

## Lecture No. 22:

### Product Development Productivity and Its Improvement

1. Cost of Product Development
2. Productivity of Product Development  
(Corrected Development Man-Hours)
3. Impact of Development Productivity to Competitiveness
4. Improvement in Development Productivity

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# 1. Cost of Product Development

Ratio of research and development cost against net sales

Items of research and development cost

- personal cost

- depreciation cost

- material cost

Scale of individual project

昭和 63 年

1 9 8 8

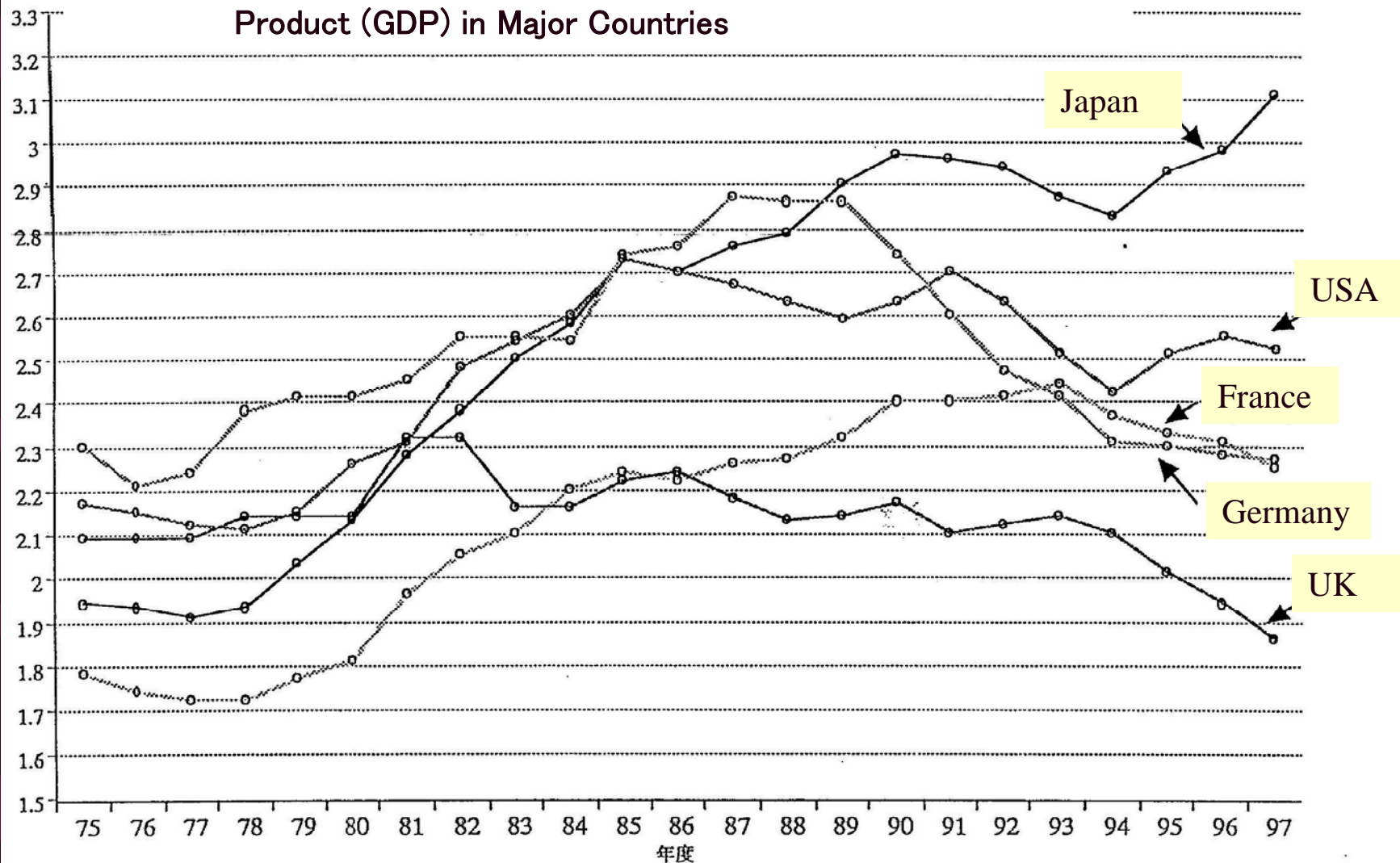
# 科学技術研究調査報告

Report on the Survey of Research and Development

総務庁統計局

Statistics Bureau, Management and Coordination Agency, Japan

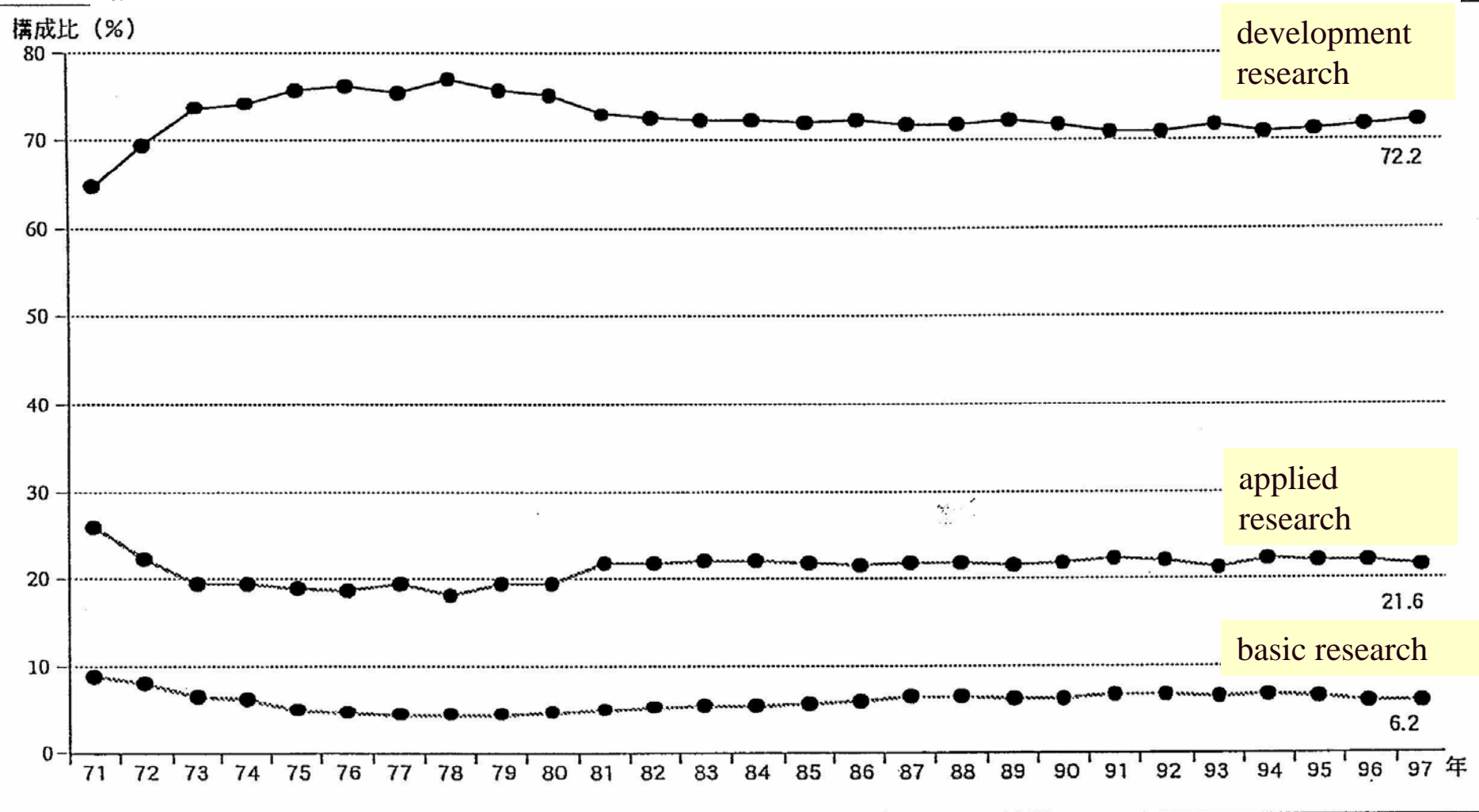
Diagram: Transition of Ratio of Research Cost vs. Gross Domestic Product (GDP) in Major Countries



資料：科学技術白書

- 注：1. 国際比較を行うため、各国とも人文、社会科学を含めている。  
 2. 日本は、1996年度よりソフトウェア業が新たに調査対象業種となっている。  
 3. 米国は暦年の値で、1997、1998年度は暫定値である。  
 4. ドイツの1996年度、1997年度、フランスの1997年度は暫定値である。  
 5. ドイツ、イギリスの統計数値のない年度は前後の年度を直線で結んでいる。

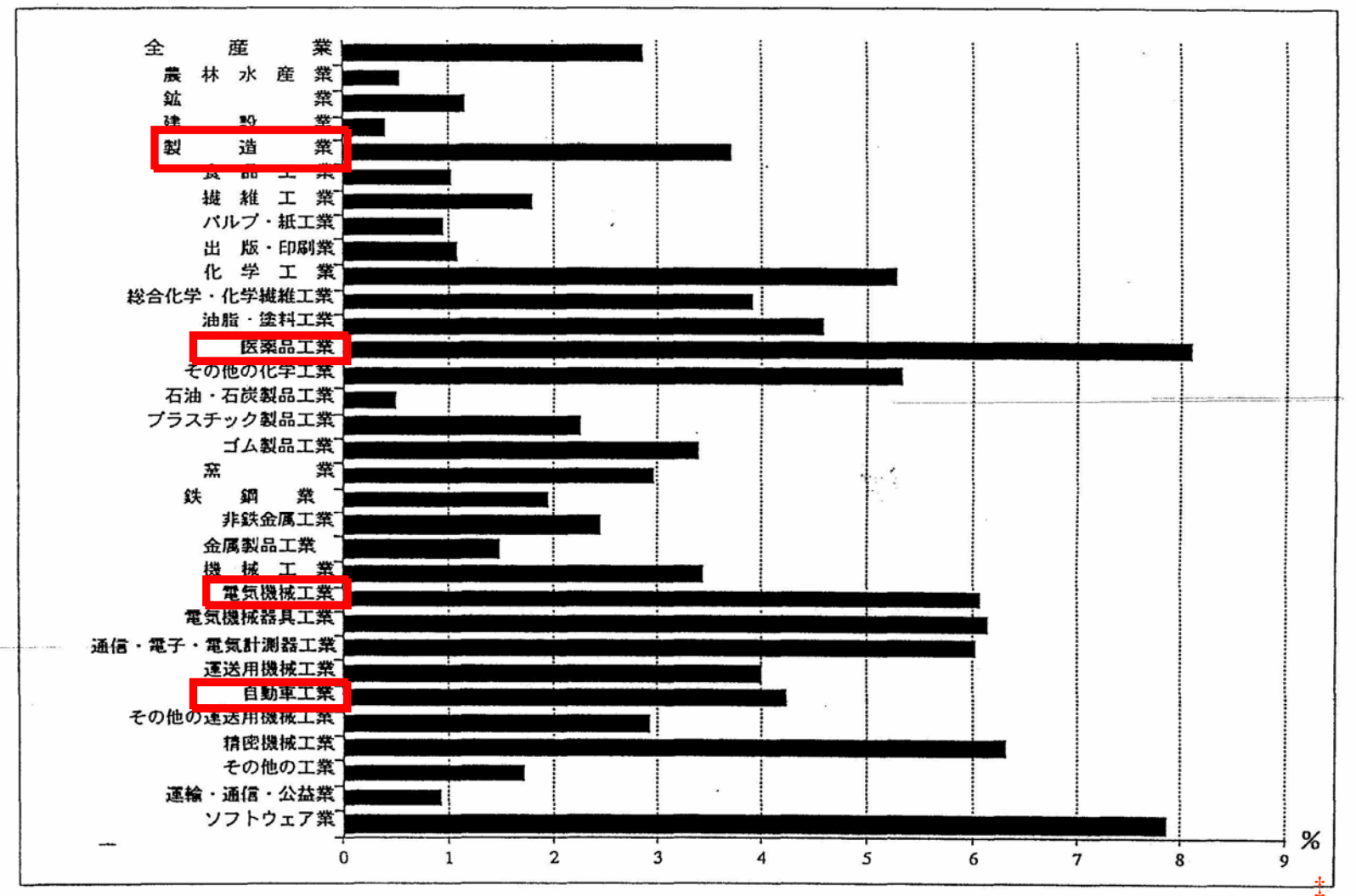
Diagram: Transition of Constituent Ratio of Research Cost by Content in Japan  
構成比



注：自然科学のみである。

Ratio of R&D Cost vs. Net Sales :  
4% in manufacturing industry, 4% in automobile, 6% in home appliance, 8% in medicine

Figure : Comparison between industries of the ratio for sales of a research cost (1997)



# Accounting Processing of Research and Development

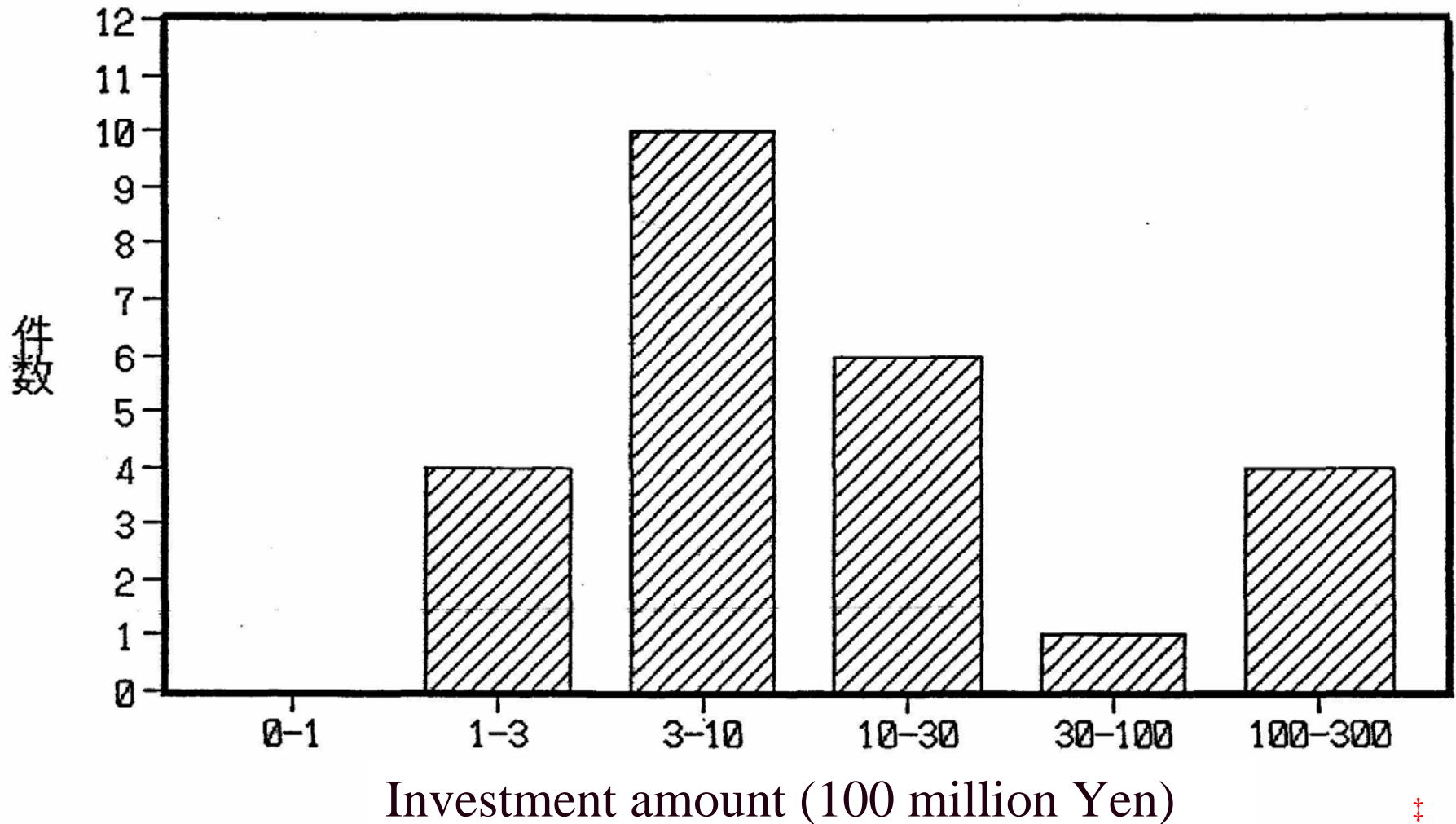
- Research and development cost . . .  
    ambiguous correspondence of activities to achievements
  - ① activities directly linked to specific product and having clear-cut nature of costing
    - ▪ ▪ **cost of manufactured goods**
  - ② research related to entire company
    - ▪ ▪ **general administrative expense**

However, the boundary is indefinite.

- property character and production cost character
- treated as **current expense** since 1999  
    (not accepted as deferred asset or depreciation)

Development cost per subject differs by case.  
Many cost a few hundred-million Yen.

gross investment amount for R&D  
(frequency distribution)



## 2. Productivity of Product Development

**Man-hour** requirement per standard development project  
(man/hour)

Corrected on project content

product complexity

technical novelty

ratio of common parts

development works, shared by supplier, etc.

automation ratio of development works

Correction of original data . . .

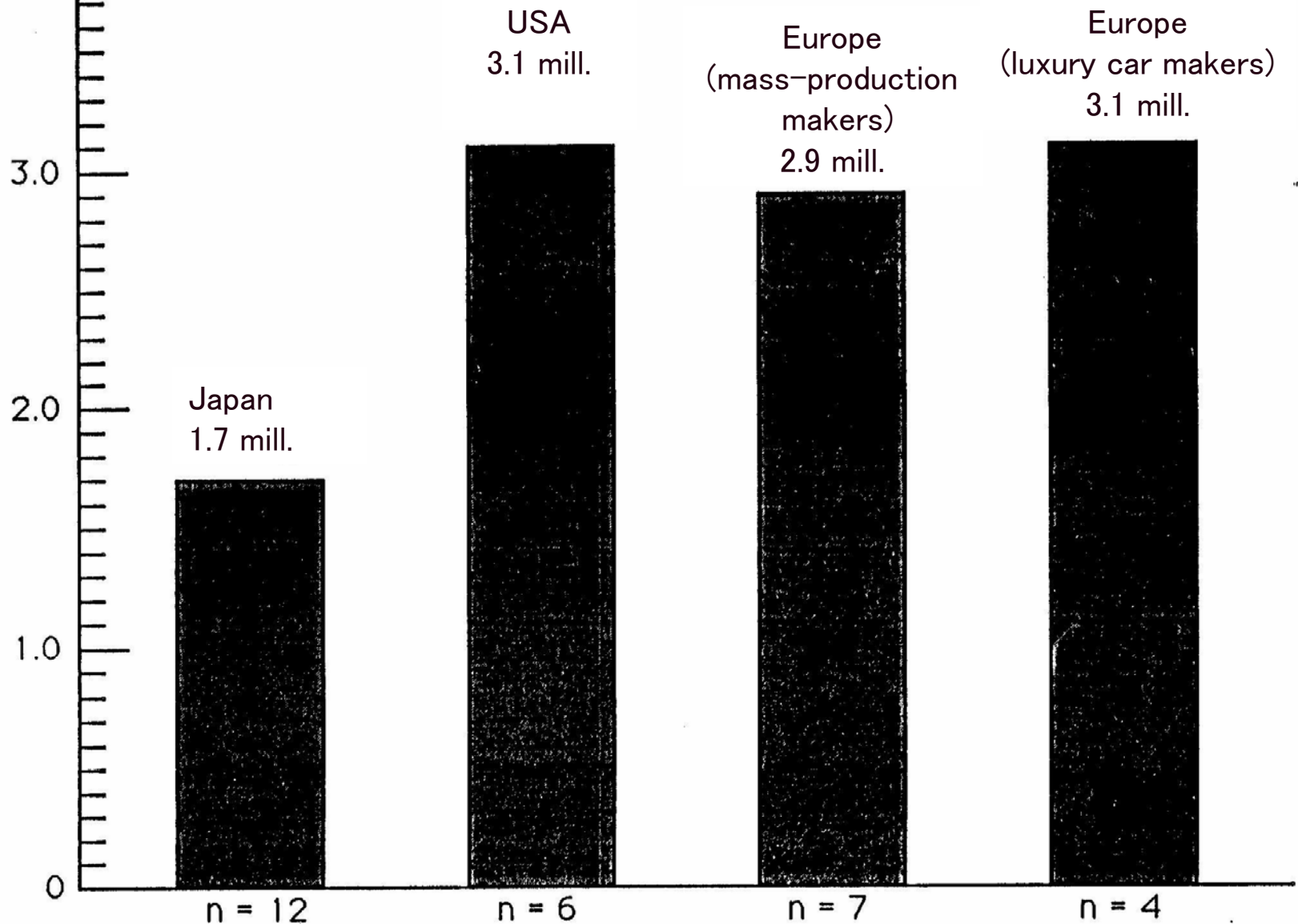
engineering method and statistical method

million  
man-hours

## International Comparison of Development Man-Hours (project contents corrected)

Example of automobiles :

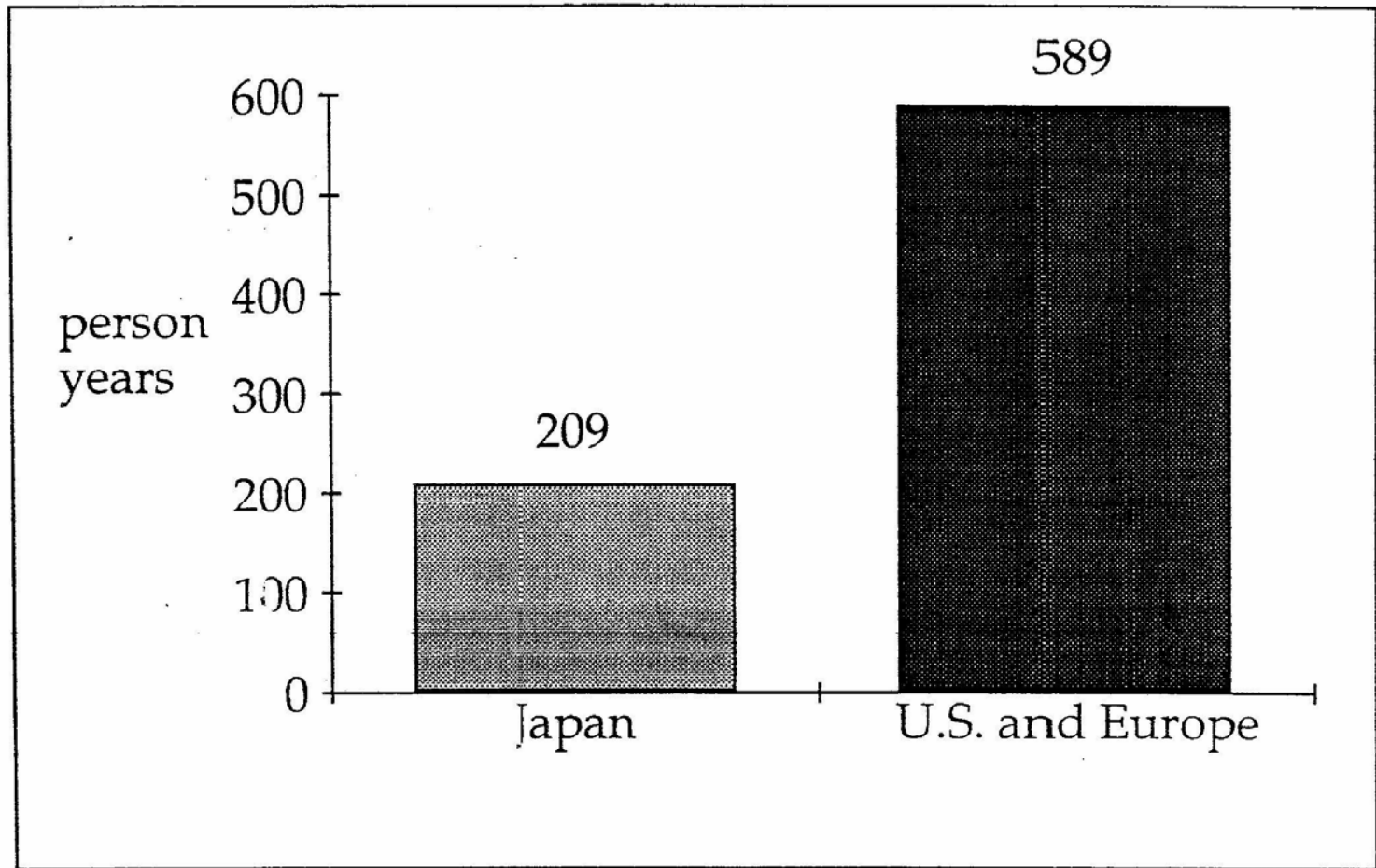
The productivity of Japanese companies is high.



# Empirical Results: R&D Productivity

Example of super computer :

The productivity of Japanese companies is high.



*Entire sample; not adjusted for content.*

### 3. Impact of Development Productivity to Competitiveness

Improve in **development productivity**

→ reduction of **development cost per project**

(1) Path of **increasing cost competitiveness**

(to reduce R&D cost per product unit price)

(2) Path of product differentiation

(to increase the number of executable projects with given R&D cost)

To response to segmented need;  
for earning “**at-bat frequency**”

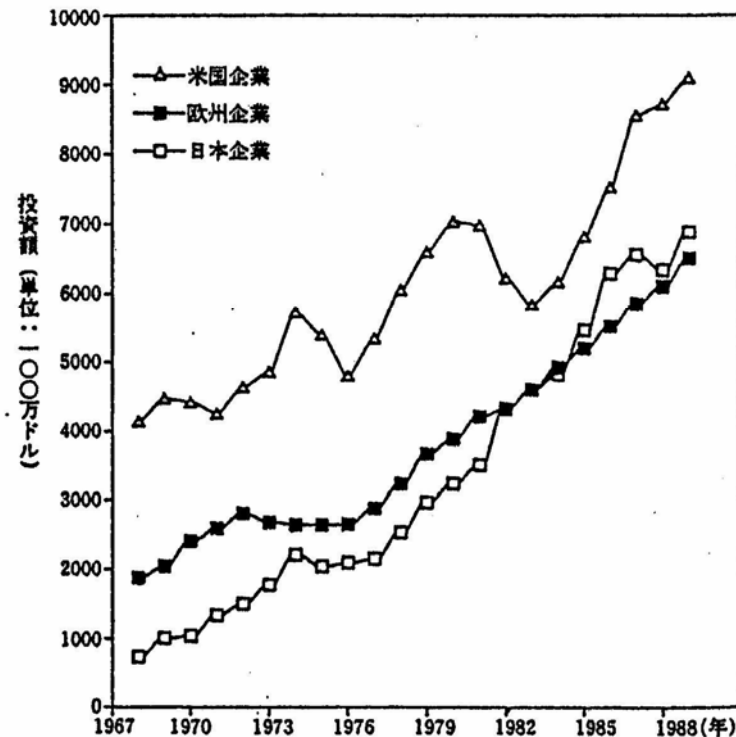
# Model Change in Development Productivity and Impact on Product Diversity : numerical example

Item	A Company (high productivity)	B Company (low productivity)	Remarks
A Number of model (2000)	6	6	D=B × C
B Volume of production	1 million sets	1 million sets	
C Listed maker price	10,000 dollars	10,000 dollars	
D Total sales amount	10 billion dollars	10 billion dollars	
E Development man-hour	1,500,000 hours (high productivity)	3,000,000 hours (low productivity)	H=E × F × G
F Development cost /hour	100 dollars	100 dollars	
G Number of annual new models developed	2	1	
H Total annual development spending	300 million dollars (3%, 300dollars/set)	300 million dollars (3%, 300dollars/set)	
I Model change frequency	4 years (short)	8 years (long)	
J Number of model (2008)	10 (many)	8 (few)	
K Development lead time	4 years	4 years	

## Comparison of Company-Wide R&D Spending

一方、R&D支出額(実質)を見ると、日本メーカーの合計は80年代急速に伸びてはいるが、総額で欧米を圧倒しているわけではない。売上の3-5%をR&Dに使うポリシーは日米欧共通である。重要なのはR&Dに「いくら使うか」ではなく、「どう使うか」であろう。

地域別でみた自動車産業の年間研究開発費(1967年～1988年)



注: 数字は本社所在地別でみた自動車メーカーの研究開発費。したがって、あるメーカーが外国にある研究所などで費やした費用も本国分と一緒に計上してある。  
投資額は1988年のドル価値をもとに換算した。

出典: OECD が毎年発表する "Compilation of Surveys of R&D by Member Governments" から Daniel Jones が算出。

	Japan	U.S.	Europe
Total R&D spending (1984, 100 million dollars)	2.7	4.7	8.2
Average man-hours per project (hour) (x)	1.2million	3.5million	3.4million
Number of new car development 1982- 87 (n)	72	21	32
Annual average model number 1982-87 (m/6)	55	28	65
Ratio of R&D spending vs. net sales (1984, 5) (k)	3.6%	3.0%	3.6%
Total passenger cars produced (1984) (Y)	7.1million	7.8million	11.5million
Average development period per project (T)	3.6years	5.2years	5.3years
Average model change interval (t=M/r)	4.6years	8.1years	12.2years
Ratio of development period vs. model change interval (t/T)	1.3	1.6	2.3

number of annual new car sales

n/6

×

development cost per hour

r

×

average man-hour

X

=

ratio of R&D spending vs. net sales

k

×

passenger car average unit price

p

×

passenger cars produced

Y

= Annual R&D spending

therefore,

n

=

p/r

×

k

×

Y

×

6

×

1/X

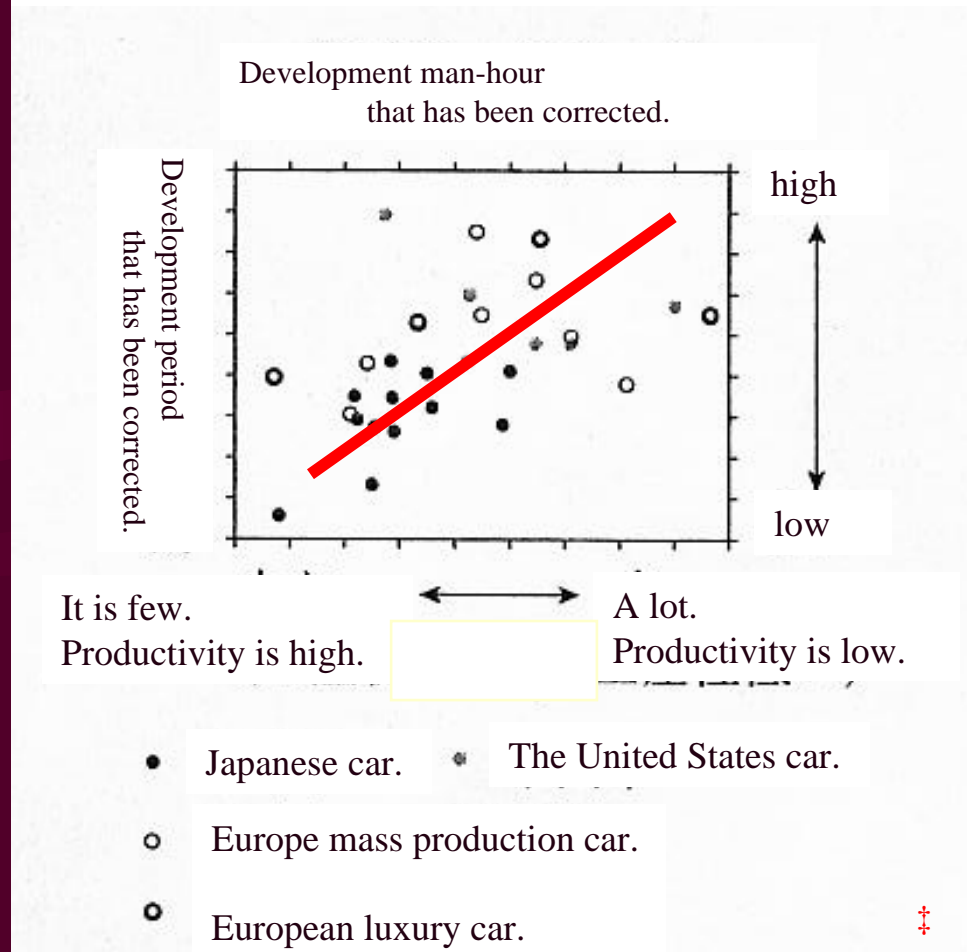
Japan	72	56	0. 036	7.1million	6	1/1.2million
U.S.A.	21	52	0. 030	7.8million	6	1/3.5million
Europe	32	44	0. 036	11.5million	6	1/3.4million

(estimation)

## 4. Improvement in Development Productivity

- Development lead-time and development productivity • • •  
positive correlation, in many cases
- **CAD-CAM-CAE** and reduction in development man-hour  
direct effect and indirect effect (front-loading , etc.)
- Number of variations, use of common parts,  
**utilization of supplier's design capability**
- Specialization and development man-hour  
(**problem of over specialization**)

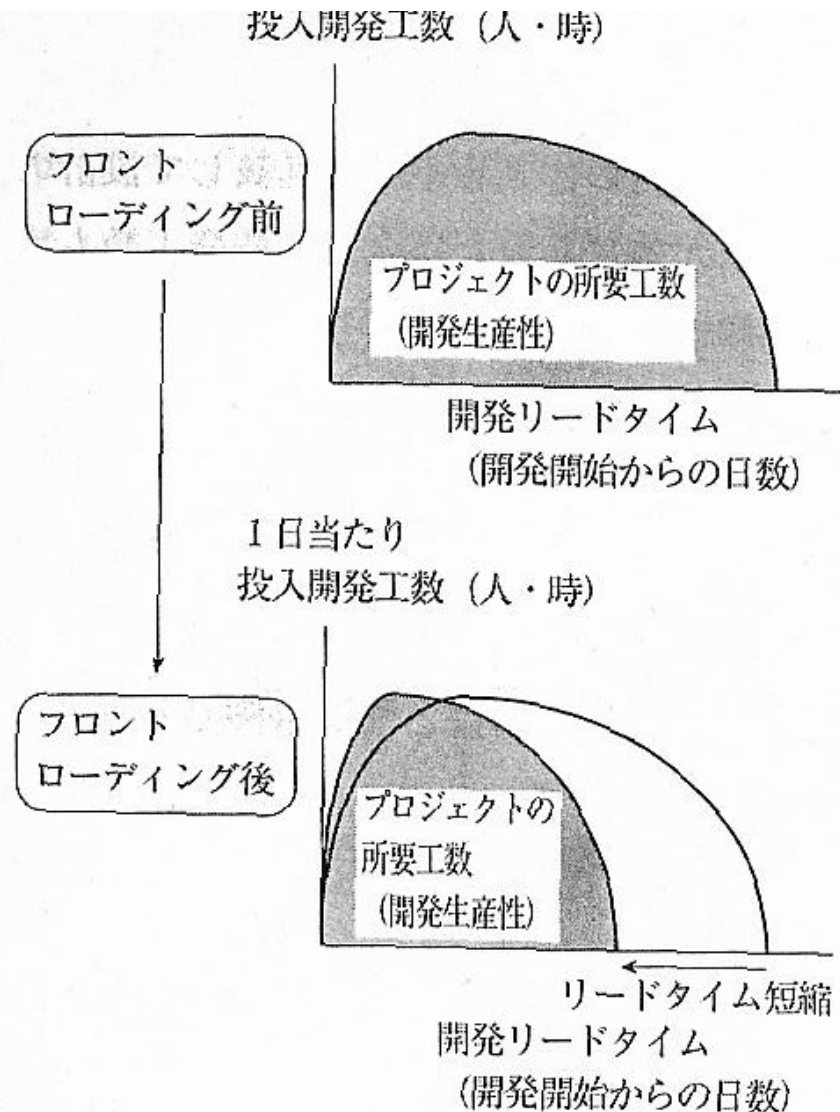
# Relationship Between Development Man-Hour and Development Lead-Time (1980s)



Takahiro Fujimoto, Clark K.B. 'Product Development Power' DIAMOND, Inc. 1991

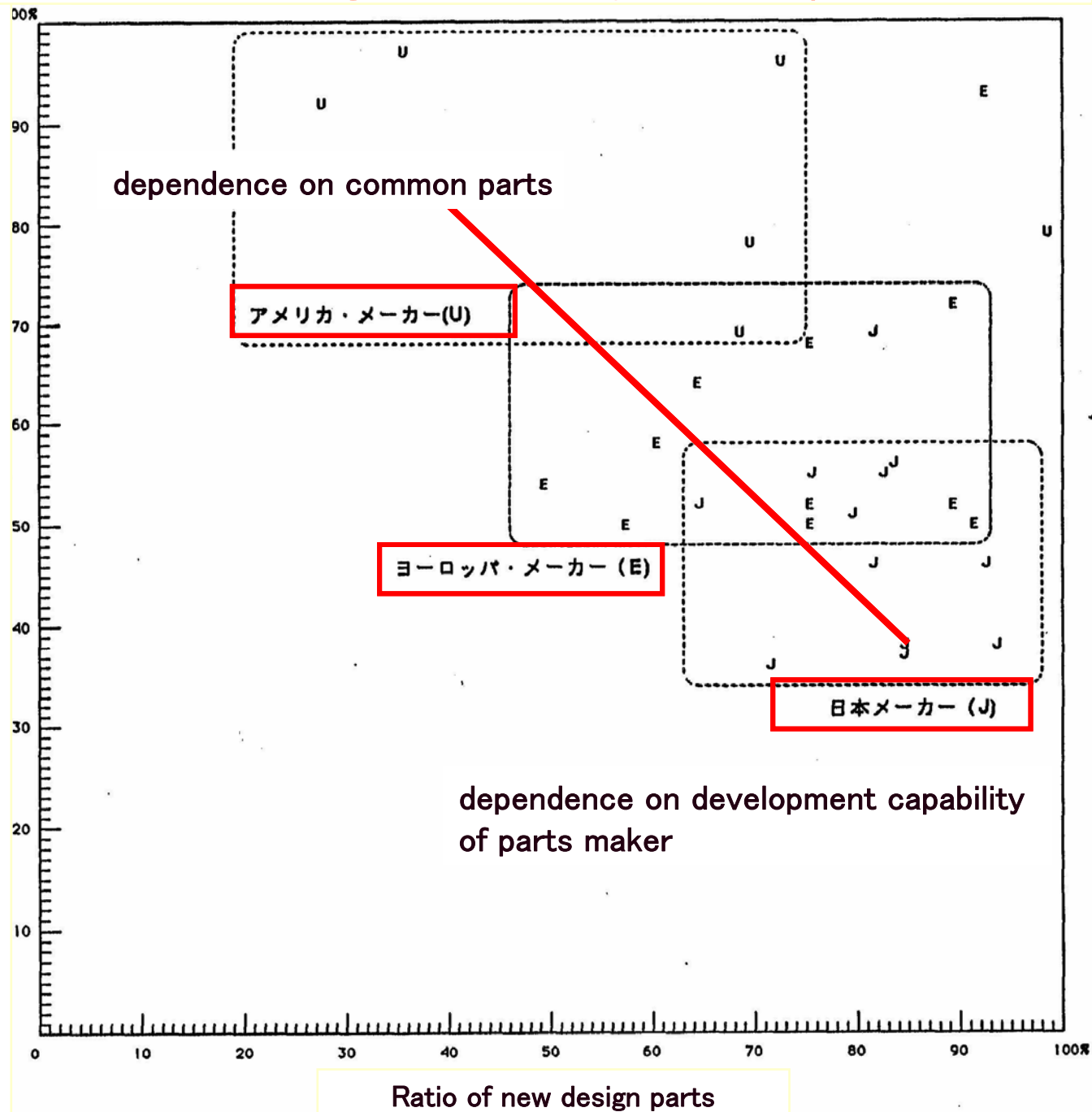
# Reduction of Man-Hour by Front-Loading (advancement of problem solving)

Front-loading and reduction in  
development man-hour (conceptual  
diagram )

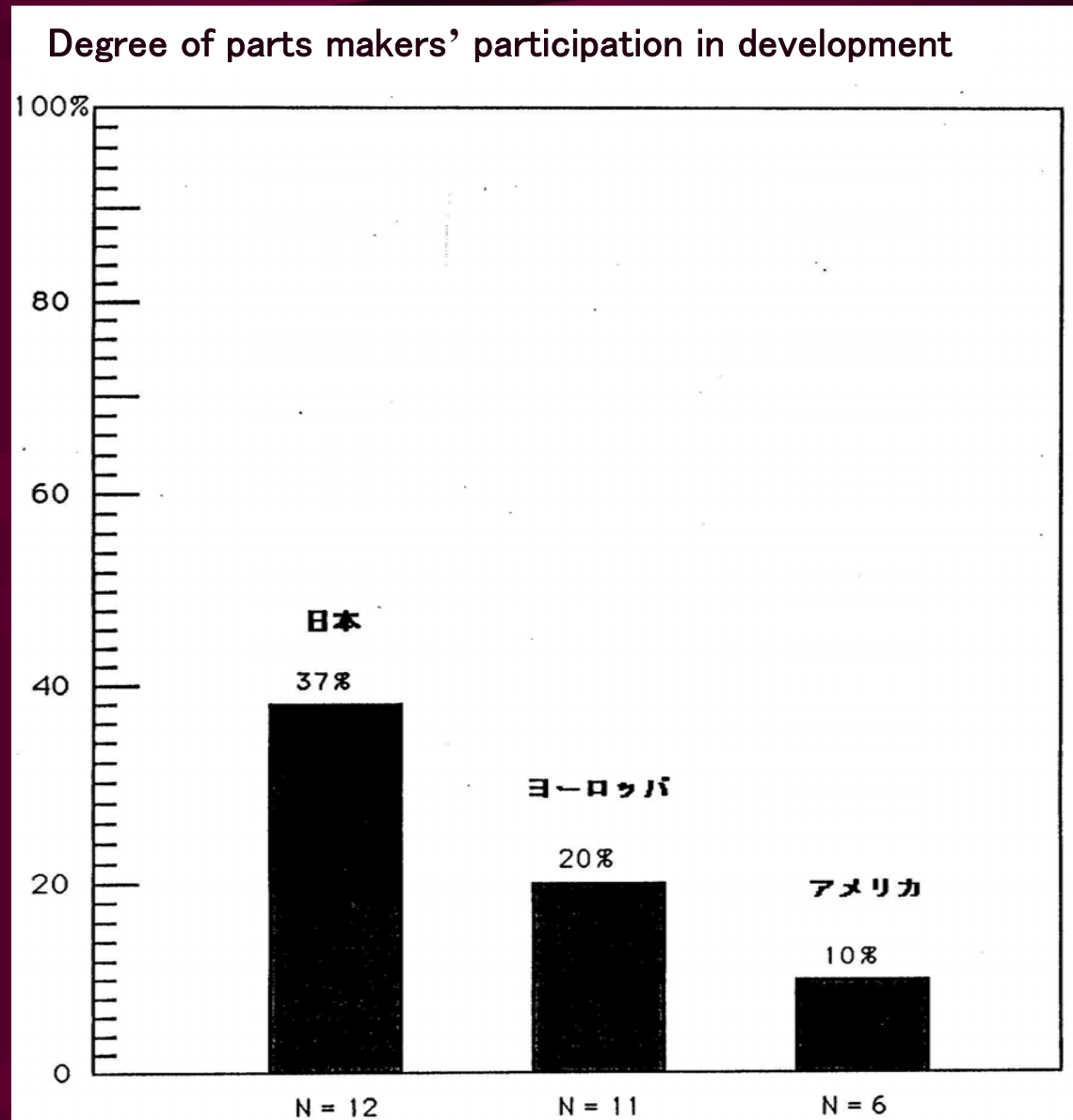


## Outsource design, or use many common parts?

Ratio of in-house development of parts



In Japan, automotive parts makers play an active role in development works.  
(approved drawing system, etc.)



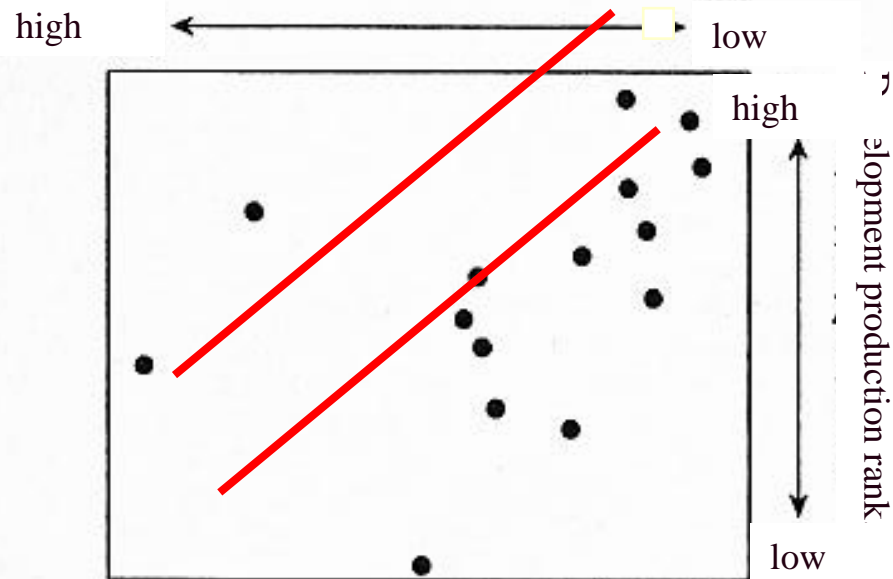
総部品開発工数に占める部品メーカーの負担分の推定値。

資料：クラーク、藤本。Product Development Performance. 1991.

# Over specialization lowers development productivity after all

## “over specialization” and development productivity

Rank of development project worker's specialist degree.



Takahiro Fujimoto, Clark K.B. 'Product Development Power' DIAMOND, Inc. 1991