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ACCOUNTING AND FINANCIAL CONTROL FOR R&D EXPENDITURES

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This paper reviews the accounting and financial control aspects of research and development (R&D) expenditures. In particular, the valuation and presentation of R&D in financial statements is discussed as well as the function of planning, budgeting, controlling, and auditing R&D activities. The discussion of accounting aspects of R&D focuses on the Financial Accounting Standards Board's guidelines for R&D valuation and presentation. Planning and budgeting for R&D involves organizational and behavioral factors, project selection criteria and techniques, as well as the content and format of R&D budgeting. The control of the R&D process can be financial or technical. The first focuses on costs while the second emphasizes time and quality controls. In conclusion a systems approach to R&D auditing and possible avenues for research is proposed.

1. Introduction

This paper is concerned with a critical review of the accounting aspects of research and development (R&D) expenditures. Three areas of accounting for R&D are cited as particularly important: (1) reporting practices for R&D, i.e. R&D valuation and financial statement presentation; (2) planning and budgeting for R&D; and (3) control and audit of R&D. Section 2 discusses the critical accounting aspects of R&D, reviewing the Financial Accounting Standards Board's guidelines for R&D valuation. Section 3 discusses planning and budgeting for R&D, focusing on the following issues: (1) organizational factors; (2) possible criteria and approaches for planning and budgeting R&D; (3) behavioral aspects of R&D budgeting; and (4) contents of R&D budgeting. Section 4 turns to the control and audit aspects of R&D. Specific procedures for control and audit are reviewed, paying particular attention to the overall planning and control system of the firm. Finally, in section 5, the relationships among the three accounting aspects of R&D and their roles in overall R&D management are summarized, and suggestions for future research in this area are presented.

2. Accounting practices for research and development

A substantial number of companies in the modern business environment are incurring large costs for research and development for the purpose of developing new and improved products. Clearly, the method of accounting for R&D expenditures is a major concern of businessmen, accountants, and the various users of financial statements.

Three accounting practices of R&D are important. (1) What is the definition of R&D? (What are the activities constituting R&D?). (2) Should R&D be charged against income when incurred or deferred (capitalized) and amortized against future income? (3) What R&D information should be disclosed in financial statements? Of the three, the second problem is the most critical and controversial, and will be the focus of our analysis.

2.1. Industry practice

Before 1974 the practice of the majority of industrial companies was to charge such expenditures to expense as incurred. [1] The accounting profession has taken a conservative approach to this problem, and generally has favored charging R&D expenditures as current expenses. This write-off policy may be founded on one of several grounds, e.g. conformity with income tax policy, the service-function concept, financial analysts' low rating of unamortized deferred research expenditures, or perhaps, most commonly, conservatism – an unwillingness to attribute value because of uncertain future benefits.

2.2. American Accounting Association

The American Accounting Association (a society for academicians), through one of its Committees established to prepare a statement of Basic Accounting Theory, issued in 1966 the following comments on accounting for R&D:

> Expenditures and other costs devoted to such activities as research and development . . . often involve an element of future usefulness and are examples of conversions that would be recognized if quantifiable and verifiable . . . Relevance demands that the best available techniques for allocating these expenditures to asset and expense categories should be utilized . . . . Studies that quantify the future benefits of advertising and research expenditures are becoming more prevalent, and where applicable should be used.

While responsive to the second accounting problem for R&D, namely expensing or deferring, this statement provided only broad principles. Detailed guidelines remained unspecified.

[1] See Madden et al. [27] and Gellein and Newman [19].

2.3. AICPA research study

The American Institute of Certified Public Accountants (AICPA) published in 1973 a study which was conducted by Gellein and Newman, recommending that: (1) R&D be classified as *continuing* research or substantial development projects, and (2) cost incurred in continuing research programs be recognized as expense immediately, while the costs of substantial development projects should be deferred if they meet the following criteria:

1. A significant project to develop a single product or a series of related products or processes should be established and well defined.
2. The Board of Directors should formally approve the project.
3. Technical feasibility of the products or processes to be developed should be determined and documented.
4. Reasonable probability of meeting planned time schedules for development, production, and sales or use of the products or processes should be demonstratable.
5. The estimated amount and the probable timing of potential revenue should be reasonably established.
6. Only costs incurred after management has evaluated and approved a project should be deferred.
7. Deferred costs should be limited to those that are reasonably allocable to specific future periods or future contracts.
8. A formal program should be established to periodically evaluate the project and to write off the costs that exceed expected revenue less completion and selling costs.

The study further recommended that a company disclose the total costs of continuing research and both the amortized and written-off amounts of substantial development projects in income statements, and that the deferred costs of a substantial development project, if material, be disclosed in the balance sheet.

2.4. FASB statement

On the other hand, the Financial Accounting Standards Board (FASB) issued, in 1974, a statement which dealt with each of the three major accounting problems for R&D. First, the FASB defined research and development and listed examples of activities that typically would be included in and excluded from R&D. With regard to the second and the third accounting problems, the Financial Accounting Standards Board concluded that "all research and development costs encompassed by this Statement shall be charged to expense when incurred. Disclosure shall be made in the financial statements of the total research and development costs charged to expense in each period for which an income statement is presented." [2]

[2] FASB statement no. 2, paragraphs 12 and 13. FASB mentions that "some costs associated with research and development activities shall be capitalized if the item has alternative future uses in research and development or otherwise" (see paragraphs 11(a) and 11(c)). FASB interpretation no. 6 states that when computer software for use in research and development activities is purchased or leased, its cost shall be accounted for as specified by paragraphs 11(c) and 12 of statement no. 2. FASB statements are part of generally accepted accounting principles which guide the practices of certified public accountants.

The effective date of this Statement was 1 January 1975. Thus, starting from that date, all private business firms' R&D should be charged against expense when incurred and the total amount disclosed in the income statement.

The FASB [14] outlines two objectives of its Statement: "reducing the number of alternative accounting and reporting practices presently followed and providing useful financial information about research and development costs". The FASB did indeed accomplish the first objective, that of reducing the number of alternative accounting and reporting practices presently followed. But the Board has failed to convince the users of financial statements that the immediate write-off of R&D expenditures (instead of deferring some portion to match against future benefits) provides useful information.

The following five factors were offered by the FASB [14] as support for its conclusion that R&D should be expensed: (1) uncertainty of future benefits; (2) lack of a causal relationship between expenditures and benefits; (3) nonasset character of R&D costs – not an economic resource; (4) expense recognition and matching concept; and (5) usefulness of resulting information.

Bierman and Dukes [5] criticized the FASB's approach to R&D, claiming that the FASB treatment regards all R&D projects as failures. They specifically attack the above-mentioned "five factors". With regard to the first they point out that "the FASB cites the low probability of success with new products. We argue that this low probability has not been proved. Moreover, it is not a valid measure of risk" (p. 50). They cite empirical studies by Mansfield [28], Minasian [30], and Bailey [4] as support for the contention that there may be less risk with R&D expenditures than with plant and equipment. The FASB defines risk only in terms of the probability of individual failure and does not consider the reduction in uncertainty which can be achieved by organizing a portfolio of R&D projects.

As to the lack of any causal relationship between expenditures and benefits, Bierman and Dukes [5] argue that "... it is incorrect to conclude that, because it has been difficult to observe a significant correlation between expenditures and subsequent benefits, future benefits are not generated by research and development expenditures" (p. 51). They marshall much support (Scherer [38]; Bailey [4]; Angilley [3]; Grabowski and Mueller [20]) for the hypothesis that research and development efforts do produce future benefits for the firm.

The FASB [14] states that "the criterion of measurability would require that a resource not be recognized as an asset for accounting purposes unless at the time it is acquired or developed its future economic benefits can be identified and objectively measured" (p. 17). Bierman and Dukes [5] point out the inconsistency of applying this concept to other major assests. For example, can the economic benefits of an automobile plant be objectively measured at the time it is acquired? If not, then according to the FASB the cost of building an automobile plant should be expensed immediately.

The FASB [14] uses the matching concept to argue for the expensing rather than the capitalization of R&D. Unfortunately, this is a poor application of the

often-invoked principle. All accountants recognize that one obvious *theoretical* justification for capitalizing R&D is that by deferring expense, R&D cost might better match future revenue. It is not surprising that Bierman and Dukes [5] are quick to point out: "If the Board has chosen to argue that matching was not an important criterion . . ., then its conclusion might be understandable. But to argue that expensing of R&D is consistent with matching is a conclusion that is difficult to comprehend" (p. 52).

The last major factor cited by the FASB as support for their recommendation is the relevance of the resulting information for investment and credit decisions. The FASB [14] concludes that "capitalization of any research and development costs is not useful in assessment of the earnings potential of the enterprise". In disputing this point, Dukes [12] suggests that capitalization may serve a useful prupose in aiding the investor to predict the future return of a security. Bierman and Dukes [5] state that "If one accepts the hypothesis that capital markets are efficient in the processing of information, disclosure of the amount of the research and development expenditure is an extremely important first step" (p. 54).

In summary, the FASB [14] uses the criteria of objectivity, conservatism, and uniformity to expense all R&D expenditures immediately. Empirical research cited by both the FASB and Bierman and Dukes reflect conflicting results. Accountants and management scientists should join their efforts in establishing what conditions permit capitalization of R&D rather than immediate expense. The FASB [14] cites the following six prerequisite conditions: (a) definition of product or process; (b) technological feasibility; (c) marketability/usefulness; (d) economic feasibility; (e) management action; and (f) distortion of net income comparisons. The main inconsistency is a clear-cut conclusion by the FASB that R&D expenditures should be expensed immediately. It refelcts the long-standing preference of accountants for arbitrary rules rather than for coping with the problems of a stochastic world.

The long-term success and the profitable operation of many firms depend on the continuing development of competitively advantageous new products. By forcing the immediate expensing of all R&D expenditures, the management of a firm might improve *short-run* profits by reducing R&D expenditures. Even internal corporate decision-making might be distorted due to a faulty measure of operating resuls (or income). In the long run, however, the dysfunctional effects of such a treatment of R&D will eventually surface.

Management scientists can participate in the development of a more realistic R&D accounting method by helping to assess expected future benefits of R&D projects. Some court cases mentioned by Van Daniker [44] on measurement of certainty for "capitalize or expense" decisions also can be used as references.

3. Planning and budgeting for R&D

The intrinsic nature of the R&D process intensifies problems in the planning, budgeting, and controlling of R&D implementation. These three processes can be

summarized by the following brief definitions:

Planning: "is the process of deciding which projects should be funded and what resources (what talents and how much of each) are needed for each project in each organizational unit" (Vancil [43,p.59]).

Budgeting: "may be thought of as the process of obtaining the necessary resources or ensuring their availability" (Vancil [43,p.59]).

Control: "may be defined simply as the action necessary to assure that objectives, plans, policies, and standards are being attained" (Welsch [45,p.16]).

Planning is defined above in a classic capital budgeting form. Limited resources must be allocated to a series of competing projects with uncertain outcomes. The portion of these limited aggregate resources available to R&D is also dependent upon the overal capital budgeing process that involves *all* corporate areas. Furthermore, not only is the total amount of resources available for R&D dependent upon the overall capital budgeting process, but this process itself is dependent upon the estimated return provided by the portfolio of R&D projects. This double dependency bind can only be resolved by an integrated capital budgeting effort involving both R&D and other corporate projects. The process should attempt to maximize long-term return on investment.

Budgeting is the process of implementing the capital budgeting decision by allocating the total resources available to the different tasks. The budgeting process must also consider the human resources limitations involved in the tasks under consideration and the particular problems inherent in R&D.

An effective R&D planning and budgeting process should consider the following four major factors: (1) organizational factors; (2) nature of R&D costs and behavioral factors; (3) project selection criteria and techniques; and (4) contents of R&D budgeting.

3.1. Organizational factors

A sound organizational structure is necessary for effective R&D planning and budgeting. Usry and Hess [42,p.44] state: "When organizational charts are reduced to their bare essentials, there are two basic types of corporate structure – the functional and the divisional. R&D has a specific place in each type."

A divisionalized organization usually has a corporate level officer in charge of the overall R&D activities of the company, while the actual R&D work is performed at *either* the corporate or division level. A functionalized organization usually has a vice-president in charge of all R&D activities of the firm, whose duties entail both executive powers over R&D staff and coordination with other functional areas. This type of organization is analogous to the divisionalized form of organization in which most R&D activity is performed at the corporate level. This latter approach to R&D is termed *concentrated* in that it gives the top R&D officer executive and coordinating responsibilities. By contrast, under a divisionalized organization form which concentrates R&D activities at the divisional level, the

organizational approach is a *distributed* one and the R&D manager possesses fundamentally coordinating and resource allocation responsibilities.

The primary advantage of the functional organization is that it provides a pool of expertise and flexibility in the use of manpower. The divisionalized organization in the distributed form will have the advantage of highly motivated divisions which can be innovative and grow.

The functional organization is suitable for small and medium companies. The divisionalized organization with concentrated form can be used for growing companies with research and new business line development activities performed at the corporate level while the development activities in an existing business can be conducted at the division level.

The budgeting process for the R&D activity becomes quite complex in the distributed form of organizational structure in that capital budgeting may require the analysis of different contexts, the allocation of specific divisional overheads, and estimation of management time allotted to R&D activities.

3.2. Nature of R&D costs and behavioral factors

Except in a few high technology areas, major R&D costs occur in personnel. A study by the National Science Foundation [31] states that one-half to three-fourths of an average company's R&D budget is used to pay the technical staff and its supporting people (technicians, secretaries, lab assistants, etc.). This fact makes the R&D effort an easy target for sudden cost-cutting drives which might lead to serious negative long-range effects on corporate growth and R&D group morale. A highly motivated and well-managed R&D group can be extremely productive and work extensively at very high efficiency; however, low morale can lead to an R&D group of little value to the organization.

R&D groups somewhat resemble "creative groups" in the advertising area. From these groups, organizations expect creativity in making recommendations on paths to be explored and developed. For the group, this theoretically implies informal working environments, little structure as to assigned tasks, and considerable reinforcement on accomplishments. On the other hand, the R&D environment, since it requires much higher technical qualifications and extensive management ability on the part of project leaders, and because it provides very little long-term reinforcement to group members, should provide "harbor" for long-term efforts. Efforts which seek to develop radical new technologies may take generations to be tested and implemented. For instance, research on plasma screens has been going on for nearly ten years both in the U.S. and Japan, but only recently has it become cost justifiable and still limited to a small number of applications.

A survey conducted in 1958 by Booz Allen and Hamilton, Inc. and quoted by Usry and Hess [42,p.44] found that scientists:

(1) need close administrative controls;

(2) need to know management objectives;

(3) have similar characteristics to ambitious nonscientific personnel; and
(4) resent being treated as different in the business environment.

In essence, then, the R&D environment encompasses a series of unique aspects: high uncertainty, need for creativity, and need to foster long-term low-profile efforts. Furthermore, outputs are intangible and R&D requires a highly technically skilled staff. Therefore, any budgeting effort for R&D must conform to the level of structure required by the activity, based on careful analysis of organizational and behavioral factors.[3] The prediction of the possible dysfunctional features of performance measures should be attempted.

3.3. Project selection criteria and techniques

R&D projects can be classified as product-oriented projects and nonproduct-oriented projects. For the product-oriented projects, capital budgeting models can be used. These models deal specifically with payback, unadjusted accounting rate of return, discounted cash-flow, simple profile charts, mathematical programming, and complex computerized evaluation systems, etc. For the nonproduct-oriented projects, research personnel or departments usually prepare a schedule showing research objectives, techniques, estimated time, materials, and equipment required.

There are mnay project selection models, criteria, and techniques mentioned in the literature. A comprehensive review of project selection criteria and techniques has been shown in the previous paper by Winkofsky et al. Three new techniques which can aid management in the selection of the optimal research projects are multiple objective linear programming, goal programming, and zero-base budgeting. A multiple objective linear programming or goal programming approach can be used for selecting product-oriented projects, while zero-base budgeting can be used for nonproduct-oriented projects. Management accountants should work jointly with management scientists and the technical R&D staff on project selection as well as in the R&D budgeting process.

3.4. Contents of R&D budgeting

The contents of R&D budgeting should include at least the following major items:

(1) project generation and proposal;
(2) cost estimates;
(3) revenue estimates; and
(4) capital budgeting and project selection.

[3] These factors are primarily based on empirical research by Souder, Maher, Baker, Shumway and Rubenstein [40] in which they have shown that R&D project implementation is a function of an R&D manager's perceptions of the impact of the selected project on organizational factors, personal decision variables, and characteristics of the project itself.

Once a project is selected, its technical staff must work to:

(5) establish natural project phases and breakdown project costs by phases;

(6) determine personnel requirements and availability;

(7) assess equipment needs availability;

(8) establish detailed phase-by-phase budget; and

(9) present detailed project budget to management with detailed cost and result forecast.

Once approval is obtained for the detailed budget, the budget becomes the model for control purposes, but with a role in performance measurement quite different from other areas of activity, as the following section attempts to explain.

4. Control and audit of R&D

The overall company planning and control system begins with setting objectives, goals, strategies, and plans; it ends with performance evaluation, control, and audit. The continuous control and audit of R&D is important for effective implementation and good future planning. This section discusses two types of R&D control: the audit function and a recommended systems approach to R&D auditing.

Most managerial functions present a clear-cut framework for the evaluation of managers responsible within cost centers (wherein managers are held liable for all costs incurred and credited with profit center revenue). Large overruns on budgets can only be justified by increased production. On the other hand, negative variances from the budget usually indicate problems on either the production or revenue side.

Control of R&D can be broken down into financial control and technical control. Financial control primarily is the control of expenditure. For product-oriented R&D projects one has to assess benefits in addition to cost control. Technical control is the control of time progress and quality of projects.

4.1. Financial control

In R&D the budgeting of costs really serves only as a guideline for the determination of expenditures. Variances in the budget might be caused either by negative events (cost overruns) or by some desirable and beneficial occurrence (unpredicted progress in the research effort). In consequence, as proposed earlier, the R&D area requires budgets that are tied together with progress estimates on the specific projects and on the various phases of the project.

Financial control is also called budgetary control. Its function is to answer the question: "How is the project progressing in relation to budgeted revenues and expenditures?"

The first step of expenditure control is to separate direct costs from indirect costs. Direct costs usually include research staff salaries, materials, and equipment. Some indirect costs are administration salaries and wages, supplies, travel, com-

munication, rentals, subscriptions, and miscellaneous expenses. Usually, direct costs are controllable by an R&D manager and some part of indirect costs may also be controllable. Thus, a *responsibility* accounting reporting system is possible.

4.2. Technical control

Technical control asks the question: "How is the project progressing in relation to original or revised plans?" It requires evaluation of projects in terms of their initial proposals. Often, findings change considerably as to the nature of a project, its scope and potential importance, and might imply considerably different resource requirements. When large variances are found, research managers should not necessarily be penalized but rather a total re-evaluation of the initial objectives of the project, and its accompanying financial budget, should be performed. Effects related to the scope and cost of the new project formulation should be integrated into the overall capital budget of the organization. In essence, the continued desirability of the project must be evaluated. An example of R&D progress report has been shown by Dicke [10]. This report contains the cost, time, and quality variables.

The zero-base budgeting method is not only a benefit measurement and project-selection method. It is also an effective control device when used as a systematic plan for reviewing all R&D activities over a period of years. For example, the manager can review the following questions: (1) Should the activity or project be performed at all? (2) What should the quality level be? (3) Should it be performed in this way? (4) How much should it cost? (5) When should it be finished?

4.3. The audit function

"Generally, management has neglected evaluating R&D even to the extent of failing to put meaningful financial controls on it" (Pritchett [33,p.24]). Attitudes such as the one described above are a reflection of the philosophy that it is not possible to appraise the productivity of R&D, and that the only controls possible are financial ones. Several other factors can be mentioned that make the audit of the R&D function a difficult task. First, the records of its activities are few if they exist at all. Secondly, results are often presented in the form of research papers and technical communications which present serious difficulty of comprehension to auditors. Thirdly, progress in the research area seldom is directly along the line of initial plans.

The above difficulties and the inherent difference of the R&D process from ordinary sales, marketing, and production functions lead to the suggestion that a different approach should be adopted for the audit of the R&D function. Reeves [35] suggests that auditing a research division should focus on the following areas: (1) criteria for selection of leaders; (2) training in management techniques; (3) downward communications appraisal (communication between the organization

and the R&D group); (4) individual performance appraisal; and (5) appraisal of equipment management and levels of effort. Pritchett [33] on the other hand prescribes a seven-step R&D audit: (1) review of goals and objectives; (2) review of approval; (3) review of controls; (4) review of R&D relationship with marketing; (5) review staff productivity; (6) review internal security; and (7) review ROI.

Reeves neglected to include in his approach technical performance appraisal. This appraisal can be achieved by many methods, including peer evaluation, evaluation by superiors, or by the achievement of objectives set initially in the budgeting effort.

R&D assessment at the pure-research end of the spectrum of R&D efforts can be closely tied to traditional measures of academic performance in universities, such as number and quality of publications, national peer ratings, and professional recognition. The other end of the spectrum, engineering, or product improvement presents much more structured tasks which can be likened to production tasks, thus permitting the use of the existant audit function tailored to such tasks.

Procedures employed by the auditors might require flexibility based on the type of activity being performed. Generally, as the major nature of R&D costs resides in personnel costs, these can be monitored by traditional cost reports. Often, however, researchers do not get paid overtime and work in a lax time-control situation. The auditor must adapt to this situation. Similarly, he must adapt to the lack of records by using increased compliance examination and less analytic and substantive testing. In order to assist the R&D function, professional managerial or clerical personnel may be utilized for the control of scarce resources (i.e. computer time, use of expensive equipment, travel monitoring) so as best to enhance the utilization of physical resources and to improve the accuracy of the audit and control functions in R&D development.

Reeves [35,p.28] concludes that "... it is possible to audit a research activity and that they, especially in the large science laboratories, need to be audited. It showed that scientists are quite objective and open minded towards an audit; in fact, they are more so than some administrative people who many times appear to be apprehensive and fearful."

Unfortunately, in spite of the open attitude of Reeves and Pritchett the actual audit of R&D by large auditing firms is confined to the verification of authenticity of disbursements. The conservatism of the profession is well reflected in the following statement by Defliese et al. [9]: "Gradually, standards of sound practice tightened, requiring that deferred research and development costs be subjected to the same sort of tests for net realizable value as other assets ..." These "sound practices standards" will certainly facilitate the audit of the R&D function but may well lead to material misrepresentation of the firm's earning power by ignoring its increased earning potential acquired through years of heavy investment in R&D. Furthermore, these rules are in contradiction with some utility regulatory commissions that permit or require deferral and amortization of significant and nonrecurring R&D expenditures and with the recognition of "goodwill" in certain merger and acquisition situations.

4.4. A systems approach to R&D auditing

When dealing with the R&D function, the control and audit tasks are quite parallel. An audit should be a comprehensive effort of global evaluation of the R&D effort while the control function should emphasize the monitoring of individual projects at their multiple steps and phases.

Problems such as the lack of vertical communication and competent management which can considerably hinder otherwise expert research efforts can be avoided by a few well-balanced efforts. Each R&D project is a small system in itself and should be clearly defined at its inception (and at each restructuring).

Churchman's [6] five key considerations are of major inportance in R&D project specifications: (1) the objectives of the project, (2) the components of the project, (3) the environment of the project, (4) the available resources, and (5) the management of the project.

The *objectives* should be clearly stated, phase-by-phase, and the specific gauge of success specified. *Components* of the projects refer to each phase of its design, each form of monitoring, and each responsibility of project members. The *environment* of a project should be considered in terms of providing a vehicle for free thought, without endangering overall success by a total lack of structure and uncertainty. *Resources* should be adequate for the task and clearly specified at the project design stage. Monitoring and control of these resources might avoid unexpected cost overruns or the cancellation of promising projects. Finally, the *management* of R&D, which has been traditionally delegated to project leaders with good technical ability but little administrative training (administrative tasks are, in fact, regarded as a burden to be performed reluctantly), should have a new focus. Careful evaluation of the management skills of R&D personnel and of the interface of R&D managers with professional managers for logistical supply is the key to successful R&D management and should be a central consideration of all R&D projects.

5. Summary

Most financial accounting literature deals with R&D valuation and financial statement presentation. This paper is an attempt to present an integrated approach, and tries to tie together *three* major accounting aspects of R&D: (1) R&D valuation and financial statement presentation; (2) planning and budgeting for R&D; and (3) control and audit of R&D. The first aspect is important for different groups of users outside the firm while the last two aspects are important for the firm per se. The overall R&D management should consider all of them.

Many firms are incurring substantial R&D costs for the purpose of developing new and improved products. The benefits accrued by these costs are scattered over the years and are only sometimes accurately estimable. On the other hand, develop-

ments in management science have considerably improved the ability of managers to make benefit measurements. In the situations where these estimates are feasible and reliable, auditors, in conforming with the generally accepted accounting principles, may actually be accepting a material error in failing to match a current expense to its potentially known flow of benefits. Therefore, the FASB's statement no. 2 should be reconsidered in light of these emerging measurement methods.

We suggest that, for future research, both accountants and management scientists participate in solving the problems of defining R&D activities and costs for each industry, determining conditions necessary for capitalizing R&D, and deciding on the format and contents of R&D disclosure in financial statements.

We have examined four aspects of R&D planning and budgeting and recommend either a multiple objective linear programming or goal programming approach for budgeting product-oriented R&D. The key problems related to the three subjects of the accounting function related to R&D are measurement problems of stochastic estimation. Accountants have been reluctant to accept any rules that are not deterministic in nature. Recent developments, such as the proposed valuation procedure in the restructuring of debt, the adoption of actuarial procedures in dealing with pension funds, and the adoption of the "productive capacity" concept in the disclosure of replacement cost estimation, show a willingness to change. This opening has to be explored by accountants and management scientists. First, by increased work in the area of benefit measurements; secondly, by translation of these results into terms that the accounting profession can use and is comfortable with; thirdly, by the development of standard accounting measures for inputs into benefit measurement models and project selection procedures that make sense to management scientists and decision-makers; fourthly, by the development by auditors of qualitative-compliance oriented audit methods to supplement stochastic estimates in the audit of the R&D process; and finally, by careful "impact analysis" of accounting rule formulation alternatives, especially of new treatment formulations by the FASB.

For R&D control, adequate accounting measurement rules and audit techniques are necessary. In addition there are a few key policies to be considered:

(1) there should exist an integrated financial and technical budget;

(2) frequent revisions and evaluations should be performed; and

(3) budget variances are not necessarily undesirable, but when larger than a prescribed amount, they should be examined, thus providing for a full examination of the project.

In addition to the suggested areas for joint work of management scientists and accountants, the area of control of R&D requires further research into the format, content, mode of presentation, and frequency of control reports. These would tie in with further research questions into the behavioral impact of control reports on R&D scientists and on methods to generate functional (as opposed to dysfunctional) behavior among management scientists when presented with the diverse types of accounting data.

References

[1] American Accounting Association, A Statement of Basic Accounting Theory (AAA, Evanston, Ill. 1966).
[2] D. Andrews, Reduction of development cost uncertainty, Management Accounting (England), (September 1971) 261–265; (October 1971) 299–304; (November 1971) 322–326.
[3] A. Angilley, Returns to scale in research in the ethical pharmaceutical industry: Some further empirical evidence, Journal of Industrial Economics (December 1973) 81–93.
[4] M.N. Bailey, Research and development costs and returns: The U.S. pharmaceutical industry, Journal of Political Economy (January–February 1972) 70–85.
[5] H. Bierman, Jr. and R.E. Dukes, Accounting for research and development costs, The Journal of Accountancy (April 1975) 48–55.
[6] C.W. Churchman, The Systems Approach (Dell Publishing Co., Inc., New York, 1968).
[7] D.A. Corbin, Accounting standards for research and development, Management Accounting (NAA) (October 1975) 47–48.
[8] K.R. Davis, Research and development expenditures, The CPA Journal (April 1974) 55–58.
[9] F.L. Defliese, K.L. Johnson and K.M. Macleod, Montgomery's Auditing (The Ronald Press, New York, 1975).
[10] H.W. Dicke, Management accounting for research and development problems, Management Accounting (NAA) (May 1969) 40–43.
[11] A.R. Drebin, Accounting for priority research, The Accounting Review (July 1966) 413–425.
[12] R.E. Dukes, Market evaluation of accounting information: A cross sectional test of investor response to expensing research and development expenditures, Unpublished Ph.D. Dissertation, Stanford University (1974).
[13] R.A. Duro, System of research and development cost control, Management Accounting (NAA) (May 1967) 25–30.
[14] Financial Accounting Standards Board, Statement of Financial Accounting Standards no. 2, Accounting for Research and Development Costs (FASB, Stamford, Conn., 1974).
[15] Financial Accounting Standard Board, Discussion memorandum, An Analysis of Issues Related to Accounting for Research and Development and Similar Costs (FASB, Stamford, Conn., 1973).
[16] Financial Accounting Standards Board, FASB Interpretation no. 4, Applicability of FASB Statement no. 2 to Business Combinations Accounted for By the Purchase Method (FASB, Stamford, Conn., 1975).
[17] Financial Accounting Standards Board, FASB Interpretation no. 5, Applicability of FASB Statement no. 2 to Development Stage Enterprises (FASB, Stamford, Conn., 1975).
[18] Financial Accounting Standards Board, FASB Interpretation no. 6, Applicability of FASB Statement no. 2 to Computer Software (FASB, Stamford, Conn., 1975).
[19] O.S. Gellein and M.S. Newman, Accounting for Research and Development Expenditures, Accounting Research Study no. 14 (AICPA, 1973).
[20] H. Grabowski and D. Mueller, Rates of return on corporate investment, research and development and advertising, Unpublished Working Paper, Cornell University (1974).
[21] F.W. Grindley, Accounting for research and development costs, Financial Executive (April 1974) 18–22.
[22] O. Johnson, A consequential approach to accounting for R&D, Journal of Accounting Research (Autumn 1967) 164–172.
[23] P.R. Langdon, Control of research and development costs, in: R.F. Vancil, ed., Financial Executive's Handbook (Homewood, Illinois, 1970) 664–681.

[24] W.T. Lin, Multiple Objective capital budgeting, Proceedings of AIDS Western Regional Meeting, San Diego, Calif., March (1976).
[25] M.J. Luh, Forecasting and budgeting in a research firm, Management Accounting (NAA) (June 1972) 35–39.
[26] K.L. Madden, L.D. McCullers and R.P. von Daniker, Materiality of research and development expenditures, Journal of Accounting Research 10 (Autumn 1972) 417–420.
[27] D.L. Madden, L.D. McCullers and R.P. von Daniker, Classification of research and development expenditures: A guide to better accounting, The CPA Journal (February 1972) 139–142.
[28] E. Mansfield, Industrial research and development: Characteristics, costs, and the diffusion of results, American Economic Review (May 1969) 65.
[29] R.W. McRae, Financial control of R&D activity: A study in applied accounting, Abacus (December 1968) 124–141.
[30] J.R. Minasian, Research and development, production functions, and rate of return, American Economic Review (May 1969) 80–85.
[31] National Science Foundation, Basic Research, Applied Research and Development in Industry, NSF 67-12 (1965).
[32] M.S. Newman, Accounting for research and development expenditures, The CPA Journal (April 1974) 55–58.
[33] S.H. Pritchett, Auditing research and development, The Internal Auditor (January–February 1972) 24–30.
[34] P.A. Pyhrr, Zero-base budgeting, Harvard Business Review (November–December 1970) 111–121.
[35] J.T. Reeve, Auditing a research division, The Internal Auditor (January–February 1975) 23–28.
[36] H.H. Rubin, Approach to the audit of research and development activities, GAO Review (Winter 1969) 45–50.
[37] H.D. Sasaki, Planning and controlling research and development costs, Management Accounting (NAA) (May 1969) 44–50.
[38] F.M. Scherer, Industrial Market Structure and Economic Performance (Rand McNally, Chicago, 1970).
[39] D.R. Synder, Cost analysis and control of RDT&E project, Management Accounting (NAA) (September 1971) 42–44.
[40] W.E. Souder, P.M. Maher, N.R. Baker, C.R. Shumway, and A.H. Rubenstein, An organizational intervention approach to the design and implementation of R&D project selection models, in: R.L. Schultz and D.P. Slevin, eds., Implementing Operations Research/Management Science (American Elsevier, New York, 1975) ch. 6.
[41] R.E. Steuer, Multiple objective linear programming with interval criterion weights, Management Science (November 1976) 305–316.
[42] M.F. Usry and J.L. Hess, Planning and control of research and development activities, Journal of Accountancy (November 1976) 43–48.
[43] R.F. Vancil, Better management and corporate development, Harvard Business Review (September–October 1972) 53–62.
[44] R.P. van Daniker, Measurement of certainty for capitalize-or-expense decision, The CPA Journal (January 1973) 45–48.
[45] G.A. Welsch, Budgeting: Profit Planning and Control, 4th ed. (Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1976).