Lecture No. 20: Process/Organization/Performance of Product Development

1. Research and Development
2. Process of Product Development
3. Organization of Product Development
4. Performance of Product Development

Takahiro Fujimoto
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So far... Management of Production system

cost management  work improvement  process/inventory management

quality management  personnel/labor management  facility management

purchasing management

Another core function in manufacturing companies... research & development/product development

process and organization of product development

development period (lead-time)

development efficiency (development productivity)

product capability (design quality)

Problem of measurement and system for management/improvement

Main focus to be placed on new product development activities at the level for an individual product
R & D Organization of Contemporary Manufacturing Company (example of NHK Spring Co.)

Author making (reference: 'Company overview' 'Corporate profile' 1993')
Reference: Takahiro Fujimoto 'Introduction to Production Management' Nihon Keizai Shimbun, Inc. 2001 (Ⅱ p166)
Many of contemporary manufacturing companies **have a research and development sector within themselves,** investing a few odd percent to ten odd percent of their sales amount to R&D activities.

**Organizational R&D activities** by manufacturing companies **began nearly in early 20th century**

Clue to a research center within a company was in a gigantic chemical maker in Germany in 1870s.

In early 20th century, GE, Dupont, Bell Telephone, Kodak, etc.

In major countries, R&D cost expended by companies (industries) occupies nearly 70% of their national R&D costs in total.
R&D Expenditures of Japan

Its ratio vs. GNP is still at the highest level in the world. (more than 3%)
Private Companies Share 2/3 of Nation's Research Cost

Constituent Ratio of Research Cost by Research Entity

companies/others: 61.9%
research organizations: 14.5%
universities/others: 23.6%

Survey Report on Scientific and Technological Research' MIC Statistics Bureau 1988
Constituent Ratio of Research Cost by Organization in Major Countries

Japan (1997) (Only a natural science)
Japan (1997) (Work conversion)
The US (1998)
Germany (1997)
France (1997)
Britain (1997)

Government research laboratories
University.
Industry
Tamiitona research laboratories.

Note 1. For the purpose of international comparison, the spectra also includes humanities and social sciences.

Note 2. (1) The scale includes only government and foreign institutions.

Note 3. The data for the US and Germany are approximate values. The data for France includes the percentage of government-funded research.

Source: Science and Technology White Book (1997), Japan (Government Research Institutes) and France (OECD: MAIN SCIENCE AND TECHNOLOGY INDICATORS).
Various Concepts Concerning Research and Development

Diagram Concept of R&D/Innovation/Science and Technology

- Basic research
- Applied research
- Development

- Discovery
- Innovation

- Science
  - Technology
    - (Development → Application)

Note: □ to indicate knowledge stock, → flow of knowledge/information
And "innovation" can be considered as a concept including "invention".

Takahiro Fujimoto 'Introduction to Production Management' Nihon Keizai Shimbun, Inc. 2001 (II p167 figure.13.2)
“Development” = on the assumption to *commercialize/commoditize* design of new product/new process, trail product, experiment, etc.

“Research” = procurement of new knowledge not directly linked to commercialization

“Basic Research” = targeted at procuring scientific knowledge itself relative to natural/social phenomena

“Applied Research” = activity to apply procured knowledge to reality
(2) "Discovery" and "Invention"

"Discovery" = procurement of new knowledge concerning natural/social phenomena

"Invention" = to create idea, sketch, trial product, etc. concerning product, process, and others, that have potentialities to be put into practical use (commercialized)

"Innovation" = to bring something into the first "commercialization", not just limiting to mere trial product or sketch

"Product technology innovation" (product innovation) "Process technology innovation" (process innovation)
(3) "Science" and "Technology"

“Science” = structure of rational knowledge concerning a general relation of cause and effect between each phenomenon.

“Technology” = structure of rational knowledge concerning a relation of cause and effect between concrete Mono (artificial article) and its function.

It was in the early 20th century that the relationship between science and technology became close. Scientists expressed their achievements in words by writing theses, while technologists did in Mono's.

In reality, things do not necessarily proceed on such linear tracks as "basic research → applied research → development", "discovery → invention → innovation ", "science → technology".
2. Process of Product Development

“Product development” = corporate activity to create "product design information" for new products to be sold in market to include, in a broad term, preparations for process design and production process

Example of automobile... product development of a car being a relatively complicated consumption good
Product Development Process of Automobile

“Development project” = bundle of a series of developmental activities to develop a specific model a bundle of developmental activities a few hundred people, over 3-4 years

Planning stage

“draw up concept”
“product basic plan”

Full-fledged development stage (engineering)

“product engineering”
“process engineering (production preparation)”
Product Development as Information Production Process

Takahiro Fujimoto
'Introduction to Production Management'
Nihon Keizai Shimbun, Inc. 2001
(II p174 figure.13.3)
Product development is a process to create design information asset through a problem-solving cycle.

Note
The relation of horizontal direction shows the problem solving cycle. The relation of the vertical direction shows the improvement of knowhow or the information property. Not only the information property of adjacent but also all of the same line and the same row the information properties is assumed to be related with a specific information property in this map potential. Moreover, the row of the product planning is related at three cycles concerning the styling, the selection of the main parts and the layout.
(1) Drawing Up Concept

"Product concept" = vision concerning how to solve customer problem and thereby achieve customer satisfaction with that new product.

Specify target customers, and plot a rough framework on needs information and customer satisfaction, which can be expressed in variety of ways, such as sentence, sketch, key word, rough product specification, etc.

Example: Eunos Roadster --- "Jinba Ittai (= man-horse unity)"
(2) Product Basic Plan

"Basic design" = "function design", and rough "structural design"

Translation of "product concept"

Such as styling, layout, product specification, design format for parts, etc.

Approval of top management

Example of Eunos Roadster

technological translation of "Jinba Ittai (man-horse unity)"
shorter axle interval, tight indoor layout, weight distribution prioritizing swirling performance, suspension form with emphasis on running capability
Exterior Design Sketch
Exterior Design: clay model in 3 dimensions
Interior Design Sketch
Interior Design and Modeling (3 dimensional)
Interior Mockup (actual 3 dimensional model for sake of appearance evaluation)
Layout Diagram (basic design for parts assignment)
Evaluation of Aerodynamics by Clay Model
Facility for Wind Tunnel Experiment
(3) Product Engineering

Cycle of **detail design, trial manufacturing, experiment**

Expenditure of development to expand from this stage on

To repeat a **problem-solving cycle** of design/trial-manufacturing/experiment, until an objective set at the product-planning stage comes to be achieved.

**Detail design drawing** of product --- file of computer-assisted design (**CAD**) now
Design of Engine and Developmental Trial Manufacturing
Detail Design and Developmental Trail Manufacturing of Parts (basically computerized now)
Manufacturing of Developmental Prototype Car (auto body)

Universe of Super-Skilled Workers
Manufacturing of Developmental Prototype Car

handmade
(ranging Yen 50 million - 100 million)
First Prototype Car (Yen 100 million)
Experiment/Evaluation Using Developmental Prototype Car
Experiment/Evaluation Using Developmental Prototype Car
Experiment/Evaluation Using Developmental Prototype Car (noise test in anechoic room)
Experiment/Evaluation on Collision Safety Using Developmental Prototype Car
(4) Process Engineering

To create information asset of machinery facility, jig, tool, mold, layout, work manual, numerical control, etc. for sake of **mass production**

To be also named "**production preparation**"

To include "**pilot line**" (volume production experiment) and "**start up**"

In broader term.

Up-stream/down-stream relationship where the result of a preceding activity (product design) constitutes the prerequisite condition to the succeeding stage (process design)

Both, in actuality, being **duplicating**/interactive in terms of time period

Cooperative activity among companies involving parts makers and facility/mold makers, etc.
To develop "element technology" (technology embodied in parts and material) in advance ("refrigerator")

In case of machine product consist of functional parts, much of "product technology" is buried in an individual constituent part as "element technology".

"Advanced development" at the level of parts, separated from a development of an entire product

Example of large computer: success and failure of a product to determine the feasibility of new element technology
General Model of Innovation

Conceptual model to regard a product innovation as a process of "information processing" "problem solving"

Three steps:
(1) "Idea creation" (problem finding)
(2) "Problem solving" (quest for alternative, evaluation)
(3) "Implementation" (in commercial production)
Development Process as System of Information Creation/Information Processing

Product development = "process of information creation/information processing"

Integration of knowledge on market needs and knowledge on technological possibility

To be translated to a group of information stock required for commercial production

"Single item production of the stock of product design information"
"Takahiro Fujimoto 'Introduction to Production Management' Nihon Keizai Shimbun, Inc. 2001 (II p174 figure.13.3)
Development Process as Bundle of Problem-Solving Cycle

Bundle of "problem solving cycle" (H. Simon)

Input = objective to achieve
Output = means to achieve objective with (solution)

Case where knowledge on cause and effect is inadequate ⋮ ⋮
  to search an alternative,
  to simulate the result of each idea
Standard (in H. Simon model) Cycle for Problem Solving

1. Problem Recognition
2. Goal Setting
3. Search
4. Model Creation
5. Simulation Implementation
6. Evaluation

Diagram: Problem Solving Cycle

Takahiro Fujimoto 'Management organization and New product development' Yuhikaku Publishing Co., Ltd. (p.228 figure.3)
Referent: 'Corporate system of Japan (volume 2)' Yuhikaku
Example: "Product Engineering" of Automobile

**Input** = targeted performance/specification/style/layout

**Detail design information** as an alternative (drawing and computer file)

Trial manufacturing and **simulation model** based on detail design information (CAE)

**Experiment/evaluation** of trial model ・・・

**Design verification** to technically check the achievement of product specification

**Confirmation of design validity** to evaluate merchantability from the standpoint of customer satisfaction

**Design change**, back in an up-stream, when the objective is not achieved

Product development project = "**multiple bundle of mutually combined cycle of problem-solving**"
Development Process as Simulation

Process of product development is a simulation of process for generating customer satisfaction in future.

"Process for generating customer satisfaction" = cause-and-effect chain comprised of production/sales/consumption

Product development process = to simulate in advance process for generating customer satisfaction that has not yet been realized in a form of adversely tracing back
Product development is to simulate production/consumption process by adversely tracing it back.

Production development process and process to create customer satisfaction (party to simulate and one to be simulated)

process to create customer satisfaction (party to be simulated)

production

product structure

product function

customer satisfaction

production

usage

customer interpretation

process design

structure design

function design

product concept

product development (party to simulate)

Takahiro Fujimoto 'Introduction to Production Management' Nihon Keizai Shimbun, Inc. 2001 (Ⅱ p178 figure.13.6)
"Competitiveness" = power of influence, held by a bundle of information embodied in a product, onto a customer

Development and production are an inseparable total system

Development and production in partnership transmit an information via a product as medium to the market place

"Product design information" is the key to combine development and production

1. product development = to create a new product design information by combining market information and technology information

2. production = to transcribe product information arrayed in process onto material

3. sales/marketing = to actually transmit information embodied in a product, and to convey it to consumers

Thus, the point is a coordinated play among development, production, and marketing.
## Development and Manufacturing: Similarities in Pattern

<table>
<thead>
<tr>
<th>Production (JIT-TQ model)</th>
<th>Development (high speed/ high efficiency model)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>pattern of process flow</strong></td>
<td></td>
</tr>
<tr>
<td>• frequent set-up change</td>
<td>• frequent model change</td>
</tr>
<tr>
<td>• short throughput time</td>
<td>• short lead-time for development</td>
</tr>
<tr>
<td>• decrease in in-work product inventory among processes</td>
<td>• decrease in informational stock among development steps</td>
</tr>
<tr>
<td>• &quot;one-by-one production&quot; (not batch transaction) of parts from upstream process to downstream process</td>
<td>• frequent transmission of information from upstream of development to downstream (not batch transaction)</td>
</tr>
<tr>
<td>• quick feedback of trouble/problem in downstream process</td>
<td>• early discovery of potential problem in developmental downstream, and its feedback</td>
</tr>
<tr>
<td>• prompt cycle of solving production problem</td>
<td>• prompt cycle of solving development problem</td>
</tr>
<tr>
<td>• activity in upstream process being induced by demand in downstream (pull system)</td>
<td>• activity in upstream being motivated by product's release date (request by downstream)</td>
</tr>
<tr>
<td><strong>organizational capability</strong></td>
<td></td>
</tr>
<tr>
<td>• capability to simultaneously improve quality/productivity/delivery</td>
<td>• capability to simultaneously improve design quality/development productivity/development period</td>
</tr>
<tr>
<td>• &quot;capability to build quality in product&quot; to produce salable product without inspection/rework</td>
<td>• capability to design easy-to-make product</td>
</tr>
<tr>
<td>• flexibility to production volume/product mix/model change</td>
<td>• flexibility to product design, development schedule, and other objective change</td>
</tr>
<tr>
<td>• productivity increase by broad job assignment to worker (multi-skilled)</td>
<td>• productivity increase by broad job assignment to worker</td>
</tr>
<tr>
<td>• worker's capability and mental set being inclined for continuous improvement and prompt problem solving</td>
<td>• engineer's capability and mental set being inclined for frequent reformation of product/process</td>
</tr>
<tr>
<td>• inventory reduction to forcefully produce information flow for problem solving and improvement</td>
<td>• reduction in development period to forcefully produce information flow between up/down streams for problem solving</td>
</tr>
</tbody>
</table>
Beyond Dichotomy of Production and R&D

"Emphasis on efficiency in production, flexibility in R&D" ??

"Importance on a group discipline in production, an individual creativity in R&D" ??

"Suitability of a mechanical organization for production, an organic organization for R&D" ??

・・・No.

R&D and production function are, rather than being bipolar, the same spectrum.

Product development = single-item production of information stock

Production system of JIT-TQ Model = improvement (continuous process innovation) being built in

Plenty of similarities can be observed between these two ($).
<table>
<thead>
<tr>
<th>Process/Activity</th>
<th>R&amp;D</th>
<th>Manufacturing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>basic study</td>
<td>product development</td>
</tr>
<tr>
<td><strong>process/activity</strong></td>
<td>unique</td>
<td>repetitive</td>
</tr>
<tr>
<td><strong>structure of operation</strong></td>
<td>extraordinary</td>
<td>ordinary</td>
</tr>
<tr>
<td><strong>organization</strong></td>
<td>organic</td>
<td>mechanical</td>
</tr>
<tr>
<td><strong>management</strong></td>
<td>gentle</td>
<td>hard</td>
</tr>
<tr>
<td><strong>emphasized value</strong></td>
<td>creative</td>
<td>efficient</td>
</tr>
<tr>
<td><strong>time</strong></td>
<td>long</td>
<td>short</td>
</tr>
</tbody>
</table>
3. Organization of Product Development

Development Organization as Joint Problem-Solving Pattern

Contemporary new product development is a collaboration work by plural persons • • • joint problem solving

Product development activity in contemporary companies is mainly "routine activity" of high repetitiveness

Product development organization contributes itself to a developmental performance through the application of the joint problem-solving routine

(1) specialization and integration of developmental organizations on an individual project level

(2) integration among plural projects

(3) formation and management of a research center group on a company-wide level in diversified companies
Dividing Departments in Development Organization: Typical Example of Automobile

Takahiro Fujimoto 'Product Development Organization and Quality of Design of Car' 1987
Reference: 'Histochemistry' Vol.22 No.1
Specialization and Integration

Basic axis of organization design

"specialization by department"
"coordination among departments"

(1) Specialization :
by developmental stage (by function)
by product group
design department being possibly separated by parts

(2) Integration :
cross-departmental organization for inter-departmental adjustment
preadjustment based on regulation/plan, etc
vertical adjustment (hierarchy)
liaison for inter-departmental adjustment (liaison)
task force (temporary team for inter-departmental adjustment)
project team (organization for inter-departmental adjustment through project)
product manager (role of promoting/adjusting project)
matrix organization
## Are a product type and a project-leader type linked?

<table>
<thead>
<tr>
<th>Complexity of Product's Internal Structure</th>
<th>Complexity of User Interface</th>
<th>Is an Engineer a Leader?</th>
<th>Is a Multi-Skilled Product Manager a Leader?</th>
<th>Is a Product Manager of Sales Department a Leader?</th>
<th>Is an Industrial Designer a Leader?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complicated</td>
<td>Simple</td>
<td>Component Self-Initiating Type of Product (machine tool, etc.)</td>
<td>Complicated Product (automobile, etc.)</td>
<td>Simple Product (food, detergent, etc.)</td>
<td>Interface Self-Initiating Type of Product (home electric appliance, wrist watch, etc.)</td>
</tr>
</tbody>
</table>

Characteristics of Japanese Product Development Organization

In 1980s, Japanese manufacturing companies, compared to Euro-American ones, tended to be
   lower in the level of **by-department specialization**, and
   more advanced in the level of **cross-departmental organization**.

Later, the Japanese-style product development organization characterized by such **wide job range** and a relatively **strong project manager** was dispersed to Euro-American companies, mainly in the automobile industry.

In the product category of "**lapping architecture**", the product development pattern having the **integrated organizational capability** of the Japanese style was the world standard.

Distinction of "**lapping architecture**" vs. "**modular architecture**"

An cooperative adjustment among departments is more important is more important in "lapping (integral) architecture".
Design of Multi-Project Organization (Nobeoka)

It is necessary to proficiently organize and operate a bundle of plural product-development projects..."multi-project organization"
Company-Wide Research and Development Organization in Diversified Company

Centralized R&D department on company-wide basis (centralization type), or
Decentralized development organization for each business sector (decentralization type)

**Centralized in headquarters** • • • concentration of company-wide R&D capability, promotion of R&D on the cross-business-sector basis avoidance of duplicating investment to R&D among departments

**Decentralize by business sector** • • • flexible/prompt response to each sector's request, development structure capable to make small adjustments

The choice is delicate.
### Permanent Organization for Development

"Does your company have the following organizations?"

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Number of Companies</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>Planning department</td>
<td>67.08</td>
</tr>
<tr>
<td>(2)</td>
<td>Development department in headquarters (mainly in searching new business)</td>
<td>51.55</td>
</tr>
<tr>
<td>(3)</td>
<td>Development department in headquarters (mainly in planning/management of technology research)</td>
<td>62.73</td>
</tr>
<tr>
<td>(4)</td>
<td>Development department in charge of development</td>
<td>18.01</td>
</tr>
<tr>
<td>(5)</td>
<td>Department concentrated in specially fostering fresh-from-oven new business</td>
<td>21.74</td>
</tr>
<tr>
<td>(6)</td>
<td>Technology research center under direct supervision of headquarters</td>
<td>42.24</td>
</tr>
<tr>
<td>(7)</td>
<td>Development department of business division (mainly in searching new business)</td>
<td>40.99</td>
</tr>
<tr>
<td>(8)</td>
<td>Development department of business division (mainly in design)</td>
<td>48.45</td>
</tr>
<tr>
<td>(9)</td>
<td>Research center of business division</td>
<td>22.36</td>
</tr>
<tr>
<td>(10)</td>
<td>Special committee to technologically evaluate new product</td>
<td>34.16</td>
</tr>
<tr>
<td>(11)</td>
<td>Special committee to economically evaluate new product</td>
<td>18.63</td>
</tr>
</tbody>
</table>

[Related question] "Which one on the following is the domestic organization of your company?"

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Number of Companies</th>
</tr>
</thead>
<tbody>
<tr>
<td>(12a)</td>
<td>Type of by-product business division</td>
<td>67.93</td>
</tr>
<tr>
<td>(12b)</td>
<td>Type of by-region business division</td>
<td>7.55</td>
</tr>
<tr>
<td>(12c)</td>
<td>Type of main product by function/Minor product by business division</td>
<td>3.77</td>
</tr>
<tr>
<td>(12d)</td>
<td>Organization by function</td>
<td>20.75</td>
</tr>
</tbody>
</table>

Toyohiro Kawano 'Investigation of actual conditions of new product development (2001.11)'
Specialization of Basic Research
Organization and Development Organization

How to maintain the split of work between a basic research center and an application/development center?

How to smoothly transfer the accomplishment of a basic research center to an application/development center?

In Japanese manufacturing companies after the war ... in 1960s, "boom in central research centers" in 1980s, "boom in basic research centers"

Tendency for a basic research center to transform to a facility for an applied research and development

"Drift" phenomenon of a basic research center

Transfer from research to development ... a researcher himself moving to the down stream
Boom in Central Research Centers and Boom in Basic Research Centers

Trend in Building Corporate Research Centers

'Agency of Industrial Science and Technology investigation' NIPPON JITSUGYO PUBLISHING 1987..3
Reference: Such an organization makes the best use of the engineer.
Kazuaki Maruge 'Basic Research, what is the problem now?'
Reference: 'Technology and Economics' Japan Techno-Economics Society

<table>
<thead>
<tr>
<th>企業名</th>
<th>研究所名</th>
<th>設立年月</th>
</tr>
</thead>
<tbody>
<tr>
<td>金印乳業</td>
<td>*生物科学研究会所</td>
<td>1983.5</td>
</tr>
<tr>
<td>エスビー食品</td>
<td>中央研究所</td>
<td>83.8</td>
</tr>
<tr>
<td>キリンビール</td>
<td>開発科学研究所</td>
<td>83.9</td>
</tr>
<tr>
<td>サッポロビール</td>
<td>中央研究所</td>
<td>84.4</td>
</tr>
<tr>
<td>明治乳業</td>
<td>84.4</td>
<td></td>
</tr>
<tr>
<td>森永製菓</td>
<td>ヘルスサイエンス研究所</td>
<td>84.8</td>
</tr>
<tr>
<td>日本冷蔵</td>
<td>総合研究所</td>
<td>84.10</td>
</tr>
<tr>
<td>森永乳業</td>
<td>パイオニアナノ研究所</td>
<td>84.12</td>
</tr>
<tr>
<td>味の素</td>
<td>新技術研究所</td>
<td>85.7</td>
</tr>
<tr>
<td></td>
<td>基礎研究所</td>
<td></td>
</tr>
<tr>
<td>三菱レイヨン</td>
<td>東京研究所</td>
<td>83.12</td>
</tr>
<tr>
<td>日本触媒化学</td>
<td>ポリマー加工研究所</td>
<td>84.3</td>
</tr>
<tr>
<td>昭和電工</td>
<td>繊維研究センター</td>
<td>84.3</td>
</tr>
<tr>
<td>日本油脂</td>
<td>研究所</td>
<td>84.4</td>
</tr>
<tr>
<td>日本化学</td>
<td>物理研究所</td>
<td>84.8</td>
</tr>
<tr>
<td>東洋曹達</td>
<td>柔軟研究所</td>
<td>85.4</td>
</tr>
<tr>
<td>津村順天堂</td>
<td>東部研究所</td>
<td>83.12</td>
</tr>
<tr>
<td>第一製紙</td>
<td>中央研究所</td>
<td>84.4</td>
</tr>
<tr>
<td>大塚製薬</td>
<td>研究所</td>
<td>84.12</td>
</tr>
<tr>
<td>本間ファイザー</td>
<td>新薬研究所</td>
<td>85.2</td>
</tr>
<tr>
<td>山内製薬</td>
<td>焼津製剤研究所</td>
<td>85.3</td>
</tr>
<tr>
<td>三島製紙</td>
<td></td>
<td></td>
</tr>
<tr>
<td>王子製紙</td>
<td></td>
<td></td>
</tr>
<tr>
<td>山陽国策パルプ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>畜業</td>
<td>旭硝子</td>
<td>84.12</td>
</tr>
<tr>
<td>東海カーボン</td>
<td>電子商品開発センター</td>
<td>85.5</td>
</tr>
<tr>
<td>金属</td>
<td>信濃産業</td>
<td>86.4</td>
</tr>
<tr>
<td>住友電気工業</td>
<td>米国研究所</td>
<td>85.1</td>
</tr>
<tr>
<td></td>
<td>基礎技術研究所</td>
<td></td>
</tr>
<tr>
<td>メガトロン</td>
<td>三菱重工業</td>
<td>84.4</td>
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注: 表中の*印は、基礎的研究所を指摘した研究所と思われるものです。
What is an optimum distance between basic research and development?

If too close • • •
A long term research will be crashed by a logic in favor of "competition of tomorrow".

If too far • • •
An achievement of research won't be reflected on development
4. Performance of Product Development

(1) **Total product strength**
   - design quality
   - manufacturing quality
   - product cost

(2) **Development productivity/Development cost**
   : volume of resource investment in development sector

(3) **Development period (lead-time)**
   : from onset of development to either product release or onset of production
C Fujimoto, The University of Tokyo

Competitive Environment and Required Organizational Capability in Product Development

competitive environment

- intensifying international competition at product level
- uncertainty/instability of competitive environment
- drastic diversification of consumer needs
- sophistication/complexity of consumer needs (consistency)

required organizational capability in product development

- projection accuracy/prompt response
- model change
- model diversification

1. quick development speed (short development speed)
2. high development efficiency (less man-hours for development)
3. high total product strength (high level of consistency in product and development system)
"Hitting Average" and Performance of Product Development

There cannot be a 100% success in a new product development.

There are always hits or misses in product development activities that are the creative process of design information.

New product development for automobiles "hit" being less than half and for pharmaceuticals one in several thousands.

Analogy of baseball:

- **product strength** = direct impact on a hitting average of a new product
- **development period and development productivity** = basic stamina of product development
- **development period** = swing speed
- **development productivity** = to earn an at-bat frequency