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REEXAMINATION OF THE BASES OF THE TOTAL EXPENDITURE FOR RESEARCH IN BUSINESS

by

Kazuo Adachi

Preface

As regards research activity in business, there has been a view that planning or budgeting for it is not desirable. In view of the great difficulty of setting standards for it and of quantitative measurement of its results, and in respect of general feelings on the side of research staff against planning and control over their activities, it has been maintained that such work should be left to autonomous and elastic management by research members themselves; only so fruits could be expected.

Such a view was particularly influential in those days when advances of scientific technology were relatively slow and research expenditures had not yet amounted to a level to require examination.

Nowadays, however, it is generally accepted that systematic management is necessary also on research work in order that it may be conducted rightly and efficiently in the light of business's objectives, although there may lie some difference from the case of other aspects of management. In Japan, too, in accompany with the recent striking technological innovations and the remarkable increases in research expenditures, adequate programming and budgeting for the activities have come to be regarded as essential for the maintenance and development of business being faced with competition.

According to a survey by Bureau of Statistics, Office of the Prime Minister, the movements in the research expenditures and the number of staff of "companies and others" for the period 1956 to 1957 are as below. (Here "companies and others" include companies with capital of 1 million yen or more — 10 million yen for agriculture-forestry-fishery — and special juristic persons carrying business, in the fields of agriculture-forestry-fishery, mining, construction, manufacturing, communication, and electricity-gas-water facilities. "Research staff" re-

fers to those persons who are college-graduates or who have knowledges of equivalent level, have research career of more than two years, and are engaging in research work with particular themes each.)

Movements in the Research Expenditure and Staff Number

Year	Expenditure		Staff	
		Increase over Preceding Year		Increase over Preceding Year
	billion yen	%	thousand	%
1956	19.9	—	8.5	—
1957	27.3	37.2	10.1	18.8
1958	32.6	19.4	11.4	12.8
1959	95.6	193.2	42.9	276.3
1960	124.4	30.1	43.6	1.9
1961	163.8	31.7	46.1	6.0
1962	179.4	9.5	54.1	17.4
1963	207.3	15.5	60.0	11.1
1964	243.9	17.6	59.0	−1.7
1965	252.4	3.5	61.0	3.4
1966	292.2	15.8	68.8	12.3
1967	—	—	70.9	3.0

(Note) Source: up to 1958 by Kenkyū-Kikan Kihon Tōkei (Basic Statistics of Research Institutions), incl. side-work staff; for 1959 to 1964 by Kagaku Gijutsu Kenkyū Chōsa (Report of the Survey of Scientific Research); for 1965 ditto preliminary report; for 1966 and 1967 prepared from ditto the Summary of 1967 Survey. The ratios of the figures of 1966 to those of five and ten years ago are 1.63 times and 10.7 times for the expenditure and 1.26 times and 6.2 times for the staff respectively.

The first principle in R&D budgeting was to coordinate or synthesize the purposes of budgeting generally with the purposes of R&D. (J.E.Walters, Research Management: Principles and Practice, 1965, p. 220.)

Since the primary fruits of research work are new scientific or technological information, they cannot be directly connected with profit amounts that make the principal objectives of business budget. This is just the reason why the activities of research division must organically be linked with the business activities as the whole at the stage of planning. It is particularly so today because generally — though with appreciable differences by industries — life cycles of products have been shortened, and so sustenance and growth of enterprises cannot be expected without increasingly fulfiling researches of new products and improvements of existing products and process, and actively making the results reflect on production and marketing; the more so in view of ever-sharpening international competition. For this aim unified planning and control must be maintained between the production and marketing process and the research and development process. This would be rendered possible to some extent by incorporating research programs and

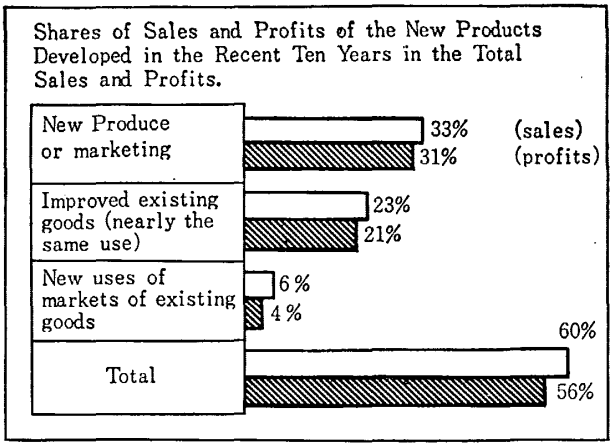
budgets into the master program and budget of the whole company.

International Comparison of Research Investments by Industries
(for recent one year) (unit. billion yen)

	Amount (million yen)	Per Cent of Sales
1. Chemical industry		
5 Japan's chemical co's. av.	1,644	2.8
5 Japan's medical goods co's. av.	2,129	4.8
U.C.C.	28,800	4.3
Eastman Kodak	26,700	6.0
ICI	22,400	3.1
Du Pont	21,250	2.1
Bayel	15,100	4.7
2. Electrical machine industry		
5 Japan's elect. machine co's av.	4,470	3.7
5 Japan's tele-communication equipment co's. av.	2,961	4.8
G.E.	—	6.0
Texas Instruments-own funds	7,920	6.7
-government's funds	9,730	7.2
Control Data	5,950	13.0
Sperry Rand	8,440	2.2
Ampex Corp. -own funds	3,380	6.1
-government's funds	1,511	2.8
3. Machinery industry		
5 Japan's general machine co's av.	349	1.5
5 Japan's auto co's. av.	1,927	1.5
3 Japan's precision instruments co's. av.	607	3.4
International Harvester	21,000	2.7
Caterpiller Tractor	16,200	3.7
Minesota Hining Mfg.	13,300	4.1
Lockheed Aircraft	9,800	2.8
Xerox	8,650	9.0

(Adapted from the Tōyōkeizai Tōkei Geppō, Jan. 1968.)

Thus, industrial research today is not a staff activity but an operation that is engaged in creating a product. This product is technology, which is a tool to be purchased and used in other areas of the company's operations. (E.D.Reeves, ESSO Research and Engineering Comp., Development of the Research Budget, in *Research Management,* Vol. 1, No. 3, Autumn 1958, p. 142.) For this reason, management on research activities are required from a whole-company viewpoint as a part of business planning and budgeting.



(Note) The graph is based on a survey by the Management Center in May 1967 for 211 companies listed in the First and Second Sections of Tokyo Securities Exchange. As is shown, if research and development work, in a wide sense, of new products are not continued, both sales and profits will be expected to rise only to an extent of 40% of the current amounts. Such rates are diversified by industries; new products constitute relatively high rates for foods, chemicals, medicines, machinery, notably electrical machines, transport equipment and so on. See Toyohiro Kōno, Wagakuni Daikigyō no Seihin Keikaku (Product Planning in the Japanese Big Business), Business, Jan. 1968.

1. Methods of Budgeting for the Research Expenditure

We have three methods of budgeting for the research expenditure as below.

1 Total-amount method;

2 Pile-up method;

3 Compromise method.

In order that a period budget may be featured with the nature of period operation plan, it must be based on a concrete program of business execution. From this standpoint, naturally the budgeting for research is expected to be grounded on a concrete plan of execution concerning individual reasearch project and subsidiary activities thereof. So in principle the pile-up method seems most desirable.

However, research activities involve various uncertain elements, their standardization is difficult, and appreciation of the results is not easy. Hence sheer dependence on the strict pile-up method would be unrealistic.

So beforehand prescription of the total amount for the activities will be conceivable. Yet adherence to such a total amount would result in an obstacle to unrestrained and elastic research work. Hence in the reality a compromise form will usually be most suitable.

In this case a prescribed total expenditure will supply the research division with an indicator of allowable volume of operation or a target of total efforts in planning for individual project, and as for top management it will furnish a criterion of judgement for the final selection of research project. (As to the budgeting for research expenditure, refer also Adachi, Kenkyū Yosan no Hensei ni tsuite (On Budgeting for Research in Business) in Kigyō Kaikei, Vol. 14, No. 12; do, Kigyō ni okeru Kenkyūhi no Yosan Kanri (Budget Control for Research in Business) in ditto Vol. 15, No. 12; do, Kigyō ni okeru Kenkyūhi no Kanri ni tsuite (On the Control of Research Expenditure in Business), in Mita Shōgaku Kenkyū, Vol. 5, No. 4.)

A survey by the Science and Technology Agency shows the break down of budgeting methods for the research expenditure in Japan's businesses as in the table below. The pile-up method accounts for 25.9%, while the compromise (of total-amount and pile-up) method is most popular constituting 32.5%. The total-amount system, in which appropriations for each individual project are not precribed but the total is checked within a certain limit in the course of advances of researches during the term, makes up as much as 23.3%. This last method is more numerous in the smaller businesses. It is to be noted that in this survey the totalling of individual operators' expenditures is included into the pile-up method but essentially this is to be taken as the total-amount system. Also noteworthy is the distinction between the pile-up method regarding partial items (e.g., personnel cost) and that about all items.

Methods of Budgeting for Research Work

	Total	Capital Scale			
		A	B	C	D
(1) Total amount simply	83	1	5	22	55
(2) Pile-up	159	14	14	65	66
of which, (1) Project-base	117	6	10	53	48
(2) Researcher-base plus extra	42	8	4	12	18
(3) Compromise of total and pile-up	200	23	21	70	86
of which, (1) Check pile-up within total	139	18	17	45	59
(2) Sum of partial pile-up and total	61	5	4	25	27
(4) Check within total according to progresses	143	0	1	31	111
(5) Others	29	1	1	7	20
Total	614	39	42	195	338

(Note) A is more than 10 billion yen, B 5–10 billion yen, C 1–5 billion yen, and D 0.1–1 billion yen.

Planning Bureau, Science and Technology Agency, Kigyō no Kenkyū Katsudō ni kansuru Chōsa, preliminary report, Dec. 1963.

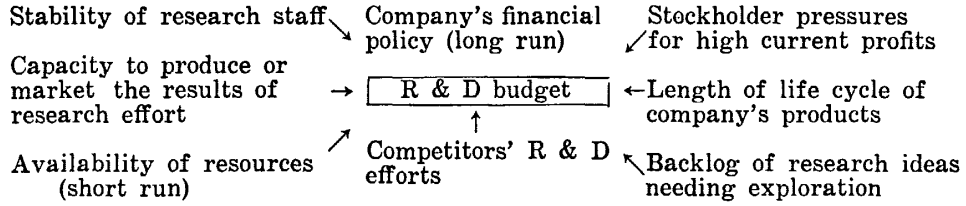
2. *Determinants of the Total Research Budget*

As to the forces that may act on the determination of the annual research budget, Robert E. Seiler has said as follows. First there is a constant pressure from the research-management to maintain the staff at least at the current level or, in most cases, at a higher level. Also there is another pressure of demand for larger appropriation to expand facilities. An increase in research staff will normally accelerate flows of research ideas and swell backlogs of study projects that are potentially profitable. This will result in a further demand for staff members by the research management. It would be hard for the top management, without objective measures to weigh the results of research efforts, to stand against such demands.

Second, a factor that directly influences the current research budget is availability of funds. Since other miscellaneous business activities must be carried out within the boundary of limited financial resources, the research budget has to be correlated with them.

Further factors to effect upon the research budget are competitors' efforts of research and pressures from stockholders asking for immediate profits and dividends. The top management, keeping confidential relations with stockholders, has to maintain proportion between current and far future profits of the company. So in the research budget equalization must be pursued between the effects on the profits of the current year when such expenditures are incurred and the effects on the long-run profitability.

These factors tend to restrain each other in annual budgeting. Most of them work to increase the appropriations while only a few toward decreasing. The relations among these determinants may be figured as below. (R.E.Seiler, Improving the Effectiveness of Research and Development, 1965, pp. 78-81.)



As may be obvious from the above descriptions, the research expenditure has an inclination to swell year by year, and such increases must be contemplated for the sake of sustenance and development of business. Nevertheless the increases cannot be so large as to contradict financial safety or profitability, nor can the expansion of the research scale be so rapid as to cause lower efficiency of research work.

Major elements to be taken into account by the top management in decision making about the total research expenditure may involve the following, for example. (British Institute of Management, Management of Research and

Development, 1964, p. 22.)

(a) The minimum that may secure the enterprise to stay in its business field;

(b) Present financial state of the enterprise, and future funds available for providing necessary production facilities for new products or methods and for cultivating markets to utilize expected results;

(c) General positions of competitors and the degree of research-orientation in the industry concerned;

(d) Whether the enterprise or the competitors are defensive or offensive;

(e) Outlook of business environments;

(f) Normal rates of obsolescence of existing products or methods, and levels of research and development work necessary to bear out new substitutable goods or methods;

(g) Feasibility of research staff or facilities inside and outside the enterprise.

All in all, the research budget is determined by management's judgement on what an amount will conform with the target program of research. The amount will be held within a certain boundary. Its upper limit will be decided by the financial capacity for research work and the utility of expected results. The ability of qualified research staff is also a determinant effectively to define the amount usable for a year. And the lower limit will be an amount that may enable an enterprise to survive in the business field. (Accounting for Research and Development, N.A.A.Research Report 29, 1955, pp. 22-23.)

As for the bases of the total budget, the writer has already presented some discussions in previous occasions, but a further study is intended in the below. (See Adachi, Taikōteki Kenkyū Keikaku no Settei — Setting Fundamental Research Plan —, in Mita Shōgaku Kenkyū, Vol. 5, No. 1; do, Kenkyūhi Sōyosangaku no Kettei ni tsuite — On the Determination of the Total Research Budget — in Keiei Soshiki to Keisan Seido, Chūō Keizai-sha.)

Bases of Determining the Total Research Budget

3

James B. Quinn, for example, has mentioned four elements as the bases of the total research budget. (James B. Quinn, Budget for Research, in Handbook of Industrial Research Management, 1959, p. 295.)

(1) Per cent of sales;

(2) Matching or exceeding competitors' outlays;

(3) Growth-rate standards;

(4) Projected rate of return.

Another view cites the following bases as being generally used. (Herman, C.Heiser, Budgeting, 1959, p. 288.)

(a) Competitive parity;

(b) Per cent of sales;
(c) "All you can afford";
(d) Rate of return.

In Japan various bases are being used as below. It may be noted that past outlays are used for the basis in a fairly large number of enterprises.

Bases of the Total Research Budget

A.			B.		
(1)	Limit permissible in financing	32%	(1)	Past research expenditures	45.2%
(2)	Average of past figures	31.3	(2)	Pile-up of research projects	42.4
(3)	A certain rate of sales	15.3	(3)	Future profits	35.9
(4)	A certain rate of previous year's amount	12.8	(4)	Future sales	29.3
(5)	Others	8.6	(5)	Past sales	13.8
	Total	100.0	(6)	Number of research operators	10.3
	(Covering 281 companies. op. cit., Kigyō no Kenkyū Katsudō ni kansuru Chōsa, Dec. 1963.)		(7)	Past profits	7.6
			(8)	Expenditures of kindred companies	3.4
			(9)	Others	1.4
				(Covering 290 companies. Nomura Sōgō Kenkyūjo, Kigyō Keieimen kara mita Kenkyū Kanri no Jōkyō Chōsa, Oct. 1966.)	

In the writer's view, it is appropriate to group the bases under four categories of (1) competitor basis, (2) output basis, (3) input basis and (4) increasing-amount basis. The output basis may include sales basis, profit basis and value added basis. The input basis may comprise research-staff basis and available fund basis.

The major condition that confines the short-run scale of research work is personnel elements including research operator, assistant or related engineers. These persons cannot be brought up in a short time. Also the expenditure per operator in a particular enterprise will not show short-run fluctuations as is the case with basic research, although substantial differences may lie by business scales or other conditions.

So the total amount for a short period, such as one budget-term, may be said to depend on the current numbers of research operators or research-related persons.

Next, funds inputted into research are relatively low in the probability of recovery compared with those for production or marketing. And in most cases the recovery requires long time.

> RCA had $50 million invested in color TV before it reached the American living room and $125 million invested in it before it began to pay off. Sometimes even successful research takes years to pay off. It

> took more than 15 years for RCA to get its money back. Du Pont spent $25 million and 25 years developing Corfan (artificial leather) before it put Corfan on the markets in 1964. RCA estimates the 90 per cent of its research ideas are useless, Du Pont that one third of chemical research projects are flops while still in the laboratory. And even after succeeding in the laboratory, most of the rest prove impractical in production. Fewer than one in ten even gets into production, and some fail then. (Franklin G. Moore, Manufacturing Management, 4th ed., 1965, pp. 311-312.)

Therefore in principle the research funds should be raised from owned money that need no repayment. In most cases, provided owned money is used, research scales will appreciable be restricted by the side of finance.

From the above viewpoints, research staff and funds constitute unoverlookable elements in the decision of the total amount. Yet primarily input should be controlled by output. Business operations that can be effective only through long-run and persistent work, such as research, must especially be preceded by long-run planning of its output. The primary results of research are new scientific knowledges whose quantitative appreciation is generally difficult, and contributions to the profit, the secondary results, are not easy to abstract.

Hence for the decision of short-run scale of research, the numbers of existing staff and the like make ruling elements. This furnishes a ground for a view that any effective research can be expected only on an expanding scale. Therein lies a significance of the increasing-amount basis.

> Ira Horowitz takes that, where the budget is increased on the basis of previous year's one, an increase of 10% may aim at a slow growth, 45% a rapid one and 20% a moderate one in the research work. (Ira Horowitz, Estimating Changes in the Research Budget, in The Journal of Industrial Engineering, Mar.-April, 1961, p. 117.)

Thus a realistic method may be found in the increasing-amount method on the basis of the input basis. However, if research work is to be actively promoted in opposition against competitors, a consideration to the competitor basis or the output basis must be paid, though it is a mere rough guideline. So these bases shall be examined in the below.

4. Competitor Basis

The aim of this basis is to carry business keeping abreast with competitor, and so it may be effective where a defensive standpoint is taken as business policy. Such a research policy being given, however, there lie the following problems in this basis.

(1) Accurate information about the scales and levels of research in other firms is generally unavailable. For example, the research costs insert-

ed in the income statements or the manufacturing costs sheet in the Securities Report do not clearly show their scopes and methods of calculation. It is therefore impossible to judge the scales and levels of competitors' activities from official reports of this kind. Not a few companies do not make public the actual amount of research expenditures to outsiders on account of consideration against competitors or taxes. (An appreciable number of companies do not insert even in the Securities Report.)

(2) Even if the total amounts in competitors were to be known, it would be meaningless to take up such totals disregarding differences of business structures or research systems. Such elements as the number of staff or the amount per operator must be taken into account at the same time. Yet there are substantial differences in the per-researcher amount by business scale or so. (As of 1964 the per-researcher amount by capital-classes of 0.1 — 1 billion yen, 1 — 10 billion yen and above 10 billion yen is respectively 2,337, 3,800 and 5,220 thousand yen — a substantial difference.)

Hence, for the aim of keeping competitive position against competitors that have different structures, e.g. scales, the first problem is the selection of the kinds of research expenditures to be taken for the basis of comparison. No absolute bases exist on this point.

(3) If competitors' research expenditures alone were taken for the indicator of competition, a company's outlay would be made regadless of existing staff — their quality and ability, which would in effect result in lower effectiveness of research work.

(4) For substantive competition with competitors, consideration must be paid not only to funds but also to other input elements such as staff number, facilities and services. Furthermore, in the ultimate competitors' overall levels and direction of research activity must be examined from a long-run viewpoint. This involves factors of non-quantitative judgement.

Embracing problems as the above, the competitor basis is nonetheless of significance as the minimum limit of research effort to be abreast with competitors. To rely solely on it, however, is dangerous on account of reasons above described.

5. Sales Basis

As the advantages of this method the following may be mentioned; (1) its simplicity, (2) the general availability and reliability of information needed to compute the forthcoming year's guiding sum, and (3) keeping research generally geared to funds availability. (J.B. Quinn, op. cit., p. 296.)

There are, however, some shortcomings which will be examined in the below.

(1) If the allowable amount of research expenditure is settled as a certain percentage of sales, it will rise in times of increasing sales while con-

tract in decreasing sales. This would involve:—

1) It is not desirable that research expenditures are decreased when sales are declining. Right in such a period of recession or of stagnant or receding growth, there will be a need of improving existing products or process or contemplating sales increase or cost decrease. For this aim short-run research must be actively fostered. A contraction in the amount will contradict this require.

Next, long-run or basic researches can be fruitful only by long-term and uninterrupted operation. Arbitrary suspension or postponement, regardless of advances of work, will impair willingness of research, too.

2) On the other hand, a sudden increase in times of sales rise is no less undesirable as is the decrease. Typically two forms are conceivable for the increase. The one is an increase in the staff number, the other that in the per-operator amount. In either case a sudden increase will not effect to elevate effectiveness of research. And, in the reality, a rapid increase in the qualified staff will be difficult in most cases.

Hence expenditures are not to be changed in short term following fluctuations of sales due to business cycles.

In the last recession period in Japan, however, substantial contractions of research expenditures were seen. This seems to have been derived from inadequate recognition of research activities on the side of top management and also the fact that there were remaining not a few number of research projects that should have been suspended, even in boom times, in respect of poor efficiency and profitability due to improper management. (The drops of growth rate of research expenditures for the periods 2nd-half 1957 to 2nd-half 1958, 1st-half 1961 to 1st-half 1962 and the last recession, each as against preceding years, may be seen in the above-shown Table on the movement of expenditures.)

Effects of Business Recession on Research and Development

	Percentage of Firms up to 1964	Percentage of Firms in 1965
Cut of research budget	18.0%	34.0%
Postponement of investment in research facilities	20.0	38.0
Cut of research staff	18.5	27.5
Reexamination of research themes	35.0	55.5
Consolidation of projects	35.5	57.5
Consolidation of existing products	24.5	34.5
Withholding of basic researches	18.0	32.5
Withholding of applied researches	4.5	10.5
Withholding of development	26.0	21.5

In the occasion of last recession enterprises took measures as above.

Budget cut, investment postponement and staff cut were adopted by 20% of the companies surveyed up to 1964 inclusive. In 1965 the ratio of such companies further increased; cut of research-resource input (personnel, money, goods) took place in firms counting double those up to 1964. (From Nihon Nōritsu Kyōkai, Kenkyū-kaihatsu Kōritsuka ni kansuru Chōsa Hōkokusho, Mar. 1966, compiling answers from 200 companies.)

Contrastively in America, according to a survey by the American Management Association covering 833 companies, the research budgets for 1958 increased by 4% over 1957 on average, despite the recession 2nd-half 1957 to 1st-half 1958. (L. G. Bliss, "Managing the Research and Development Activity" in H.B.Maynard ed., Top Management Handbook, 1960, p. 546.) By another survey taken in 1959, in only 3 cases out of 121 companies the budget was decreased due to decline of sales or profits. (Ira Horowitz, op. cit., p. 117.)

(2) Among the constituent items of research expenditure, personnel costs and equipment costs make up a substantial portion. So the research expenditure has a nature of the committed costs significantly.

As to the concept of committed costs there are two interpretations. The one is a view to be called "binding costs", and the other is "determined costs" or "established costs." The binding costs mean "unavoidable costs" whose incurrence cannot be avoided unless with some losses for a certain period once decision has been made. The latter implies costs on which decision making has been made or whose incurrence is established, that is, sunk costs in a wide sense. For the details of these costs concepts, please refer the writer, Capacity Costs Gainen o megutte (Around the Concepts of Capacity Costs), in Sangyō Keiri, Aug. 1967; ditto Committed Costs Gainen to Managed Costs Gainen — Kiketsu Genka Gainen, Chōki Genka Gainen ni kanrenshite (Concepts of Committed Costs and Managed Costs — in Connection with Established Costs and Long-term Costs), in do Sept. 1967; ditto subtitle, Managed Costs no Jiyūsairyō-sei, Capacity Costs Sei, Miketsu Genka-sei o Chūshin to shite (— Refering to the Nature of Discretional Costs, Capacity Costs and Unestablished Cost of the Managed Costs), in ditto Oct. 1967.

Those expenditures related to existing staff and facilities are much of nature of the established costs, and also of the long-binding costs, on which, once determined, short-run changes are difficult to make. So, also from this viewpoint research scales should be decided on long-run prospects, not be influenced by short-run fluctuations of sales.

Trend of item composition of research expenditures in Japan is shown below.

(3) The aim of adjusting research expenditures in accordance with in-

Trend of Composition in Research Expenditures, by items (%)

	Personnel Cost	Materials Cost	Purchase of Fixed Assets	Other Expense
1959	34.3	19.4	29.2	16.4
1960	31.9	20.2	34.9	13.0
1961	32.5	19.3	35.0	13.2
1962	36.7	20.3	27.7	15.2
1963	39.5	20.4	24.5	15.6
1964	39.8	20.1	24.8	15.3
1965	43.2	20.7	20.5	15.6
1966	44.0	21.5	18.4	16.1

creases and decreases in sales lies in an intention to secure a certain profit rate even in times of stagnant or declining sales by cutting such expenses that, as research expenditure, have no short-term relation with profit growth or rather work to oppress it if long-term researches are majorly involved.

To take a certain percentage of sales as the allowable research amount from such a viewpoint, however, raises some problems as follows.

First an increase in sales does not always lead to an increase in profit. Profit rates as against sales are on a downward trend in Japan. So from the viewpoint of securing profits, it would be more desirable directly to employ profits for the basis of allowable amount for research than the sales basis.

Next the view that a cut of research expenditures, notably for long-run research or basic research, at a period of decreasing sales furnishes some protection to the term profit is not always correct, since any such effect on short-run profit rate may be softened by deferment of accounting, and since expenditures for basic research usually do not constitute so large a portion of the total amount. (According to Kagaku Gijutsu Kenkyū Chōsa, the portion of basic research expenditures for 1966 and 1965 is 11.2% and 10.4%.)

Hence it may be said that such an increase in short-run profit by postponement or suspension is less significant compared with a fear of lower technical level in long-run.

(4) For the sales basis there is no objective and reasonable standard to show what a rate is optimum, minimum or maximum. The amount for research should be examined from a long-run outlook, taking into account other items of cost and profit.

(5) In connection with (4), it is to be noted that a ratio of research expenditure to sales does not always reflect the level of research effort or the degree of concern on it by management. The matter may naturally be different between industries with a large rate of purchased value, e.g. material costs, hence a small rate of added value, and industries with inverse construction, for example, chemical fibre spinning and medicine manufacture. (According to the Shuyō Kigyō Bunseki of Nippon Ginkō, in 1st-half 1967 the rate of added value was 24.35% for the former and 34.74% for the latter.)

And, even where the added value is of the same rate, proportions of its constituent items must be considered. For instance, labor-intensive industries with larger personnel expense and capital-intensive ones with smaller such expense the same treatment is not to be applied.

(6) It has been held that enterprises with a higher ratio of research expenditure to sales have a higher growth potentiality. However, this fact has a correlation with another fact that *vice versa* enterprises with a high growth rate have capability of investing a higher ratio of sales to research. It is unable to decide cause and effect.

> By a report of the Stanford Research Institute titled "Business Strategy for Changing Environments," an analysis covering 400 manufacturing companies involved in Moody's Handbook for the ten years 1948 to 1958 showed that a high grade of correlation exists between research expenditures as percentages of sales and growth rates. (Robert M. Bowle, Aligning Product Research Programs with Total Company Objectives, Research Management, Vol. V, No.1, Winter 1962, p.24.)

It is evidenced by numerous cases that many big enterprises of America today have built up their present positions by research investment, while those that have achieved remarkable growth have power to make still larger investment in it.

Also as for Japan it may be said that the recent high-tempo growth has resulted in the capability of making larger research investment. (See the writer, ibid, Kenkyūhi Sōyosangaku no Kettei, p. 307.)

In the case of American technology-dependent industries, the correlation between the ratio of research expenditure to sales and the profit rate is fairly high. In Japan, however, such correlation is generally unobservable due to the higher dependency on imported techniques and other conditions.

This contrast between the two countries may be seen, for example, with medicine manufacturing as below. (See, Waga Kuni Iyakuhin Kōgyō no Genjō to Mondaiten, Kōgin Chōsa Geppō, No. 134, Nov. 1967, pp. 31–33.)

As may be apparent from the above examination, any specified ratio is not sufficient to determine the optimum, minimum or maximum amount of research expenditure. Yet this basis, combining other bases, would furnish a broad measure to show an enterprise's willingness or concern on research work, and also testing of this ratio would serve for business planning for a term.

As to the appreciation of this indicator, there is seen a wide difference of views between top-management and research-management, by a survey in America. As is shown in the figures below, most of the top-management regard the sales percentage as obviously valuable in determining annual expenditure for research while an appreciable part of the research-management take it as almost worthless. Yet even those top-management who regard it worthful do not adopt it as a fixed basis. They appreciate it as a basis of comparing

Comparison of Research Investment of Medicine Makers between America and Japan, 1965 (unit: billion yen)

America	Sales	Net Profit	Research Expenditure
Eli Lilly & Co.	113.9	15.0(13.2)	11.2(9.9)
Chas. Pfizer & Co., Inc.	195.3	19.2(9.8)	7.1(3.7)
Merck & Co., Inc.	119.5	21.4(18.0)	11.7(9.8)
Smith Kline and French Labs.	87.7	15.2(17.3)	8.5(9.8)
Abbott Labs.	85.2	8.8(10.4)	6.1(7.2)
Upjohn Co.	87.2	13.3(15.3)	8.3(9.6)
Parke Davis & Co.	80.8	11.7(14.5)	5.1(6.4)
Warner-Lambert Pharm. Co.	138.1	13.8(10.0)	4.7(3.4)
American Cyanamid Co.	310.6	33.5(10.8)	14.9(4.8)
Richardson-Merrell, Inc.	76.8	7.3(9.6)	4.0(4.5)
Bristol-Myers Co.	140.9	12.0(8.5)	4.5(2.9)
Miles Laboratories, Inc.	49.5	2.9(5.9)	2.3(4.7)
Schering Corp.	42.3	5.1(12.2)	3.5(8.3)
Mead Johnson & Co.	40.6	2.1(5.2)	2.0(5.1)
Total	1568.9	181.8	94.5
Average	112.0	12.9(11.6)	6.7(6.0)

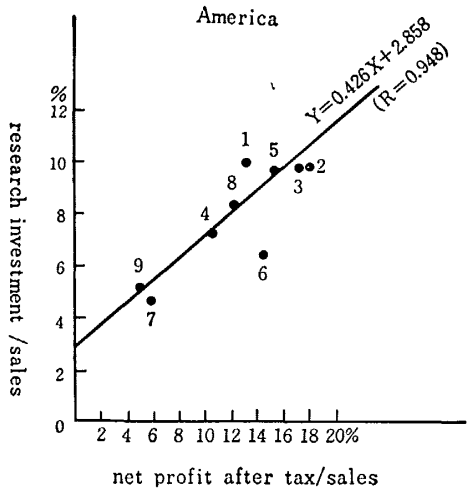
(unit: billion yen)

Japan	Sales	Net Profit	Research Expenditure
Takeda Chemical Industries, Ltd.	98.8	6.2(6.3)	3.2(3.3)
Tanabe Seiyaku Co., Ltd.	35.0	1.1(3.2)	1.5(4.3)
Sankyō Company Limited	33.6	1.9(5.8)	1.2(3.8)
Shionogi & Co., Ltd.	31.7	2.0(6.6)	1.4(4.5)
Fujisawa Pharmaceutical Company Limited	16.8	1.0(6.3)	0.5(3.5)
Daiichi Seiyaku Co., Ltd.	15.3	0.8(5.3)	0.5(3.3)
Yamanouchi Pharmaceutical Co., Ltd.	15.0	1.0(6.9)	0.2(1.9)
Dainihon Pharmaceutical Co., Ltd.	8.4	0.4(5.7)	0.3(4.2)
Chūgai Pharmaceutical Co., Ltd.	11.4	△1.0(△9.2)	0.5(4.4)
Eizai Co., Ltd.	13.4	0.7(5.9)	0.5(3.8)
Ban'yū Pharmaceutical Co., Ltd.	11.4	1.4(12.4)	0.1(1.0)
Yoshitomi Pharmaceutical Ind., Ltd.	9.3	0.5(6.3)	0.4(4.4)
Total	300.7	16.6	10.7
Average	25.0	1.3(5.5)	0.9(3.6)

(Source) For America, Fortune (July 1966), Moody's Industrial Manual (1966), etc. For Japan, Securities Report of each company.

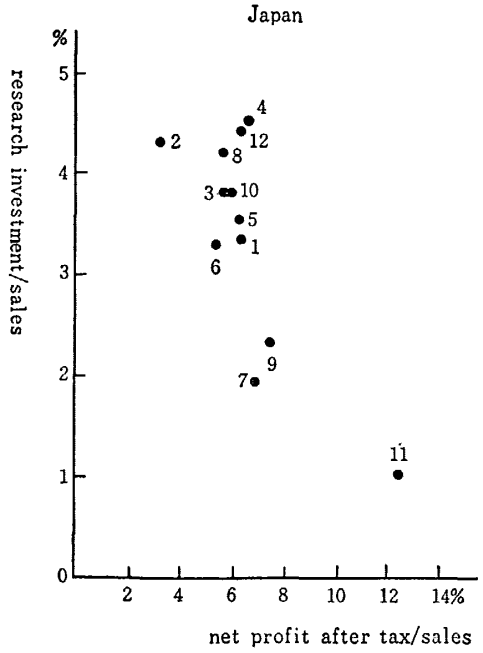
(Note) Figures in parentheses are ratios to sales, in %; net profit is after tax.

Research Investments and Profits in Relation to Sales, in major medicine makers



Firms
1. Lilly
2. Merck
3. Smith Kline and French Labs.
4. Abbott
5. Upjohn
6. Parke Davis
7. Miles
8. Schering
9. Mead Johnson

(Note) Performances for 1965. Data from each Annual Report. Firms shown are specialty makers only from among 17 big companies related.



Firms
1. Takeda
2. Tanabe
3. Sankyō
4. Shionogi
5. Fujisawa
6. Daiichi
7. Yamanouchi
8. Dainihon
9. Chūgai
10. Eizai
11. Ban'yū
12. Yoshitomi

(Note) Performances for 1965, excepting Chūgai for which figures of 1963 are shown because of the red-ink in 1965.

actual values or relative efforts in the business circles. (Robert E. Seiler, op. cit., p. 84.)

Opinion as to Usefulness of R & D Spending-Sales Ratio

Opinion	Administrative Officers (line)	R & D Officers (staff)
R & D spending-sales ratio of direct use in determining R & D budget	66.6%	10.0%
R & D spending-sales ratio of little value in determining R & D budget	16.7	50.0
Not sure	16.7	40.0
Total	100.0%	100.0%

6. Value Added Basis

A profit basis is superior to the sales basis because, as has been observed already, research funds are better financed from owned funds, and the effects of research expenditure on profit have to be deliberated since the work is not always able to be connected with realization of profit in short run. A determination of research expenditure as a certain ratio of profit, however, would result in control of research scales by business operations, similarly as is with the case of sales basis. If the profit basis is to be adopted under an intention of deciding the expenditure as a dividend of created value and as a reinvestment in research, value added would be more desirable than profit.

Of course the value added basis is also not exempt from the shortcomings common to any output basis. So it is not proper to determine the amount merely by a certain percentage of value added. Consideration on value added is, however, essential in business planning or costs planning for a term. There may be some criticism against the introduction of value added into business planning. If profit planning is doubtlessly to be the main axis of business planning, the idea of value added basis would involve a fear of misleading business planning. Yet in order to attain stable growth of an enterprise, it is necessary to obtain appropriate value added and allocate it rightly to its business participants. An excise planning on this point cannot be performed in the stage of conventional profit planning. That is to say, such a way of thinking as sales—costs→profits, or sales→costs+profits, or profits→sales—costs makes it difficult to grasp information that could be obtained from a viewpoint that places both profit-constituting items and cost items on the same dimension, and also to understand it. False grasp or judgement is apt to be derived about such information as gross savings, real profits or gross profits, which are indispensable to business planning.

Most items of research expenditure have character of investment in effect, even where they are treated as production costs or general expenses for a certain term. They have an aspect of outlays for the aim of future profits, though uncertain. Where such outlays are directed to researches for im-

proving existing products or process, they will of course contribute to the realization of current profits, whose measurement may be performed objectively to some extent. To speak exactly, however, even these outlays make investments that should correspond to the periods in which their results on products or process are effective. So a quite different treatment is required from that of those expenditures that are incurred currently for normal operations of production and marketing. This is so because, in other words, if such research outlays were not made, the term profit would be increased so much for a short run.

Judgements on research expenditures depend on the management's will on: which should be given heavier weight, current profit or long-run profit. In this sense the expenditures come under the "policy costs" or "discretionary costs."

In view of such character of research expenditures, it is desirable to determine their amount as an item of distribution of added value, maintaining connection with profits and others.

For this aim the following points should be paid consideration.

(1) Generally the cost items, as constituents of value added, are grasped under a classification of forms, such as personnel costs, financing costs, depreciation, rent and so on. It would be desirable, however, to add a functional classification by, for example, production costs, order getting costs and order filling costs, research costs, general administrative costs, etc., for the purpose of relating research expenditures to added value. That is to say, constituent items of production costs or order-filling costs shall be grasped under formal classification, and proportional balance among items shall be maintained: by this means, the adequacy of the level of research expenditures and other policy costs (advertisement, education, welfare, contributions) as compared with the levels of profit, depreciation, personnel costs and so on.

purchased value	production costs and order-filling costs: personnel costs	depreciation	others	policy costs (incl. research costs)	finance costs	others	profit
	value added						

In this connection it is also necessary to examine the adequate level of the personnel costs for research work as against the total personnel costs including other fields.

The Kagaku Gijutsu Hakusho (White Paper on Science and Technology) takes a view that added value, excluding material costs, is more practical than the sales basis as the indicator of research efforts, though not as the basis to determine total budget, of enterprises.

By a Belgian conference for science policy the ratio of research expenditure was named "research coefficient," whose features have been

clarified as follows.

1) The research coefficient shows distinct differentials by types of industries.

2) If industries are ranked according to the order of the co-efficient, the pattern resembles among countries.

3) The coefficients of most industries present remarkable differences by countries, showing the differences of research efforts by countries for respective industries.

The coefficients by industries in Japan are calculated as below. The level is internationally high for industries of chemicals, transport equipment, steel, food and fibre, while low for electrical machinery and general machinery.

Trends of Research Expenditures, Research Coefficients and Ratios to Sales in Japan, by Industries (in ¥billion and %)

Year	Items	Elect. Machinery	Chemicals	Ceramics	Steel	Metal Goods	Pulp & Paper	Food	Fiber	Transport Equipment
1959	Expenditure	21.237	23.376	2.761	5.883	1.039	1.323	2.577	3.557	8.937
	Coefficient	5.5	5.6	1.7	1.9	0.7	1.3	0.8	1.0	2.9
	Ratio to Sales	1.84	1.40	0.81	0.50	0.72	0.41	0.31	0.46	0.95
1960	Expenditure	28.066	27.024	3.396	8.686	670	1.573	3.388	5.480	14.478
	Coefficient	5.7	4.3	1.6	2.2	0.3	1.3	0.9	1.3	3.3
	Ratio to Sales	1.90	1.50	0.70	0.45	0.41	0.34	0.32	0.71	1.14
1961	Expenditure	38.984	36.832	3.205	9.954	1.840	1.809	4.791	5.105	16.670
	Coefficient	5.8	5.8	1.2	1.9	0.6	1.2	1.1	1.0	3.5
	Ratio to Sales	1.93	1.64	0.69	0.52	0.60	0.37	0.35	0.47	1.05
1962	Expenditure	43.420	41.993	4.115	12.142	1.617	2.094	6.137	5.575	17.714
	Coefficient	5.6	6.2	1.3	2.9	0.5	1.2	1.1	1.0	3.3
	Ratio to Sales	2.09	1.77	0.79	0.70	0.64	0.41	0.34	0.56	1.00
1963	Expenditure	50.415	52.372	4.472	11.803	1.743	2.383	6.965	6.877	22.696
	Coefficient	6.5	6.3	1.2	2.4	0.4	1.2	1.0	1.1	3.3
	Ratio to Sales	2.29	1.77	0.74	0.65	0.62	0.41	0.32	0.65	1.06
1964	Expenditure	50.697	65.723	5.549	13.323	3.731	3.329	8.284	7.822	24.199
	Coefficient	5.7	6.7	1.3	2.0	0.8	1.5	1.2	1.2	3.0
	Ratio to Sales	2.28	1.83	0.72	0.65	0.76	0.39	0.37	0.61	1.16

Compiled from the Kagaku Gijutsu Hakusho, 1967.

(2) It should be noticed that the expense items constituting added value come under the capacity costs. The business costs are divided into the capacity costs and the activity costs. The capacity costs have been defined as costs that incessantly emerge due to holding of capacity for prospective future activities (Accounting for Costs of Capacity, N.A.A. Research Report, No. 39, May 1, 1963), and the activity costs as those that emerge according to current

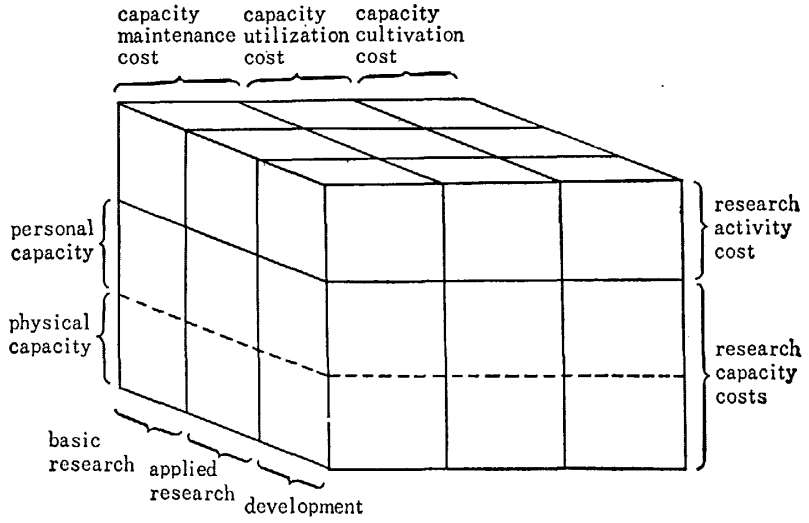
operations and are controlled thereby (Walter B. McFarland, Concepts for Management Accounting. p. 51).

The meaning of the capacity costs has been gradually widened from the initial interpretation as manufacturing equipment-related costs, and hence may include research expenditures as an item. (As to the concept of capacity costs refer the writer, Capacity Costs Gainen no Saikentō (Reexamination of the Concept of Capacity Costs), in Sangyō Keiri, Jan. 1967; Capacity Cost Gainen o megutte (Around the Concept of Capacity Costs), do Aug. 1967.)

The capacity costs in a wide sense may further be divided, from a managerial viewpoint, into costs for preparing business capacity (depreciation, fixed part of regular employees' salaries and wages), those for maintenance of capacity (maintenance expense), those for cultivation of capacity (education and training expense) and those for promoting capacity utilization (advertisement). Research expenditures make a constituent item for the last named three costs; that is to say, the research expenditure for factory safety pertains to capacity maintenance, that for improving existing products concerns promotion of capacity utilization, and that for new products regards cultivation of capacity.

As to the research operation itself, there exist research-capacity costs concerning staff or facilities and research-operation costs that emerge accompanying the utilization of research capacity. Yet the research as a whole is to be regarded as the capacity costs.

These relations are shown in a picture below.



In budgeting the total research expenditure, deliberation is necessary on, beside above-mentioned various points, the program-balance among basic research, applied research and development as well as long-, medium- and short-term researches. (As for the program-balance see the writer, Kigyō ni okeru

Research Program no Kihon Mondai-in Kenkyūhi Yosan Hensei ni kanrenshite (Basic Problems of Research Program in Business—in Relation with Budgeting of Research Expenditures), Mita Shōgaku Kenkyū, Vol. 5, No. 3).