Transformation of R&D, and Production Relationship



R: Research, D: Development, P: Production

# Technology Transfer Methodology

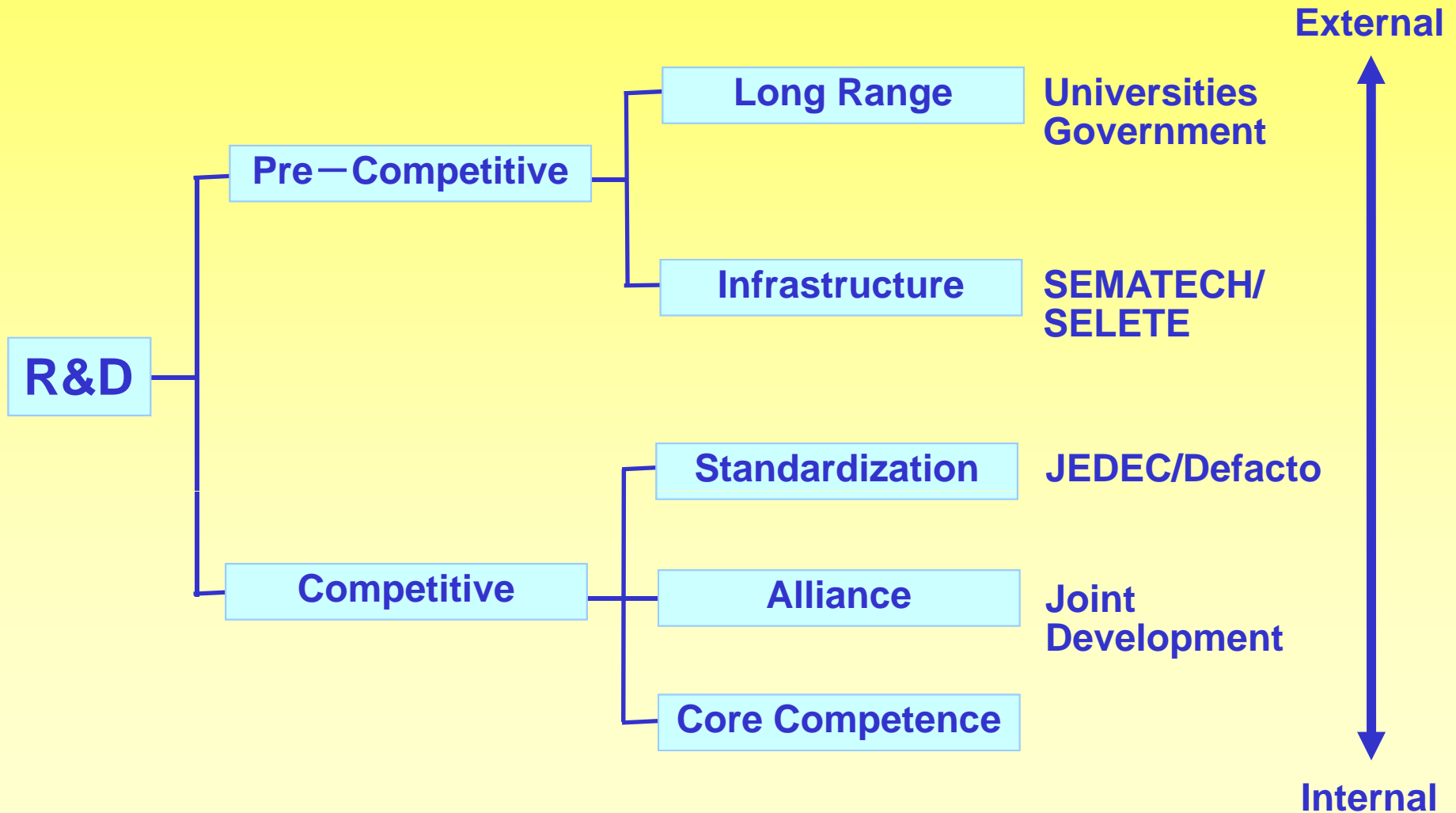
## In Hitachi



### Issues

- Weakened Long-Range Research
- Development Cost Reduction
- Methodology for Managing Large Cross Functional Team

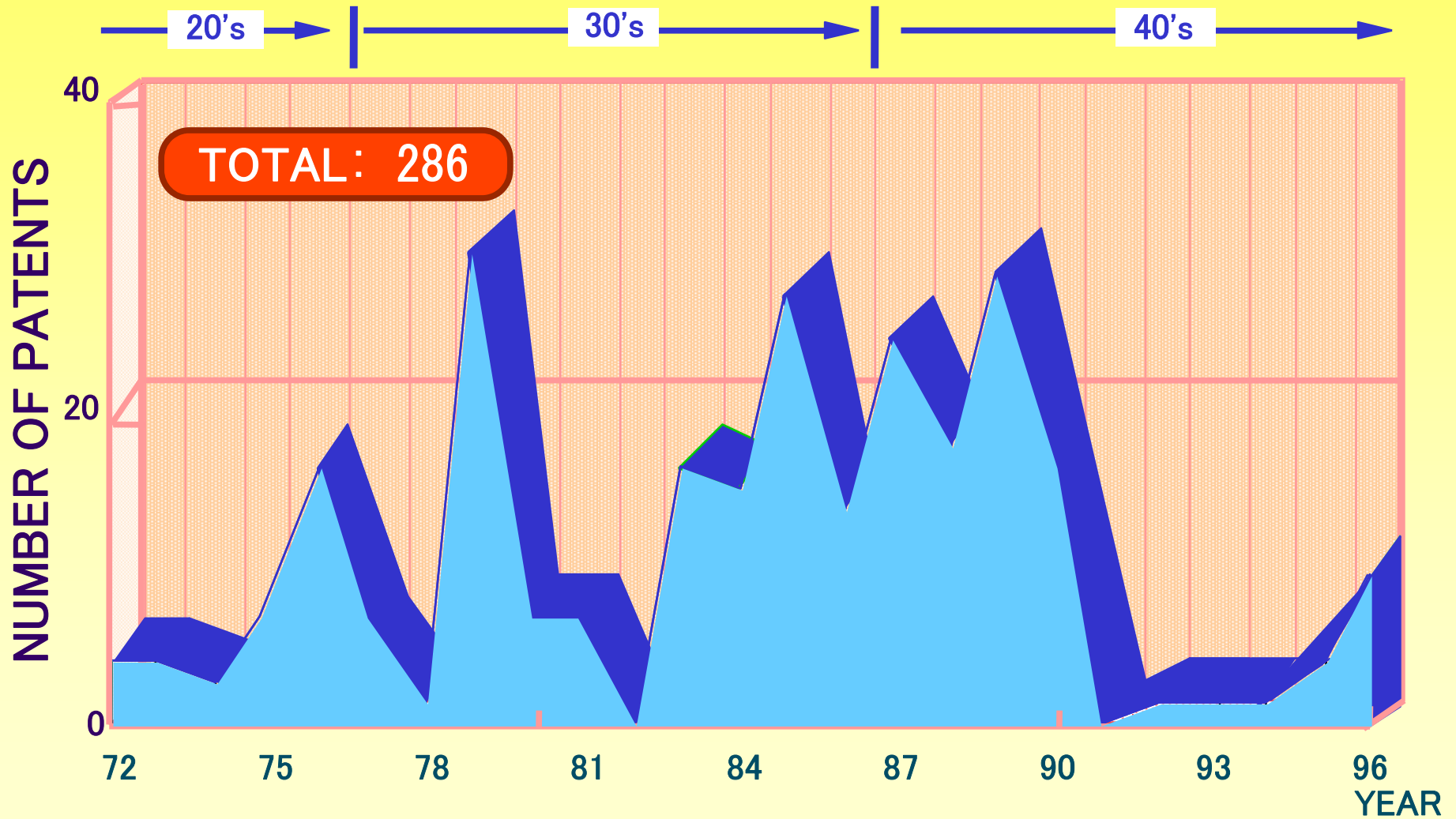
# Diversification of R&D (Internal & External)



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# My Patent Productivity



Think About!  
**WHAT** was  
Hit Ratio?

The Answer was 7% !

## Number of Patents Contributed to Business

The President Special Patent Award : 3

The President Patent Award : 7

The Strategic Patent Award-Gold : 5

The Strategic Patent Award-Silver : 4

The Strategic Patent Award-Copper : 1

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**Total Useful Patents : 20**



Discussion Session!

What is

Your Impression?

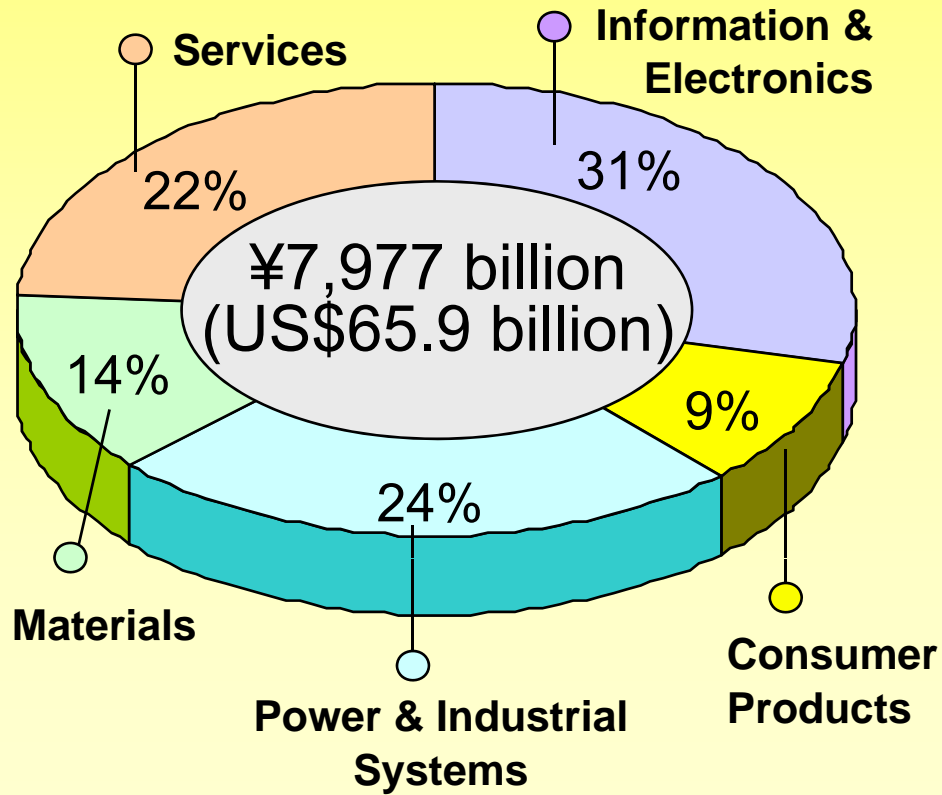
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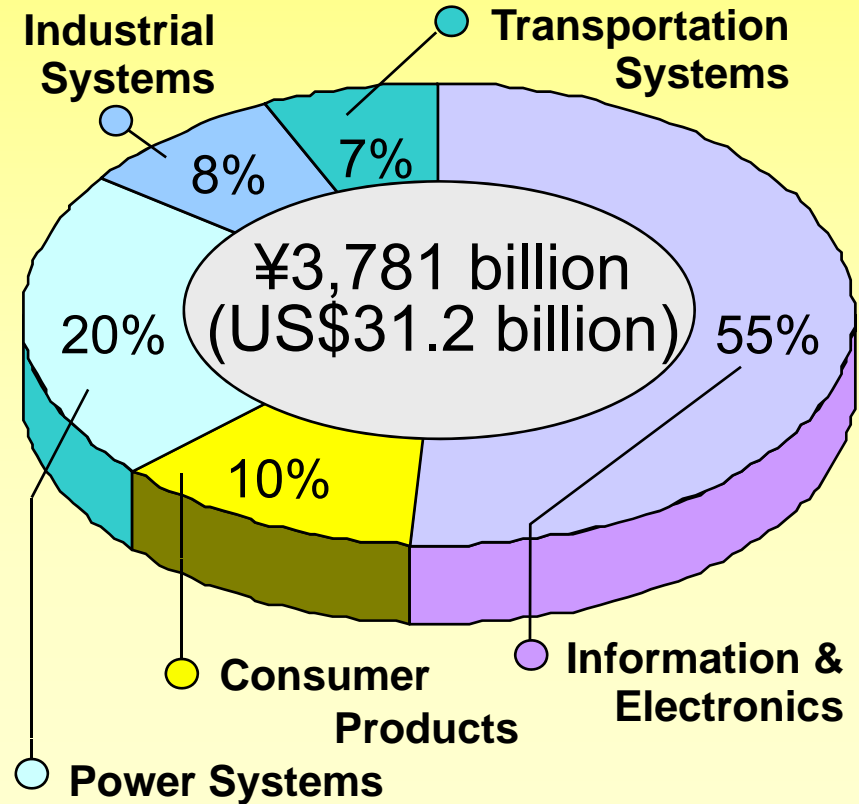
# 1998 Sales Breakdown

Financial Year ending 31 March 1999, USD1=JPY121

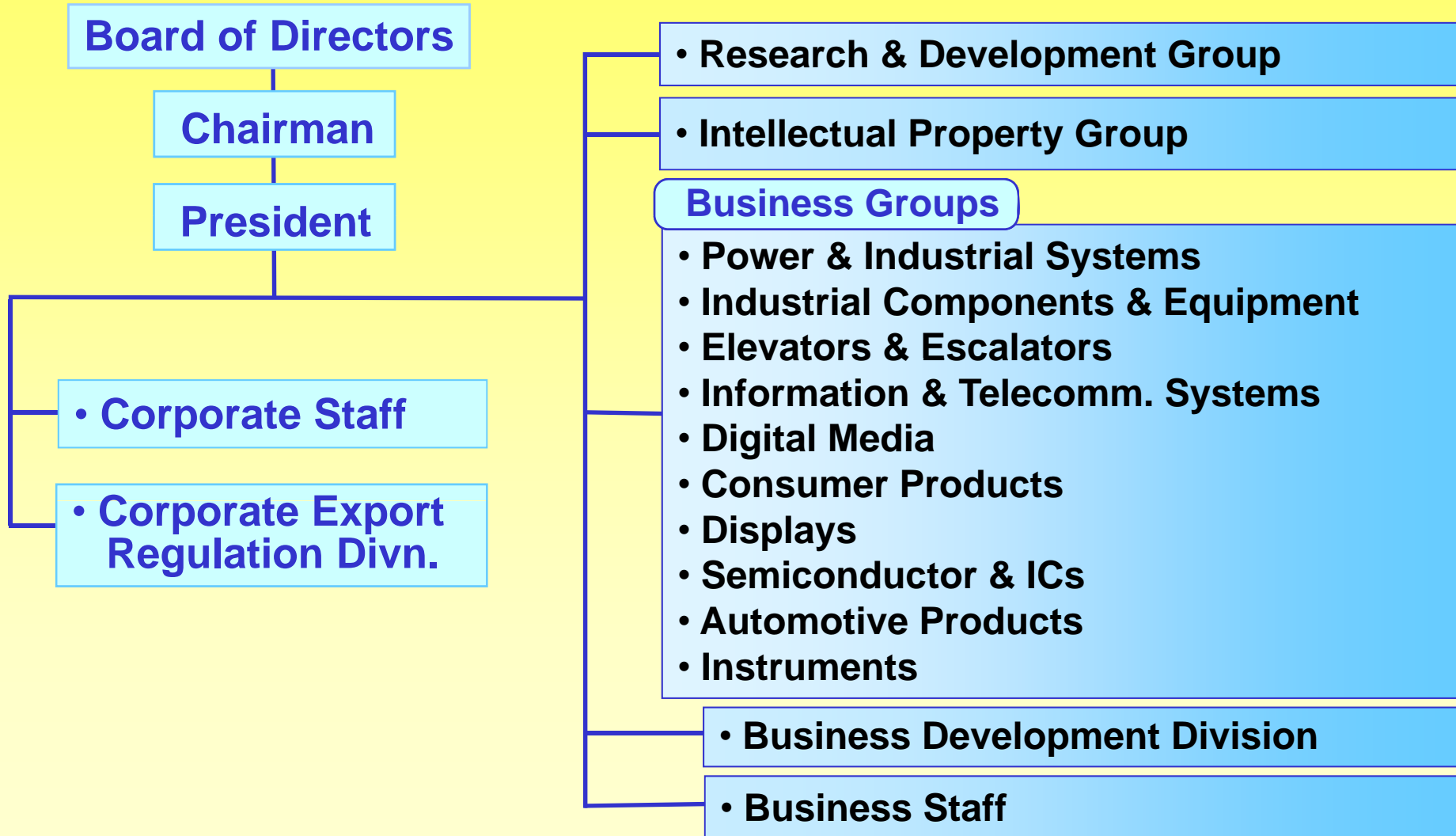
## Consolidated (HITACHI Group)



## Non-Consolidated (HITACHI, Ltd)



# Organization of Hitachi, Ltd. (as of April 1999)



# Foundation

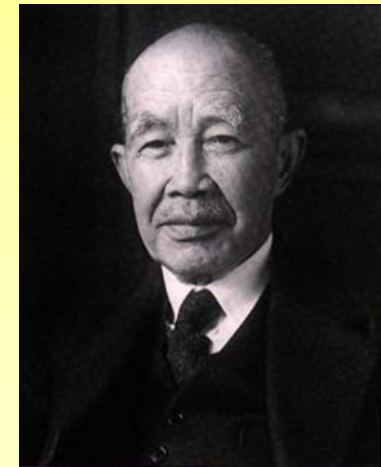
- **Establishment:** April 1942
- **Mission:** Creating new technologies for the coming 10 to 20 years, as well as pursuing development work for today's business.



**BABA Kumeo**  
**First General**  
**Manager**



**HCRL in 1942**



**ODAIRA Namihei**  
**Founder**  
**of Hitachi, Ltd.**

# HCRL History

Period	Feature/Focus	Topics
I 1940's	Construction during WWII	'42 Establishment of HCRL
II 1950's	Learning	'54 Start of reactor research
		'56 Start of transistor research prototype
		'58 Presentation of the electron microscope (grand prize) and analog computer (gold award) at the International Exhibition in Brussels
III 1960's	Expansion	'66 Development of Japan's first mainframe computer, HITAC 5020
		'69 Development of world's largest superconducting magnet
IV 1970's	Quantity to Quality	'78 Development of the world's first solid-state image-pickup device
		'80 Development of the 64 kbit DRAM

# HCRL History

Period	Feature/Focus	Topics
V 1980's	Creating original concepts & enhancing core technologies	'82 Development of electron holography technology Development of the supercomputer
		'83 Development of laser diodes in optical communication Proposal of high resolution TV systems (IDTV, EDTV)
		'86 Development of the superconducting transistor
VI 1990's	Becoming a leader in technology for new business	'91 Development of the 2Gb/in <sup>2</sup> magnetic disk
		'92 Development of the Single-Chip RISC Processor (SH Microprocessor)
		'93 Development of high-speed DNA analysis & functional MRI technologies
		'95 Development of the 1 Gbit DRAM & Video Authoring System
		'98 Operation of 128Mb Single-Electron Memory at Room Temperature