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INDUSTRIAL RESEARCH INSTITUTES

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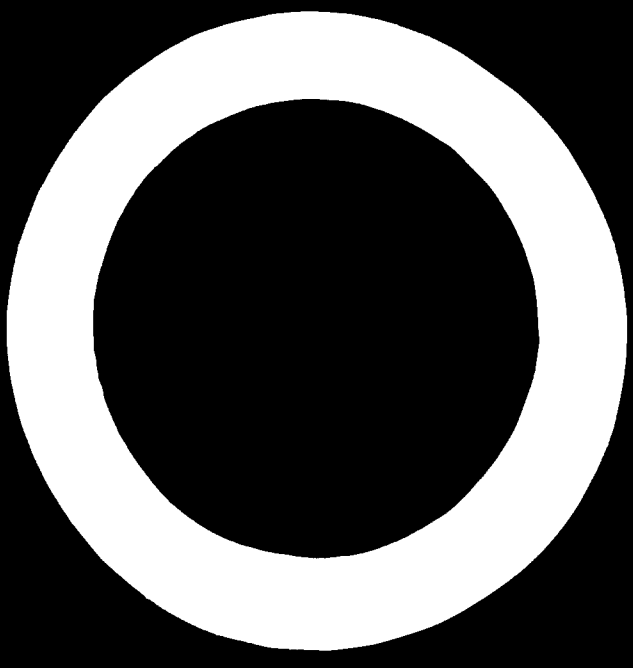

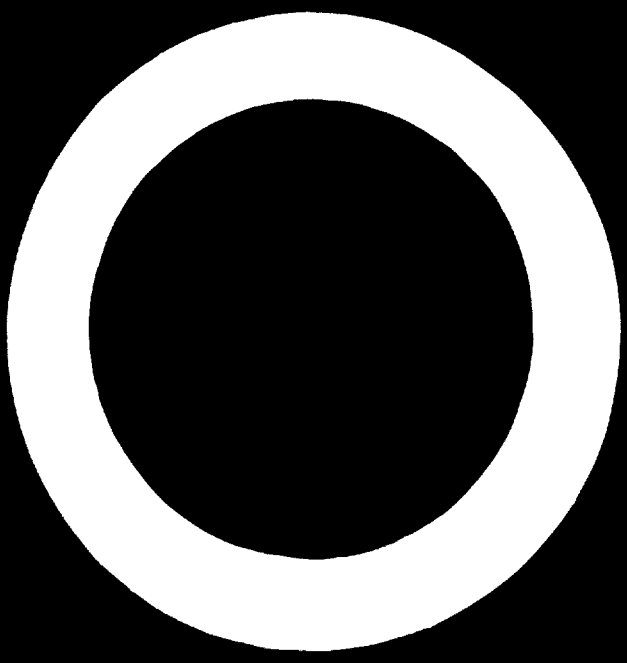

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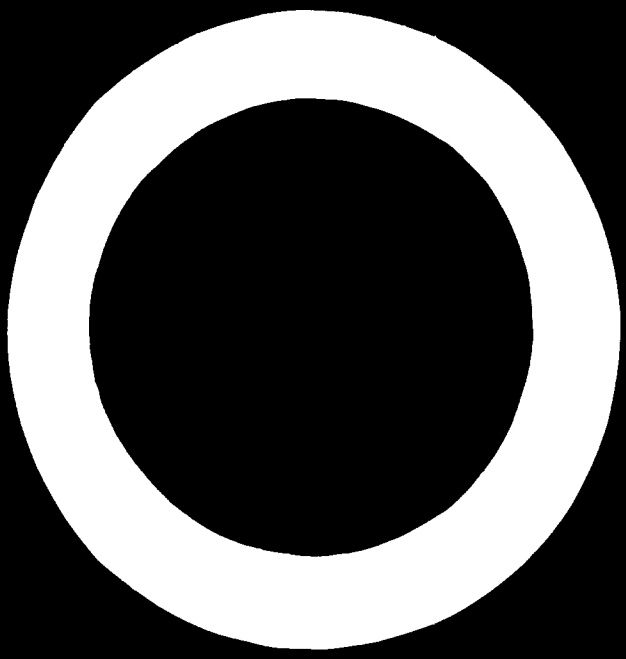

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Guidelines for evaluation

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CONTENTS

Introduction

Economic growth depends to a large extent on industrial development, which in turn is greatly influenced by the national research effort and the rate at which the results of the research are applied industrially. Although the concept of industrial research is relatively new, dating only from the beginning of this century, it has developed rapidly. It is through the generation of new ideas and techniques and finding means of exploiting new materials and processes that progressive industrial advancement can be achieved. Industrial research institutes are the accepted instrument for this purpose, whether established within the frame of existing national development agencies or as independent entities. These institutes are organized to undertake research in the fields of interest to industry, render various technical services, and carry out investigations of industrial projects either at the initiative of the institute itself or at the request of enterprises, the business community, industry or the Government.

Because the movement towards establishing industrial research institutes as a means of aiding industrial development is becoming widespread, it is desirable to evaluate them, if possible, at regular intervals, if the results of their work and their achievements are to find practical application in industry and effectively contribute to industrial development. Such evaluation would provide the means for assessing the effectiveness of the research institute and identifying areas where it needs strengthening. The evaluation may lead to a reorientation and restructuring of the organization with emphasis on certain fields of work, so that the institute can adapt itself to the needs of industry. The evaluation would cover various aspects of the structure, operation and work of the institutes, particularly their finance, and the utilization of their findings. The selection of a method for making such an evaluation is a difficult task, but one which should be undertaken. The difficulty is illustrated by the fact that, even for the research and development programme of an individual enterprise, no system for quantitative evaluation of productivity has found wide acceptance.

These guidelines outline procedures for assessing the effectiveness of an institute through both quantitative and qualitative approaches. Chapters 1 to 5 are concerned with criteria for which quantitative information can be collected, although any system of scoring or rating performance on this basis remains a matter of subjective opinion. The topics covered are: financial position, work carried out, development of technical capabilities and provision of facilities. Chapters 6 to 9 deal with subjects that can be evaluated only subjectively, but a methodology is proposed that will assist in making the ratings more meaningful. The aspects discussed are: general administration, selection of programme areas, administration of technical activities and personnel administration. Chapter 10 proposes a comprehensive technique for the over-all rating of management and the performance of an industrial research institute.

This study is based on information obtained through direct acquaintance with several industrial research institutes in developing countries in Asia, Latin America, and the Middle East, as well as on more extensive knowledge of similar organizations in Western Europe and the United States in both earlier periods when industrial research institutes first began to function and the present. The history of the industrial research institute, its origin and subsequent expansion, provides a basis for formulating guiding principles for similar institutes in other countries.

The material presented in this study concentrates on critical factors bearing on the contributions institutes can make to national development. Directors of institutes, because of their usual background as research scientists, may tend to emphasize technical aspects rather than the broad problems of administrative policies and procedures. The programmes are likely to reflect professional interests rather than be directed towards more practical activities, for which the need is great in developing countries. Ability to attract client-supported projects is one of the most significant measures of direct service to industry and a guarantee that the results will be applied in industry. In-house projects supported out of general funds are not given adequate scrutiny as to their ultimate impact on national development, and emphasis is instead placed on longer-range investigations that have greater scientific appeal and prestige. Throughout the world there is need for improved programmes of technical assistance to medium-sized and small companies, a subject of vital importance to developing countries. There is insufficient use of input-output and cost-benefit analyses in the selection and management of research projects. Evaluation procedures concentrate on technical feasibility and often neglect engineering, marketing and economic factors. The most important omission, particularly for in-house projects, is failure to consider entrepreneurial feasibility, i.e. by whom and in what manner will the results be used.

The procedures proposed in this study may appear too complex for use by a relatively new industrial research institute in a developing country. However, it is believed that they can be used selectively and in less detailed form to suit individual cases. The basic purpose is to provide a checklist of the major administrative functions necessary for the evaluation of performance and future prospects in whatever depth may seem suitable.

This study was prepared with the assistance of Lawrence W. Bass,[1] acting as a consultant to UNIDO.

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Since 1965, Mr. Bass has been active as an independent consultant for such organizations as Arthur D. Little Inc., the National Academy of Sciences, Washington, D.C., and for UNIDO. In this capacity he has undertaken many field assignments in developing countries of Asia and Latin America, participated in a large number of meetings and symposia on research and development, prepared studies and papers on the subject, and perused very closely national policies on research and development in various countries.

Chapter 1

EVALUATION AS A MANAGERIAL TECHNIQUE

Essential characteristics of evaluation procedures

The application of the scientific method to the administration of private and public activities has made it essential to devise some method of measuring the effectiveness of planning and implementing selected courses of action. If evaluation is to be meaningful, the parameters of progress towards goals should be defined in terms that are as quantitative as their character will permit.

Admittedly, assessment of many functions will necessarily be subjective and qualitative, but the establishment of suitable criteria will provide more rational guidelines for measuring performance.

Process of management

To permit evaluation of a complex of activities, the programme must be broken down into units of sufficient homogeneity to allow systematic analysis. The methodology for planning and implementing a given unit includes the following steps:

(a) Definition of the problem for which a course of action is to be proposed;

(b) Determination of the basic factors of the situation to be met;

(c) Proposal and comparative review of alternative routes to the solution of the problem;

(d) Selection of the most favourable route;

(e) Decision to adopt a course of action;

(f) Implementation of the decision.

This succession of steps may be represented schematically as set forth below to illustrate their relation to the managerial functions of selecting goals, deciding on methods for their attainment, and instituting activities to bring selected plans to fruition.

	Policies	*Criteria*	*Action*
Problem definition	x		
Problem analysis		x	
Alternative solutions		x	
Selection of optimum	x	x	
Decision			x
Implementation			x

For successful management, two additional steps are required:

(g) Progressive review of implementation;

(h) Continuing review of policies, criteria, and procedures to incorporate the benefits of experience.

Evaluation of operating and staff functions

In measuring the performance of a complex organization, management is confronted with two types of evaluation, one which can be quantitative because it deals with actual results, and the other qualitative because it relates to activities that are only preparatory to decision and action.

In an individual establishment, quantitative evaluation can be made, for example, of the productive and distributive operations because their results show up in numerical values. Other activities, which may be classed as staff or overhead functions, contribute only indirectly to operations, and hence judgements as to their effectiveness must in general be subjective. Management itself is customarily classified as an overhead function, even though its effectiveness is measurable by the over-all performance of the organization as an economic entity.

In a government complex, too, certain functional groups produce results that can be measured quantitatively, such as revenue production. Assessing the contributions of other activities to the national welfare often remains qualitative because these activities are advisory or promotional rather than operational.

Evaluation of technical programmes

Much attention is being given to methods of measuring the contributions of technical programmes, but thus far no direct evaluation procedures have received wide acceptance. Because the technical groups do not have operational responsibilities, their contribution depends on the utilization of their findings by others. The evaluation of technical performance therefore tends to be qualitative.

This conclusion has a solid basis in one of the fundamental tenets of management philosophy, namely, that authority and responsibility must be in balance. Technical departments have a staff or advisory capacity; except in rare instances, they do not have authority to implement the new and improved

technology they create, but instead the authority and responsibility are vested in line operational functions. Hence, the responsibilities of technical departments may be defined as follows:

(a) To provide needed technological information;

(b) To promote the introduction of technological advances in operations.

Attempts to devise quantitative evaluation methods for research and development performance have been hindered by several factors. These methods embody the concept of assigning a share of financial benefits to the creation and adoption of new and improved technology. The difficulties encountered include the following:

(a) Evaluation schemes of this type measure the effect of past performance and do not address themselves directly to the current programme.

(b) When they do concern themselves with future benefits from current projects, they rest on the uncertain assumption that the technology being created will be utilized and that the competitive environment will remain relatively constant. The uncertainty is in proportion to the distance in time from the completion date of the projects.

(c) The calculation of benefits from past work usually involves an arbitrary assumption as to the share of financial gains properly assignable to research and development as opposed to the contributions made by the operating departments in utilizing the technology. This may lead to friction between the technical department and the production and marketing departments.

(d) Forecasts of future benefits from projects in process are usually made by the technical department, and the degree of objectivity is therefore suspect.

(e) The estimation of productivity is normally concerned with major, innovative projects. Hence the routine work required to support existing operations, which usually constitutes the bulk of the programme, is often not examined critically.

The tendency, therefore, even in sophisticated enterprises in highly developed countries, is to take the value of technical activities as a matter of faith. Major projects are evaluated in terms of expected future benefits, and the costs of technical work are evaluated in comparison with the expected financial gains. In large organizations the innovative projects are frequently assigned to central technical groups, while supporting work is distributed among operating divisions. This arrangement sometimes leads to gaps in intermediate-range technical programmes falling between the two extremes.

Most managements thus consider a technical programme a necessary and justified expense. Individual sectors are scrutinized, but there is often no attempt to evaluate the programme as a whole to estimate probable total benefits. Figures are available for comparing the cost of research and development of industrial sectors and individual organizations, and these can be used as general guidelines. However, the technical requirements of an individual enterprise must be programmed as a special case.

Principles for evaluation

In developing countries an industrial research institute is often the sole major technical resource. The introduction of technology new to the country is admitted to be an important factor in economic development. The institute is expensive to operate and absorbs proportionately a large percentage of available technical personnel. Consequently, it is extremely important to establish some principles for its evaluation.

Quantitative assessment of past performance

One type of direct evaluation reflects the degree of confidence placed in the institute by its founders and clients. As a gross measure, the amount of funds made available to support its activities has value. This assessment should take into consideration the relation between the sums contributed by the founders, public or semi-public agencies, who reflect the basic assumption of its contribution to national development, and those provided by its customers or clients for work on specific topics. Derivatives of the data on financial support are the size of staff and the existing facilities.

Just as in the case of the technical programme in an individual establishment, certain quantitative measures can be suggested. These relate, first, to the kinds and amounts of technological information developed, and second, to such data—necessarily fragmentary—as can be assembled on the utilization of the information by the country's industry and government agencies. These are the direct measures of past performance.

Growth rate of past performance

The current data on the financial support, staff and facilities reflect only the local situation, and by themselves do not provide a basis for meaningful comparisons with similar institutions in other countries. They may be studied in relation to current data for other organizations, but the complex of national policies, physical resources, climate for development etc. may be so difficult that no valid conclusion can be drawn.

This study will therefore use the growth rate of financial support, projects completed, staff, and facilities as the basis for evaluating the institute's achievements in meeting local needs and conditions. The earlier sections will describe methods for compiling and examining the data and will propose general criteria for assessing performance.

Posture for future performance

Estimates of future contributions to national development are difficult to make on a quantitative basis except in isolated cases. Trend lines based on extrapolation of past performance have some value in projecting the course of technical programmes, and use will be made of them, but more importance should be placed on qualitative assessment of the ability of the institute to carry out its objectives in the future.

The later sections of this study will therefore present a scheme for rating the posture of the institute qualitatively. Major facets will include the management, the principles for selecting in-house work and for attracting a clientele, the administrative procedures for carrying out work, and the development of personnel and facilities. These are all diverse in nature, but an attempt will be made to propose a composite method for rating.

EVALUATION OF FINANCIAL POSITION

Gross income

The funds received to support the programme of an industrial research institute reflect the attitude of its founders and clients towards its present and potential future contributions to industrial development. The term "founders" is used throughout this study to denote those public or semi-public agencies (including private philanthropic foundations or industry associations) under whose auspices the institute was established; these agencies almost always continue their support over a period of years. They are sometimes called "sponsors", but this name is not used here to avoid confusion with "clients", who are frequently designated as sponsors because the term "sponsored research" is commonly used to define projects supported directly by third parties.

The term "client" is used for any enterprise, establishment, association, or agency that enters into an agreement to pay all or part of the cost of a specific project or programme conducted at its request. The results of the work may become the exclusive property of the client, sometimes subject to release as public information after a certain lapse of time, or may enter the public domain at once. In many countries public agencies may act as clients by contracting for work which they support by allocation of funds from their own budgets. In other cases, the industrial research institutes do not receive directly the fees paid for work or services, but instead these are paid into the public treasury; presumably the budgets for the institutes will in due course reflect the volume of such fees in the subsidies they receive from public sources. Direct payment to the institutes appears to be desirable, however, because it provides a strong incentive to increase the amount of sponsored work on behalf of clients who expect to use the results to improve their operations.

Analysis of income according to source

The data on income received during a current fiscal period have value as a measure of actual position, but they must be placed in historical perspective to be a useful tool for evaluation. Hence the procedure for reporting income should follow a pattern consistent with that of previous years. For this purpose, data should be converted into stable monetary units. Any special income or adjustments (such as for prepayments or accounts receivable) should receive uniform treatment.

The gross analysis according to source will therefore include the following categories:

(a) Supporting income funds received from founders as subsidy to support basic expenses, including in-house projects;

(b) Earned income fees received from clients as partial or total payment of costs of investigations conducted for them;

(c) Other sources special grants or royalties on patents or proprietary information etc.;

(d) Adjustments to bring receipts into line with the current fiscal period;

(e) Capital funds special payments for facilities or equipment not part of normal income.

Growth rate of income

The rate of growth of total income provides an over-all measure of the success of the institute in meeting the expectations of its founders and clients. A recommended practice is to compute the following series of data:

(a) Annual growth rate of total income, using monetary units of constant value in per cent;

(b) Annual growth rate of supporting income received from founders on the same basis in per cent;

(c) Annual growth rate of earned income from clients on the same basis in per cent;

(d) Ratio of supporting income to total income for each year of the series;

(e) Ratio of earned income to total income for each year;

(f) Analysis of yearly fluctuations in special income and adjustments in income where these are of sufficient magnitude to show a trend.

Evaluation of income growth

In the early period of an industrial research institute's evolution, the major source of income is usually the supporting income from the founder agencies, and the rate of growth from this source will depend upon the policies of the founders. The type of work undertaken is likely to be in one general category. such as product and process development, because the organization has not yet been able to build up other areas of service. Most of the projects are in-house studies because clients have not yet begun to use the institute's service on a large scale.

When an institute is established, the founders usually recognize that they should support some reasonable rate of growth. The experience of most technical organizations is that this rate is not likely to exceed 25 per cent per year, unless other groups already in existence are merged into the new organization. After the initial appointment of a director and a nucleus of staff, it is a heavy drain on the available time of the small executive group to recruit, indoctrinate, and prepare a programme of activities for new employees at a growth rate greater than 25 per cent per year. Admittedly, there are exceptional cases, particularly in highly industrialized countries when an emergency has to be met, in which large technical groups have

been assembled with great rapidity. These circumstances are not likely to occur in developing countries, however, and a growth rate of supporting income of 25 per cent per year can be considered creditable.

The policy of earning income from fees for specific projects must naturally be adapted to meet local conditions and harmonize with national economic policy. There is a trend even in nationalized economies to encourage contract research of this type. The arguments for such a policy are several. First, the average person is more likely to scrutinize something carefully if he has to pay for it than if he receives it free of charge. Second, it is only fair to industry as a whole that individual enterprises or agencies defray the expense of studies made for their specific use. Finally, experience has shown that charging fees for services discourages individual enterprises from making unreasonable use of services and thereby from wasting national technical resources.

It is therefore frequently established as a policy of industrial research institutes that supporting income will be used for the basic expenses of the organization, for a programme of in-house studies to develop skills and information in the national interest, and to create a background that will encourage clients to turn to the institute for specific projects. The extent to which this policy is actually followed can be determined by comparing the relative rates of growth in supporting income and earned income, but this comparison is not possible until sponsored requests for specific services have begun to come in—a situation that may not occur until two or three years after the institute was founded.

Too little information is available on actual performance records of industrial research institutes in various countries to establish hard-and-fast criteria. The following arbitrary guidelines are offered for consideration by institutes in countries in which industrial expansion is occurring at a rate of 5 per cent or more a year. If the founders are convinced that the institute is performing an essential service for the national welfare, they should be willing to support growth of the basic organization at a rate of at least 5 to 10 per cent per year. If the institute can convince industrial and government enterprises of the value of its services, the rate of growth of earned income should be greater than that of supporting income, and a ratio of 1.5:1.0 to 2.0:1.0 should be attainable.

Summary of evaluation scheme

The foregoing comments have been summarized in table 1 for institutes in countries with good rates of industrial development.

TABLE 1. SCHEME FOR EVALUATING PERFORMANCE OF AN INDUSTRIAL RESEARCH INSTITUTE

Points to be evaluated	*Performance*		
	Modest	*Good*	*Excellent*
Annual growth rate of gross income	Less than 10%	10 to 20%	20% or more
Annual growth rate of supporting income when sponsored projects are to be encouraged	Less than 5%	5 to 10%	10% or more

TABLE 1 *(cont.)*

Points to be evaluated	*Performance*		
	Modest	*Good*	*Excellent*
Annual growth rate of earned income when sponsored projects are to be encouraged	Less than 5%	5 to 10%	15% or more
Ratio of growth rate of earned income to supporting income	Less than 1:1	1:1 to 2:1	2:1 or more
Percentage of total income represented by earned income after 10 years of operation	Less than 30%	30 to 50%	50% or more

Procedures for more detailed analysis of supporting and earned income are discussed in the following sections. It is recommended that these more critical evaluations of sources of support be carried out.

Supporting income

Supporting income can be analysed from different points of view, depending on the policy of the board of directors as regards acceptance and encouragement of sponsored research projects.

Policies of the founders regarding support

Institutes deriving support only from founders

An institute that derives support only from founders is organized in the belief that it is a proper function of public and semi-public sources to support programmes to supply industrial technology to the economy. Evaluation of the effectiveness of the organization, as justification for continuing and increasing the amount of support, must be made by the board of directors on the basis of information and opinions supplied to them by the management of the institute and by those using the services. Procedures for assembling quantitative and qualitative information are suggested in later sections.

The board of directors must establish a policy, preferably for a period of years, concerning the amount of support that the founders are expected to provide. The boards are frequently composed of representatives of the chief founders, but in some cases they include scientists or technologists, industrial managers, or representatives of national planning agencies.

Logical formulation of a policy for support requires a definition of the institute's functions (i.e. the expectation of kind of performance) as well as an

evaluation of the need for the services to be provided and of the effectiveness of past performance. The existence of a national policy for industrial development, or of a national science policy of the kind being adopted by many countries, is helpful in formulating decisions.

The factors that may influence the founders to decide to increase the level of support are: policies adopted by the board reflecting belief in an increasing need for the institute's services; provision of documentation of successful performance by the institute; expression of need on the part of beneficiaries of the services; national policies for stimulating industrial development; increases in the basis for calculating support from some index; increases for special purposes such as provision of some new type of service; and increases to compensate for inflation. The burden of proving the need for increased support normally rests on the management of the institute.

The budgetary requirements of an industrial research institute generally increase every year. Salary levels go up, even if there is no inflationary trend, as a result of the increased seniority of staff members. An increase of from 5 to 10 per cent per year in total operating cost may therefore be necessary even though there is no increase in staff.

Assuming that an institute of this type rarely suffers a levelling off or even a decline in support until it becomes fairly large, it is pertinent to consider the reasons why the budget may remain nearly static, except for increases to maintain existing staff. These include: basic policies of the founders to stabilize the organization at a certain level; decrease in resources available to the founders; declining confidence in the need for the institute's services; or inertia on the part of the board.

As a means of evaluating the past, present and future financial performance of a totally subsidized institute, it may be considered that an increase of 10 per cent or less per year in constant monetary units is low, 10 to 20 per cent adequate, and above 20 per cent generous.

Institutes deriving partial support from clients

If the governing policies of an industrial research institute provide also for acceptance of sponsored projects, its performance becomes more susceptible to objective evaluation in terms of the extent to which its services are paid for by clients. Even in countries with nationalized economies there are examples of adoption of this type of operation.

In highly industrialized countries, many industrial research organizations derive all their income from sponsored projects. Such a situation can hardly be expected in a developing country; hence the founders can look forward to continuing subsidies until their local industrial economies have become stronger and more diversified.

The discussion below will centre on financial support from founders to supplement fees from clients. The next section will deal with analysis of earned income.

Although supporting funds are only part of the income of many institutes, the board of directors has to consider the need for continuing subsidies to maintain the basic operations. Certainly during the early years of acceptance of contracts from third parties, the volume of sponsored work cannot be expected to reach a level that will permit dynamic growth. Therefore, the need for continued founder support is evident. When contracts amount to an appreciable share of total income, the board may wish to re-examine its policies.

The basic reasons for continuing support are: evidence of success of the institute as a technical resource for the country; maintenance of an organization for expanding the technical skills of the country; provision for developing new skills which will enlarge the scope of the sponsored projects; and support of programmes for the general good of the economy that are unattainable through other means.

The board has certain choices of action: continuation of the previous pattern of subsidy to encourage vigorous growth of the basic functions; gradual reduction of the net subsidy to stimulate self-reliance of the institute; or change in the policies governing the use of the funds.

If the institute succeeds in expanding its sponsored work, a reasonable policy may be to continue the increase in subsidy at a parallel rate to permit the development of new types of services or to provide for expansion of general projects in the national interest.

In some cases the board of directors may, through inertia, maintain support at a constant rate, but this is in effect decreasing founder contributions; the basic costs of the institute increase continually, particularly if there is an inflationary trend, and therefore a larger proportion of funds received from clients has to be diverted to pay for overhead costs or for projects of public interest.

Evaluation procedures would appear to be most meaningful when based on the ratio between supporting funds and earned income. If the subsidy is kept at a rate that maintains a constant or increasing proportion of subsidy, this indicates a strong belief in the effectiveness of the institute as a national resource. If support is at a level that merely meets or even falls below the rising costs of basic functions, it is evidence that the founders think that the purposes of the institute will be best served by placing more responsibility on the organization to expand through an increase in sponsored projects. The decision will reflect the board's appraisal of the need for technical resources in the country and the best means of supplying the necessary services.

Earned income

The provision of supporting income rests on the decisions of the board of directors and on the policies of the founders. The level of earned income, however, assuming an encouraging attitude of the management board, depends on the skills with which the institute diagnoses needs for technical assistance, creates acceptance on the part of industrial enterprises or agencies of Government, and carries through to a successful conclusion sponsored projects in sufficient volume to expand this acceptance.

Chapters 7 and 8 deal with the qualitative evaluation of managerial methods of obtaining and carrying out sponsored projects. The present section relates to quantitative analysis and projection of earned income, which provide a factual background against which to assess the need for improved management techniques.

Analysis of earned income

If the historical pattern of earning from sponsored projects is to be used constructively for managerial purposes, the gross figures must be broken down logically. The following classification of sources is suggested.

Major sources

The analysis should begin with a compilation of data showing trends and current status of percentages of income from public agencies, individual enterprises or establishments, trade or industry associations and miscellaneous.

Sectors of industry

A similar breakdown should be made according to branch of industry, such as foods, textiles etc. This gross classification is less desirable than a more detailed listing, because the situation may vary greatly among different subdivisions of a large sector of industry. For food industries, for example, data should be separated for dairy products, meat products, canned and preserved products, cereals, baked goods etc. The classifications adopted should follow those used by government agencies in collecting statistics.

Types of enterprises

Because of the emphasis placed on providing technical assistance to small enterprises, it is desirable to analyse the size of the clients that place projects. According to the classification most frequently used, enterprises with 300 or more employees are large. The designation of medium-sized enterprises is less consistent, and, if possible, some figure should be selected by discussion with government statistical or planning agencies who could express a preference for ranges such as 50 to 299, 75 to 299, or 100 to 299. Small enterprises are those below the limit selected for medium size. In this connexion, it should be pointed out that the enterprises in developing countries that use institute services directly are most likely to be those of medium size. Few large companies exist. Throughout the world there is difficulty in finding means to give technical assistance to small companies. Experience indicates that industrial associations may provide the best means of reaching them.

Types of services

The analysis should include also a compilation of the types of services that appear to be in most demand, such as feasibility studies, economic analyses, market surveys, engineering projects, product and process development, technical service, and analysis and testing.

Co-ordination of sources

It may be desirable to carry the analysis still further in certain areas. For example, if a considerable amount of work is being done for various branches of the food industry, it may be useful to examine the number of projects in different types of service undertaken at the request of enterprises of different sizes and categories.

To analyse the entire programme in such detail would require a great deal of effort if the volume of sponsored projects is large. Judgement has to be exercised in determining what types of analyses will shed most light on the pattern of work evolving and in determining which trends are most significant.

Summary of information on earned income

A summary of information on earned income can be presented best as a tabulation of the more important projects both as to their current magnitude and to the directions in which they appear to be moving.

Analysis of project cost recovery

In a later section attention will be directed to accounting procedures for determining the expense incurred in project work. Here it need only be said that the analysis of earned income should concern itself with the extent to which the fees charged cover the costs of the work.

Estimation of future earned income

Because management has to consider its plans for expanding staff and facilities as well as for developing specialized skills in the light of probable demands for services, it is important that the data on sources of earned income in the past should be analysed in order to project future trends. The findings need to be scrutinized, however, from other points of view.

Government policies for industrial development, for example, may play an important part in determining the relative rates of growth in various sectors of industry and various types of enterprises. The economic climate may exert the same kind of influence but not necessarily in the identical direction. Some factors may stimulate industry to make greater use of technical assistance; the imposition of stricter quality specifications for the local market or for export would have such an effect.

The internal policies and resources of the institute may indicate that linear extrapolations of trend lines should be modified. The addition or the development of new skills or the acquisition of new equipment may open new avenues of service in a number of directions. New managerial techniques, such as improved programmes for promotion, may encourage modification of estimates. In any case, management should be prepared to estimate for a few years ahead the probable volume of earned income classified according to major source, sector of industry, type of client, and type of service. The very act of planning the expansion of skills and resources to meet the projected demand helps to create a sense of purpose throughout the organization.

As shown in table 1, an annual growth rate of 5 per cent or less was classed as moderate performance; 5 to 15 per cent as good; and 15 per cent or more as excellent. These percentages refer to gross earned income. Using the same classification, the major sources of earned income can be categorized as those of modest or declining potential and those which promise good or excellent growth.

Analysis of expenditures

Accounting procedures for technical programmes have two distinct functions. The first is obviously to record properly receipts and expenditures according to the accounting principles accepted in the country. The second is to provide financial data in a form that will enable management to allocate the funds most effectively. With respect to this second function, it should be pointed out that the professional staff should not be subjected to unnecessary and excessive accounting detail, which is irritating to them and therefore an interference with work. As an example, careful

recording of the purchasing, storing, and dispensation of equipment and supplies is a necessary accounting procedure. However, the issuing of such items from the storeroom to responsible members of the professional staff should be accomplished with a minimum of formal paper work. Most industrial research institutes find it an unnecessary complication to charge these relatively small items against specific projects or activities. For administrative control—as distinguished from accounting control—it proves adequate to accumulate the total expense involved and to distribute it *pro rata* against the various projects according to some arbitrary scheme such as the cost of professional time.

Major classes of expense

A rough breakdown of expense into two major categories—direct project expenses and other expenses—is a useful managerial tool, particularly for examination of trends. Direct project expense, if calculated as indicated in the next paragraph, should amount to at least 60 per cent and preferably 70 per cent of total expenses. If it is much lower than 65 per cent, either the overhead is too high or not all pertinent expenses are being charged against projects.

Analysis of project expense

Proper administration of the technical programme requires the definition of areas of work, the assignment of budgets to them, the maintenance of cost accounts and the exercise of budgetary control over expenditures. Many industrial research organizations have found a project system to be the most effective procedure. The system is most useful if it is extended to all technical activities, including composite projects for exploratory work and miscellaneous short assignments, and even to overhead activities. The essence is the preparation of records of expenditure of the man-hours of each member of the staff broken down by project.

Basis for computation

The records of costs should include salaries and fringe benefits of professional staff (sometimes for supporting staff also) and other direct expenses such as actual costs or *pro-rata* allotments of supplies and equipment. Travel, shop expense, secretarial costs, expense of preparing and reproducing reports are often included. In order to attain realistic costing, the projects often receive charges for a proportionate share of overhead expense.

Review of basis for fees

Industrial research institutes in developing countries frequently find that their clients object to the schedule of fees they propose. This situation still exists in highly industrialized countries to some extent, particularly when enterprises are not accustomed to negotiating for services with outside organizations. Acceptance of reasonable fees is a matter of education, since most enterprises do not know what their internal costs would be if the project were such that it could be undertaken by their own personnel. The best answer to complaints about the cost of the professional services of institutes is that their schedules are set by customary

procedures; institute personnel can perform the work as efficiently as the personnel of the client; and the actual cost per man-hour for the latter if correctly computed would be roughly the same as for institute staff.

As a result of the resistance to paying adequate fees, institutes frequently set the fees too low and thus frequently fail to recover their costs on projects. Because the fees are set too low, justifiable items of expense are shifted into overhead, and the overhead for project work is kept at a minimum; the overhead is a drain on other funds of the institute, notably its supporting income. An additional factor is the tendency of institute personnel to underestimate the amount of effort that will be required to solve a problem.

Project costs of sponsored work

For good financial control it is therefore important to have continuing appraisal of project costs in terms of fees charged. Records of the percentages of total costs represented by major elements of expense will frequently reveal the weaknesses of the estimating procedures. When taken together with similar records of overhead costs they provide excellent background for improving financial performance.

Costs of in-house, or unsponsored, projects

A major weakness in financial administration is failure to estimate and control work undertaken on unsponsored projects. Sound management requires that it be subjected to the same type of scrutiny as is given to work for clients.

Analysis of overhead expenses

Non-project costs even in well-managed organizations account for 30 to 40 per cent of the total budget. They are frequently not subjected to adequate scrutiny to determine whether the budgets are realistic and how they can be controlled.

Classification of expenses

The first step in classifying expenses is to set up appropriate categories, the number of which should be kept to the minimum necessary for proper evaluation and control. Suggested categories include the following:

(a) Administration;
(b) Office services (secretarial, accounting etc.);
(c) Supporting services (maintenance, storekeeping, housekeeping etc.);
(d) Buildings (rent or amortization, utilities);
(e) Supplies and equipment;
(f) Public relations;
(g) Professional development of staff.

Control of overheads

The categories of overheads should be defined; the definitions should be made known to the staff members who need to know them; and some senior employee should be designated to supervise each account unless the director plans to perform this function himself.

Forecast of expenses

Just as the management of an institute should develop a realistic estimate of its sources of income, so it should prepare an estimate of expenses not only for the ensuing fiscal period (yearly basis) but also for a longer period (forecast of trends).

Statement of effect of policies

Changing trends may result in the adoption of new policies or the modification of existing policies. For example, adjustments in the overhead rate assessed against projects may require revision, or the estimate of funds available for in-house projects may be influenced by the amount of expected supporting income.

Forecast of expense of client projects

The estimates of the volume and character of sponsored work, together with the influence of changing policies, should be reflected in the budget and longer-range forecasts. The major items to be evaluated should include actual values and percentages of total expense for:

(a) Professional salaries, with adjustment for across-the-board changes;

(b) Salaries of supporting personnel, reflecting any changes in ratio of professional to supporting personnel;

(c) Direct expenses on projects, incorporating modifications based on previous experience;

(d) Overhead chargeable to projects, incorporating any influence of changes in policies.

The forecasts should also include estimates of the recovery of expenses through fees.

Forecast of expense of in-house projects

The budget and longer-range estimates of the expense of in-house projects should be analysed in a similar manner.

Continuing review of forecasts

The budgetary performance should be reviewed quarterly, and the annual budgets should be inspected to introduce needed corrections. Monthly data should be studied, but the figures may be subject to temporary fluctuations that obscure trends. Longer-range forecasts should be reviewed at least semi-annually to correct them for influences that have become apparent from current experience.

Comparison of estimated expense with income

It is obvious that expenses should be compared continuously with income. While this should be done monthly as the financial reports are prepared, important changes in provisions for expense can best be made quarterly to iron out temporary fluctuations.

Balance between expense and income

Satisfactory management requires that the institute operate at least on a balanced budget, including the sums set aside in reserve accounts, such as for major capital expenditures. Prudent management should take into account the possibility of major fluctuations in income or expense, and thus expenditures should be less than gross receipt by a reasonable margin; the excess of income may be kept in the current account to be available for later use towards the end of a fiscal period or may be added to a reserve fund for emergencies. A policy of maintaining total expenses at a rate of 2 per cent less than income is sound; a rate of 5 per cent is on the high side. These figures reflect the philosophy that an industrial research institute should operate on a break-even basis, avoiding the occurrence of a deficit, but using an optimum amount of its resources to achieve its basic purposes.

Sometimes government policies may prevent an accumulation of reserves out of public funds allocated to the institute, through enforcement of regulations that funds not spent in a defined fiscal period cannot be postponed for future use but must be returned to the national treasury. Under these circumstances it may still be possible to create a reasonable reserve from other sources of income.

Estimation of client project costs

Good management requires that its estimating procedure be kept under continual review to improve the recovery of costs incurred. To encourage clients to use the services of the institute, a policy may be established whereby only part of the overhead costs are included in the project costs. This should be reflected clearly in the cost calculation so that the project will not show a deficit.

During the early period of operation of an institute, before the project leaders have become skilled in estimating project costs and maintaining budgetary control, the estimates may err by 10 per cent or more, and almost always on the low side. These deficits may reflect not only inadequate estimates, but also deficiencies in the policies under which the budgets are prepared.

As time goes on, both the estimating skills and governing policies will improve, and the average discrepancy between fees and expense may be reduced to 5 per cent or less. In some organizations in which cost control is rigorous, the surpluses and deficits on all projects may be kept to a very low percentage.

Failure to recover legitimate project costs reduces the ability of the institute to perform its public-service functions. The project deficits have to be taken care of out of general funds; this adjustment increases the overhead and thus reduces the funds available to support in-house work.

Estimation of in-house project costs

The estimates of expenses for internal activities are very frequently poorly prepared or controlled. Subjects of research are proposed, discussed, and approved, often with very little consideration of cost-benefit relationships. This situation leads to expenditure of technical effort without careful planning and to difficulty in training the staff in the techniques they need for managing client projects.

The administrative control of in-house projects should be on a par with that of client projects. The limits of error between estimate and performance should be in parallel.

Estimation of overhead accounts

The same principles should apply to individual categories of overhead expense. Unfortunately, the review of overheads may be quite detailed regarding specific items, but they are often not subjected to broad managerial scrutiny as to desirable and justifiable bases for expenditures to carry out the objectives of the institute.

The accuracy of overhead forecasts is sometimes greater than project estimates because of the large amount of data from previous fiscal periods.

Chapter 3

EVALUATION OF TECHNICAL PRODUCTIVITY

Many directors of technical organizations have limited appreciation of the applicability of managerial principles to their programmes. They concede that there must be systematic management of certain internal affairs such as financial control, handling of supplies and equipment, personnel administration, and maintenance and housekeeping. Supervision of such matters is often delegated to one or more staff departments, with the director assuming over-all responsibility for overseeing performance.

The technical programme itself, however, is often tacitly assumed to involve a very different type of administration. Instead of attempting to compare results with input of effort, the executive staff tend to rely on intuitive scientific judgement for assessing performance while paying only lip service to objective criteria. This situation is partly due to the kind of training received by research directors, many of whom have done postgraduate work abroad with emphasis on fundamental investigations. The traditional attitude towards such studies is that they cannot be planned in the usual sense of the word, because the results at any stage are unpredictable and therefore cannot be used in advance as part of a preconceived programme. A second reason is that until recently there has been little literature on systematic managerial techniques for project evaluation.

Establishment of a basis for evaluation

Before managerial principles can be applied to specific cases, certain basic ground rules have to be established. These include the definition of the objectives of the industrial research institute and the establishment of policies to be followed in authorizing and supervising individual projects. They include also the definition of the criteria to be used in evaluating proposals and performance.

Definition of general objectives

For the purpose of this study, it is assumed that the institute was founded to make direct contributions to the industrial development of the country and that its performance is to be judged on the basis of its success in making such contributions.

It is assumed further that the evidence of success is to be found in its influence in upgrading the technological level of individual enterprises in either the private or the public sector. In the belief that it is equitable for such enterprises to pay for work done on their behalf, the institute will endeavour to charge fees commensurate with the effort supplied. On the basis of these assumptions, the institute will adopt the view that, while it benefits from the supporting funds provided by its founders, the purpose of this support is to enable the institute to develop skills and programmes that will lead to projects supported by clients.

This definition differentiates an industrial research institute from a scientific research organization established to create new knowledge but without responsibility for applying it to industrial development. While national policies may lead to the formation of several scientific research establishments, their differing goals and probably differing impact on industrial development should be clearly recognized by those responsible for implementing science policies.

Policies formulated for newly organized industrial research institutes are often based on two faulty premises. First, it is usually assumed that there will at once be a ready demand on the part of the industrial establishments of the country for technical assistance; on the contrary, experience shows that it may take several years to create a large clientele, even when no fees are charged. Second, it is commonly believed that small and medium-sized enterprises will be major users of institutes because they lack technical resources of their own; actually, it is a major problem in countries in all stages of development, including the highly industrialized countries, to find satisfactory methods of giving technical help to small enterprises.

Criteria for evaluating projects

The evaluation of projects at the proposal stage or at intervals during the work is a complex problem. Five major criteria are hereby suggested:

(a) Technical feasibility;

(b) Engineering feasibility;

(c) Market feasibility;

(d) Economic feasibility;

(e) Managerial feasibility.

The first four types of feasibility studies can be carried out by the institute when it has adequate staff for process engineering, market research and economic evaluation. But no matter how favourable the results of these studies may be, no implementation will occur until responsible executives in industry or government agencies show sufficient interest in a project. Neglect of this criterion often leads institutes to work on in-house projects until they reach the stage where they are large and costly, when careful investigation earlier would have revealed the probability that no one would undertake commercialization. Even in sponsored projects, institute personnel do not always explore fully at interim stages the client's interest in commercial application of the information for which he has paid all or part of the cost.

Evaluation of sponsored projects

Because sponsored work was requested and paid for by clients to fill a need, the results will probably be put to practical use more quickly than information from in-house investigations, unless in-house projects have been chosen to reflect industrial interest. Public relations programmes of industrial research institutes are successful in rough proportion to the extent that they point out the practical use to which their projects have been put.

Institutes frequently fail to put their performance in the most favourable light, not only to the audience of the industrial world they are trying to reach, but even to their boards of directors. Emphasis on size and qualifications of staff, facilities or exotic equipment, abstract description of types of services, and lists of publications have more appeal to scientific and technical personnel than they do to the managers of manufacturing enterprises. The latter instead wish to know in what specific ways the institute can be helpful to them.

Clients are frequently unwilling to have very much information on successful projects released. They may be unwilling to give figures on cost savings or the profitability of new developments, but will consent to make qualitative statements. They may be prepared to state the volume of throughput, the number of new jobs created, the investment represented by new plant or equipment, or even the general significance of the installation to national policy. The institute should give out no information without the formal approval of the client, because unauthorized releases can destroy good relationships. A few cases have been known where clients were unwilling to confirm favourable comments on projects because they feared that the institute might raise its charges on future work for them.

The institute staff often fail to obtain information about successful projects. When a project has been completed, those who were working on it become fully occupied in other activities and overlook the importance of keeping informed on projects that have been completed. Even managerial personnel may fail to maintain contact with former clients. For this reason it is advantageous to establish a policy that former sponsors of projects should be revisited periodically, for example, every six months or once a year. The experience of long-established research organizations is that a large amount of new work, often half or more of the total volume, comes directly or indirectly from satisfied clients.

Analysis of productivity in major types of projects

The following classification of major types of projects is suggested as a means of evaluating the assistance the institute has given to industry and government agencies:

(a) New industrial operations;

(b) National or regional development surveys;

(c) Managerial projects, including feasibility studies, economic analyses, market surveys, engineering evaluations and raw material surveys;

(d) Assistance to small and medium-sized enterprises;

(e) Studies on industrial operations, including best-practice surveys and quality-control surveys;

(f) Product- and process-development projects;

(g) Technical service;

(h) Analysis and testing;

(i) Information services, including literature surveys.

Under each of these headings a procedure will be suggested for collecting data and evaluating performance. The activities are so diverse that it appears advisable to assess the programme by section rather than as a whole. In each case, however, the procedure involves collecting the number of examples, placing these totals in historical perspective, estimating their combined impact on industrial development, and drawing conclusions as to their past and potential growth.

New industrial operations

The most striking and impressive type of performance falls under the heading of "new industrial operations", and the institute should make most effective use of any examples for which it can claim complete or partial responsibility. The clients may be reluctant to disclose certain types of information, but the institute should make the most of that approved for release. Obviously, few examples will be available during the early history of the organization.

The first step is to describe new operations that have been started during the reporting period, which is usually the past fiscal year. Information should be given on the type and volume of products being made or to be made, the number of employees, the capital invested, and the impact on the national economy. When the institute has had only partial responsibility for the development, it should endeavour to obtain permission to claim its share of credit, for example, the small-scale work on product and process.

Because the institute will have relatively few cases of this type to report, it should endeavour to bring up to date the history of previous developments of a similar type, which will provide a good opportunity to renew contact with former sponsors. Any growth in volume of production, the cumulative production since installation, new products introduced, increases in number of employees and use of local raw materials or equipment are all newsworthy.

In any case it is legitimate for the institute to give a complete list of new industrial installations it has assisted over a period of years or since its foundation. To show cumulative growth of this type of activities, a summary listing may be drawn up as follows:

(a) Number of new operations;

(b) Total cost of installations;

(c) Total employment in operations.

It would be difficult to give value of production or volume of production (except in a list of individual cases) because of different types of commodities.

It is not feasible to propose ratings based on the specific number of successful projects. So much depends on local conditions that comparisons of experience of different institutes are meaningless. The rate of growth over a period of years appears to be the best measure of performance. If the institute is becoming a more important

resource for industrial development, the number of new industrial installations in the creation of which it has been instrumental should increase more rapidly than its earned income. This type of analysis may be expressed by the ratio:

$$\frac{\text{Growth rate in new installations}}{\text{Growth rate in earned income.}}$$

An increase in the above ratio would indicate a greater contribution of the institute to industrial development.

National or regional development surveys

National or regional development surveys will usually be supported by public or semi-public organizations, and hence a good deal of information on their results should be releasable. The success of undertaking such projects will be reflected in the rate of growth, but this measurement will be heavily influenced by the public policies for authorizing this kind of survey. The best measure of productivity would appear to be the ratio between growth rate in number of development surveys against growth rate of earned income.

Managerial projects

Managerial projects, which include feasibility studies, economic analyses, market surveys, engineering evaluations, and raw material surveys, will usually be sponsored by an individual enterprise, although public agencies may support raw material surveys. Although these activities are classed together here, they may show wide fluctuations; therefore, internal management procedures should require a detailed examination of each type.

For evaluation of performance the following ratio may be used:

$$\frac{\text{Growth rate in number of managerial projects}}{\text{Growth rate in earned income.}}$$

Assistance to small and medium-sized enterprises

Assistance to small and medium-sized enterprises can best be measured through the number of enterprises with which contact is made either directly or indirectly. Although the assistance supplied may be similar to that supplied to large enterprises, it should be listed separately to permit evaluation of the service of the institute to the small-scale sector. Direct contacts with small enterprises through calls or inquiries should be listed and counted. Indirect contacts will be through industry associations or other similar public or quasi-public organizations, and the number will be the same as the list of enterprises to which information is communicated.

Much of this type of activity will be paid for by supporting funds because it is the general policy of the institute to provide services to small and medium-sized enterprises. Three different ratios may be used to determine the effectiveness of performance:

$$(a)\quad \frac{\text{Growth rate in number of contacts}}{\text{Growth rate in total income}}$$

$$(b)\quad \frac{\text{Growth rate in number of direct contacts}}{\text{Growth rate in total income}}$$

$$(c)\quad \frac{\text{Growth rate in number of indirect contacts}}{\text{Growth rate in total income.}}$$

It may be useful to calculate these ratios separately for small and medium-sized enterprises.

The essential measurement is number of contacts. Some of these may result in other types of activities such as technical service or analyses and tests. Nevertheless, the simple act of creating a contact between a technical resource and a small enterprise is considered to be progress, and, therefore, it is believed that this sort of evaluation should be performed.

Studies on industrial operations

Systematic surveys of the practices of groups of individual enterprises provide an opportunity for improving the technological posture of sectors of industry. Studies of this type may be financed by industrial associations or by contributions from the enterprises participating in the project. They are also an important part of in-house activities because they not only represent an important public service, but also afford the institute a means of acquiring practical background in the industries concerned, of establishing valuable contacts that may lead to sponsored projects, and of defining major problems that can be undertaken either for in-house programmes or for one or more enterprises. They represent an excellent avenue for providing service to small and medium-sized industrial units.

Several types of studies may be pursued. Quality-control surveys of raw materials and finished products provide valuable information to the industrial sector on advantageous purchasing opportunities, while the establishment of higher standards for products leads to better consumer satisfaction and an improved market position. Investigations of process-control techniques can lead to improved efficiency of operations, more uniform quality, and reduction of wastes and rejects. A broader approach is to undertake industrial engineering surveys of the entire operation to establish a pattern of best practices to be recommended for adoption by all enterprises. Studies of the efficiency of various types of equipment in use can lead to better selection for future installations and even to improvement in design.

Programmes of this type are most acceptable to individual enterprises when specific information relating to their operations is held in confidence. This can be done through coded tabulation of the data collected on a standardized basis, the manager of each enterprise being provided with the complete table and the identification symbol of information relative to his enterprise so that its performance can be compared with that of enterprises in the same industrial sector. This practice is often acceptable even in highly competitive economies. Also, it is sometimes advisable to select certain enterprises for study in greater depth and for use as examples to the rest of the industry of the effect of improved practices.

The performance of the institute can best be judged by the growth rate of projects of this type. For sponsored projects the diversity of activities is shown by the increase in number of such studies according to the ratio:

$$\frac{\text{Growth rate of number of industrial operations studies}}{\text{Growth rate of earned income.}}$$

The magnitude of effort is revealed by the relation:

$$\frac{\text{Growth rate in budget for industrial operations studies}}{\text{Growth rate of earned income.}}$$

Product- and process-development projects

Projects concerned with product and process development are often the chief activity of an industrial research institute in its early years of operation and will continue to be important after the scope of its services becomes broader. They vary considerably in character. Often they may involve only a practical demonstration that foreign technology can be used directly on available raw materials for economic production of products satisfactory for the local market. On the other hand, differences in starting materials, equipment available, processing factors or consumer preference may make it necessary to devote considerable study to modifications of technology to suit local conditions.

For evaluation of performance the following ratio may be used:

$$\frac{\text{Growth rate of number of product- and process-development projects}}{\text{Growth rate of earned income.}}$$

Technical service

Industrial research institutes will seldom be able to carry out technical service on a self-supporting basis. The time spent in analysing the problems and the short duration of most investigations make it difficult to establish a pattern of fees that will be satisfactory to clients and still reimburse the institute for the cost of the

professional effort. This is true in highly developed countries, and few if any organizations are able to support themselves solely through short-range work of this type. But technical service provides valuable assistance to industry as part of the programme supported by the founders, and it is helpful in establishing good relationships with potential sponsors of larger projects. If it is allowed to expand haphazardly, however, it can absorb an increasing proportion of the institute's technical personnel. It is very desirable to set up a schedule of fees, for example *per diem* charges, which will make the users of the service more conscious of its value and more likely to pay serious attention to the advice received.

In any event a list of individual cases of technical service performed should be maintained, with the number of technical man-hours devoted to each, including those spent in discussing the problem before it is defined; these man-hours often have to be excluded from the fees charged.

Several measures can be used for analysing technical service work. The number of cases, whether gratis or covered by fees, can be compared in growth rate by the following ratio:

$$\frac{\text{Growth rate in number of technical service cases}}{\text{Growth rate of earned income.}}$$

The percentage of available professional time consumed in such services should be scrutinized in terms of the relationship:

$$\frac{\text{Growth rate in man-hours for technical services}}{\text{Total man-hours available for technical staff.}}$$

Other ratios for studying the rate of growth may be useful in a given situation. If the amount of technical service is large, it will be advantageous to study its trend in detail by analysing the amount of work in such classifications as advice on raw materials, on product quality, on process control and on equipment adjustment and maintenance.

Analysis and testing

Time spent on analysis and testing should be accounted for by listing the individual tests or groups of tests in several categories: those carried out on a fee basis; those conducted in connexion with sponsored projects; those to assist in-house projects; those performed as a public service; and time spent in developing and improving methodology. It is good practice to charge sponsored and in-house projects for time spent in analytical work conducted for them.

A careful analysis of time spent on analysis and testing will help to make the service more effective. Because the techniques and operations tend to become uniform in pattern, they are susceptible to systematic scrutiny to determine ways in which time expenditure may be reduced. Organizations that do considerable analysis and testing find it useful to develop schedules of standard fees for the types of determinations for which the demand is greatest. The fees should be established on the basis of the average costs for the total operation of receiving and handling

samples, carrying out the tests, and recording and reporting results, plus a proportionate overhead. Fee schedules should be established as realistically as possible, because it is often difficult to persuade clients to agree to increased rates. Fees charged for non-standardized analyses and tests should be based on actual time spent on the complete transaction.

Performance of analytical and testing services may be evaluated from several points of view. It would be advisable to compile on a monthly and a yearly basis variations of staff time spent on activities according to the origin of work, as for example:

(a) Time spent on commercial analysis;

(b) Time charged to sponsored projects;

(c) Time charged to in-house projects;

(d) Time charged to technical services;

(e) Time spent on activities performed in community service.

The relationship is of interest in terms of time spent on all forms of analytical work as a percentage of total time of all institute personnel. The rates of growth of all these indices should be examined in relationship to institute policy and to the demands of the clientele.

Information services

Data on the use made of the library and information service of the institute should be compiled. However, the only good criterion for evaluating this aspect of operations appears to be the growth in numbers of outsiders who use the services or facilities.

These functions seldom generate income in the form of fees, except for extensive literature searches that may be undertaken for clients. It is therefore suggested that cumulative records be kept of the following, and that the annual growth rates be calculated for a period long enough to establish trends:

(a) Number of outside readers using the library;

(b) Number of external inquiries handled;

(c) Number of special literature searches carried out in connexion with sponsored projects;

(d) Number of special literature searches carried out in connexion with in-house projects.

(e) Number of literature searches undertaken on a contract basis.

Evaluation of in-house projects

Because an important part of the work of industrial research institutes consists of public-service programmes carried out with supporting funds, these activities should be evaluated by the procedures used for client-sponsored projects described in the preceding section. For this purpose, the financial basis used in examining ratios should be the growth rate of supporting income.

Interpretation of data for guidance of future policies and forecasts

The evaluations proposed in this study require examination of growth rates of sources of income and of various activities, rather than their absolute magnitudes. This method of analysis has the advantage that the data already provide trend lines for use in projecting a future pattern that conforms to the policies of the institute, the technological needs of the country and its individual enterprises and the capabilities of the institute staff.

Absolute values would not be useful in interpreting the success of operations because a sufficient body of information for comparing performance among different institutes does not now exist. Even when such information becomes available, its comparative significance will not be great because of the differing conditions in countries.

The interpretive treatment here proposed assumes that the best available measure of the manner in which an institute serves the needs of its national community is the extent to which enterprises and agencies find its various services useful. This information is revealed by analysis of its earned income by class of activity. Policies for the future, to be determined by the board of directors and the management, depend on whether the directions of growth are in harmony with the basic objectives of the founders.

For in-house activities the conclusion is offered that the patterns should follow the growth trends for sponsored work. The tendency is for scientific and longer-range technological ideals to dominate the programme. The board of directors and the management therefore have to scrutinize carefully the component sectors of in-house work to determine whether the knowledge and skills that are to be developed by using supporting funds are those that the industrial complex of the country will find most useful.

Chapter 4

EVALUATION OF STAFF CAPABILITIES

Size and classification of staff

Historical growth of staff

The increase in staff will follow the general trend of growth in total income, provided that the latter is expressed in monetary units of constant value. Large adjustments in salary and wage levels, which will be reflected in the income, may cause deviation from this pattern.

Because the technical staff is the vital resource of an industrial research institute, it is important to analyse carefully the nature of its growth. An obvious aspect to consider is the ratio between professional and non-professional personnel. This ratio will vary according to the policy of the institute, the customary practices of the country in managing technical organizations and the character of the programme. For example, in some countries it is usual to maintain a ratio of 1:1 to 1:2 between professionals and non-professionals in research and development groups, while in others it may run as high as 1:4 to 1:5. Unfortunately, uniform data have not been collected and therefore comparisons are difficult. In some countries the requirements for professional status are set very high, and often many of the supporting staff will have had technical training that would entitle them to a professional rating elsewhere. Furthermore, some types of technical activities, particularly those involving many routine operations, require a smaller input of strictly professional skills.

For these reasons it is not feasible to propose any uniform pattern for staff composition. An appropriate procedure for an institute would be to analyse staff composition and relate its variation to the nature and volume of the work of the institute. A major concern should be to examine the ratio between personnel engaged in administrative work and technical and professional work in order to keep the ratio as low as possible.

Analysis of growth of staff

A commonly used standard for professional status is the equivalent of a baccalaureate degree in engineering, the physical sciences, mathematics, technology or the social sciences from an educational institution of an acceptable standard. In

some countries it is possible to accord professional standing to an individual who does not have such formal qualifications, but has shown through his performance on the job that he has acquired comparable knowledge through self-education, experience, and organized habits of thought.

Many organizations find it useful to summarize the status of personnel in chart form, particularly for salary administration. Often two charts are used, one for professional and one for supporting staff. Plotting is done by using one axis for seniority, i.e. years of experience, the other for salary. For professional workers, years of experience are usually based on the number of years since the first university degree. For supporting personnel, age is the most commonly used basis.

The following ratios are suggested for analysis of measurement of progress in staffing:

$$(a)\quad \frac{\text{Rate of growth of professional staff}}{\text{Rate of growth of total income}}$$

$$(b)\quad \frac{\text{Rate of growth of total staff}}{\text{Rate of growth of total income}}$$

$$(c)\quad \frac{\text{Rate of growth of professional staff}}{\text{Rate of growth of total staff}}$$

$$(d)\quad \frac{\text{Rate of growth of professional and supporting staff engaged in technical work}}{\text{Rate of growth of administrative and service staff.}}$$

This method of analysis may also be used to study changes in disciplines or experience of professional staff.

Analysis of rate of staff turnover

It is revealing to analyse the changes in staff taking place through separations and additions, particularly changes in the management of the technical staff, since the institute must maintain an adequate level of experience in order to carry out its activities. The discussion here will be limited to professional staff, but the same kind of analysis may be extended to supporting staff.

Table 2 suggests a type of tabulation for assembling data. It is advisable to use cumulative figures for a period of years (five, for example) in order to iron out short-term variations.

TABLE 2. ANALYSIS OF PROFESSIONAL TURNOVER FOR THE PERIOD.....

Class	*Number at start of period*	*Number at end*	*Total number of separations*	*Average per cent of separations per year*
Director and assistant director				
Section or division heads				
Project leaders or other senior technical staff				
Junior technical staff				

The rate of turnover will vary with each institute and may be much influenced by the policies of the institute; for example, the institute may serve as a training ground for technical personnel for future jobs in industrial or government enterprises. By and large, attention should be concentrated on changes in senior technical men because they form the nucleus of experienced personnel for conducting the technical programme. Some organizations have been able to maintain a fairly low average level of separations in the first three classes of the table—around 6 per cent per year - and this can be considered satisfactory. If it rises to 25 per cent or higher, the efficiency of the institute may well be impaired by lack of continuity in the leadership provided for its technical projects.

It may be the policy of the Government to use the institute as a training ground for junior professional personnel. After gaining a few years of experience in industrial development activities, these individuals are encouraged to take positions in various enterprises or in government agencies. Such a policy will clearly result in a higher turnover of junior professional personnel. However, it also results in the upgrading of technical personnel and the establishment of new sources of contacts for the institute in business and in the Government.

Analysis of reasons for an excessive number of separations

The loss of professional personnel should be continuously studied so that the findings can be used in adjusting administrative policies. The experience of an institute, however, reflects not only internal policies, but also the changing pattern of employment opportunities within the country. In a growing economy, many of the technical personnel who leave an institute find positions at a middle or high managerial level rather than positions similar to those they held in the institute.

Because an excessive number of separations in the upper echelons of professional personnel will reduce the effectiveness of technical activities, the director and his staff should endeavour to determine the reasons for the separations. This can be done best through comprehensive interviews with the individuals before they leave to take

up their new work, although it is often difficult to persuade them to explain their basic reasons for leaving. A brief list of major reasons for departure should be used for this purpose, for example: higher salary level, greater opportunity for advancement, more attractive type of work, better working conditions, dissatisfaction with institute policies, personal difficulties with superiors or colleagues. By tabulating the number of separations per year under each of the items in the list, trends may be shown that can be counteracted by changes in managerial policies.

Analysis of professional training and experience of staff

Evaluation of recruitment and personnel development policies of an institute involves a series of questions that can be answered to some extent from data compiled according to previous recommendations, but new types of insights are required. Examples of the type of scrutiny recommended are given below.

Initially, the staff of an institute may have been assembled largely from individuals with only an academic background. Personnel with these qualifications may be satisfactory for longer-range projects on product and process development, but they may lack the experience and interest necessary for undertaking other types of work included in the total programme. The director has to face the problem objectively and has to seek means to overcome deficiencies in the background of his staff.

The first step is to compare the performance of the institute with the plans formulated for its service to industrial development. These plans are often initially rather vague, but they should be re-examined to determine the basic needs of industrial enterprises and government agencies and to formulate an optimum course of action that should have been followed to fill them.

Table 3 may be used for analysing needs, objectives, and performance in general terms. The same classification of types of activities used in chapter 3 is employed here.

The results of such tabulation are very useful as an over-all guide to staff expansion. For example, it may appear that ratings previously given to some of the national needs were unrealistic because sectors in which the institute has good staff competence did not grow. The question needs further analysis, however, because the staff strength is limited to specific sectors of industry that are not expanding, or the institute management may decide that the problems of creating a clientele are too difficult.

A tabulation of this type, then, can serve only as a general guideline for recruitment policy. The conclusions from the analysis may have a strong effect on the qualifications to be emphasized in selecting new members of the professional staff or in developing improved skills. The desirability of some industrial experience will be given greater weight for certain types of service. Or, personnel in sectors showing little growth may be given opportunities to gain experience in others that need expanded programmes.

Analysis of staff capabilities by number of those holding higher degrees is so obvious and common a procedure that it is not discussed here.

TABLE 3. PRIORITIES OF NATIONAL NEEDS, INSTITUTE OBJECTIVES, AND RECRUITMENT POLICY

Major types of projects	*National need*	*Institute policy priority*	*Actual growth rate*	*Recruitment targets*
New industrial operations				
National or regional development surveys				
Managerial projects				
Small and medium-sized enterprises				
Studies on industrial operations				
Product and process development				
Technical service				
Analysis and testing				
Information services				

EVALUATION OF FACILITIES

Analysis of building facilities

Some general guidelines exist for evaluating the adequacy of buildings. These relate chiefly to working space and not to aesthetic features. For example, only about 60 per cent of the total floor area of a laboratory and pilot plant building will be available as working space for technical activities, the balance being used for offices, library, rest rooms, corridors, storerooms etc. Also, experience indicates the degree of occupancy of working space as a measure of efficiency in working conditions. The following figures for average space for each professional worker represent general experience:

(a) 20 square metres is crowded, inefficient;

(b) 20 to 40 square metres is adequate;

(c) 40 square metres is liberal and permits considerable expansion in staff.

The relationship between laboratory space and pilot plant space has to be judged on suitability for the types of work included in the institute's programme.

Other criteria cannot be evaluated quantitatively and must be judged subjectively. These include: general suitability for efficient technical work, such as appearance, cleanliness, lighting; suitability of fixtures, such as laboratory furniture, desks, utilities; safety features; ease of access to storerooms, offices, library, conference rooms; lunch rooms; rest rooms; utilities and shop facilities; locational features, such as access to transportation, parking space, buses.

The architectural features of the building should have little weight in an evaluation of an industrial research institute. Unfortunately, the founders often give high priority to beautiful and impressive buildings. As a result, large sums are often spent on external and decorative features, and the time of the director and his staff is dissipated on such matters.

A favourable evaluation should be given to institutes that start with modest buildings, demonstrate their ability to serve industry and Government well, and are in due course accorded the recognition of support for a new, permanent home. As a result of their experience during their years of growth, they are in better position to plan the buildings so as to provide functional utility rather than architectural splendour.

In some highly industrialized countries the cost of a building for research and development may represent the equivalent of the annual operating cost of the

programme it houses. This represents a capital investment per worker similar to that in capital-intensive industrial installations. It seems reasonable to expect that this kind of information would facilitate international comparisons that would assist institutes in their plans for buildings.

Analysis of equipment

It is essential that the needs of the institute for equipment are analysed according to the current and proposed activities of the institute rather than according to the sophistication and advanced technology involved in a particular and generally costly piece of equipment. Such needs should be evaluated very carefully. It is a common occurrence that the rate of utilization of costlier equipment is lower than that of less expensive but more useful equipment.

The manner of providing funds is often a deterrent to wise policies. Providing large sums at infrequent intervals, with the requirement that they be spent within a certain period or else revert to the source, results in a crash purchasing programme rather than a carefully planned course of action. The wise plan is to make funds available on a fixed schedule in accordance with an estimate of needs, and to permit placing unexpended sums in an accumulated reserve.

Good management, therefore, requires that the institute management establish a budget for capital, which may cover building changes as well as new equipment. The size of the budget will depend on a number of factors, such as the existing status of equipment, the existing fields of investigation, and new fields to be entered.

Comparative figures are not available to assist in formulating budgetary requirements. It is likely, however, that the purchase of new equipment should grow at a somewhat faster rate than the operating budget because new types of instruments and pre-pilot or pilot units are being developed in more advanced economies: they incorporate new techniques that are helpful in solving local problems. The annual capital budget should probably be about 5 to 10 per cent of the operating budget.

Analysis of library and information facilities

Little comparative information is available for judging the adequacy of library collections. Because technical literature is increasing at an astounding rate, the problem of supplying monographs, journals, microfilms and pamphlet material is becoming acute.

One may estimate that a collection of 2,000 to 3,000 monographs and bound volumes of important journals will be necessary to supply technical information to an institute with a total staff of 100 and a professional staff of 50. The number of journals to be obtained on a subscription or exchange basis may run to 200 to 300. The rate of growth of the collection may well be 1.5 to 2.0 times the rate of growth of the professional staff. The use of an arbitrary figure based on experience, such as US$10 to $15 per volume, can provide the basis for a suitable annual budget.

Many laboratories are installing readers for microfilms. Other forms of equipment needed are photocopiers, or devices for reproducing types of printed material. These are fairly expensive to purchase and will represent a considerable investment for smaller organizations.

Finally, most technical libraries need to supplement their own collections through inter-library loans. The libraries involved should agree upon satisfactory procedures for making the loans as well as for supplying photocopies.

Analysis of service facilities

The maintenance of an adequate stores facility for equipment and supplies is essential to effective operation. This requires expenditure for stocking, maintaining inventory, and storeroom personnel for a large number of items. If the stock is not geared to supplying rapidly most of the items needed for current operation, productivity will suffer. In developing countries this represents a particularly important problem because of the delay in obtaining shipments from abroad. The servicing, housekeeping, maintenance and repair of the facility represent a considerable but necessary expense.

Secretarial services are often a bottleneck for the professional staff in preparing reports and conducting necessary correspondence. The offices in which secretaries are located are often at considerable distances from the technical areas, and much time is lost in going back and forth. The use of dictating machines is common in some organizations to conserve secretarial time. Internal telephones and paging systems can do much to cut down time spent in locating personnel.

Budgetary provisions for facilities and services

Little information is available to guide industrial research institutes in regulating their expenditures for physical facilities. It is recommended that the institutes establish records showing expenditures for these facilities, the rate at which they are utilized, and the income derived from services supplied. Using these records, they will be in a position to exchange information with similar institutions.

Chapter 6

GENERAL ADMINISTRATION

Charter, objectives, and planning

Charter

The charter of an industrial research institute is the basic statement defining the method of organization and the purposes for which the institute was established. It may be in the form of articles of incorporation or it may be covered by a legislative act or government decree. It usually states in general terms a description of the organization, the objectives, the responsibilities and duties of the governing body, the character or extent of financial backing from public or quasi-public sources, and the basic principles of operation, including any limitations on its functions.

Because the charter defines responsibilities and authority broadly, it usually gives the institute sufficient freedom of action to permit logical growth and expansion. It must be carefully drafted to permit the board of directors reasonable latitude in determining policy. Because of its legal character, it is rarely amended except for major changes, and therefore it should be free from undesirable limitations.

An important point to be considered is whether the institute should be granted autonomous status. The view is widely held that even though an institute is founded under government auspices, it will function most satisfactorily if the board of directors is empowered to direct its activities as an independent body. This provision enhances its prestige, assures freedom from bureaucratic controls and regulations, and gives it a greater opportunity to win acceptance among the industrial enterprises, private or public, which become its clients.

Objectives and planning

The statement of objectives in the charter is usually so broad that it defines only in a general way the goals the institute is supposed to achieve. When the institute begins operations, it finds that the definition of objectives in the charter provides such leeway that it can set its own course. Experience alone will reveal which activities arouse the interest of industrial managers and hence will have greatest impact on industrial development.

Sound managerial practice requires more precisely defined objectives, which must be approved by the board of directors and communicated in a suitable form to the staff. This is the procedure being followed to an increasing extent by well-managed industrial enterprises, so as to focus the attention of the organization on directions of growth believed to be most promising. The redefined objectives of an industrial research institute should set forth the goals in terms of proposed rates of growth of different services. The establishment of definite goals is facilitated by national plans for the development of industry. When such plans have been well worked out, they indicate which sectors of industry are given priority by the Government and which operations within these industries are considered to be most suitable for the attainment of the country's objectives.

National development plans, however, need to be analysed by the management of the institute to determine the specific areas in which the institute can be most helpful. Some sectors of industry will be beyond the scope of the institute's present and planned capabilities. Others will present difficulties because of the structure of the industry, resistance to technological change, and inability to absorb advanced technology.

If there is no national plan to aid the formulation of objectives, the institute will have to rely on its own experience and on such advice as it can obtain from informed observers of the industrial scene. In any case the institute will draw heavily on this experience and advice in defining its objectives.

These objectives, and such criteria as the management may be able to define, will determine plans for rates of growth for:

(a) Types of services;
(b) Sectors of industry;
(c) Types of enterprises;
(d) Character of support.

For sponsored projects, the desires of the industrial community will be of decisive importance. For in-house projects, the definition of criteria is essential to ensure proper selectivity in the use of supporting funds.

Administrative functions and responsibilities

Many organizations suffer from poorly defined functional responsibility and authority. Three steps are important to remedy this defect:

(a) Clarification of functions;
(b) Preparation of an organization chart;
(c) Preparation of job descriptions to define responsibilities and authority of all individuals.

As a means of clarifying the functional aspects of an industrial research institute, table 4 has been prepared. This table represents a hypothetical array of functions and responsibilities of a typical industrial research institute and should not be regarded as a pattern to be followed rigidly. The functions may be varied to suit an individual case, and, in particular, the assignment of responsibilities will show considerable variation in different organizations. In all cases, however, the functions and responsibilities should be defined in some suitable way, and the policies governing

them should be communicated on the basis of "need-to-know". It is especially important to consider the broad range of primary responsibilities that rests on the director, who must decide which responsibilities he can delegate so that he may concentrate his efforts on those which he believes require his personal attention.

The following detailed explanation will help to clarify table 4 and the application of its principles to the management of an institute.

Institutional policies are formulated by the director, the chief executive, with the assistance of his deputies, who constitute the executive staff, and are submitted to the board of directors for its approval as operating principles for carrying out the objectives of the organization. They are communicated to the rest of the staff in a form appropriate for the guidance of the various echelons in carrying out their respective responsibilities.

TABLE 4. ANALYSIS OF FUNCTIONAL RESPONSIBILITIES

Functions	*Board of directors*	*Institute director*	*Deputy directors*	*Section heads*	*Echelons project leaders*	*Technical staff*	*Administrative executives*	*Administrative staff*
Institutional policies	3	1	4	5	5	5	5	5
Technical objectives	3	1	4	5	5	5	5	5
Organizational structure	3	1	4	4	5	5	5	5
Planning	3	1	4	4	1	–	4	–
Project formulation	–	3	2	2	1	5	5	–
Project execution	–	3	3	3	1	4	5	–
Client contact policy	3	1	4	4	4	5	5	–
Client contacts, executive level	5	1	2	2	4	5	5	–
Client contacts, working level	–	3	–	–	1	4	5	–
Personnel policies	3	1	4	4	5	5	4	5
Personnel procedures	–	3	4	4	5	5	1	–
Personnel policy execution	–	1	2	2	5	5	2	5
Public relations policies	3	1	4	4	5	5	2	5
Public relations execution	–	3	4	4	5	5	1	4
Financial policies	1	2	4	4	5	5	4	5
Financial procedures	–	3	5	5	5	5	1	4
Financial control	3	1	2	4	4	5	2	5

Key: Primary responsibility 1; Delegated responsibility 2; Responsibility for approval 3; Direct participation 4; Need for information 5; Nil –

Technical objectives are formulated, approved and communicated in a parallel manner. Criteria are prepared for evaluating and assigning priorities to individual projects as they relate to the objectives.

Organizational structure is determined by the director with the approval of the board of directors. In preparing the organizational plan, the director will usually find it expedient to call on his deputies, section heads and key members of the administrative staff for comments and suggestions.

Planning is the responsibility of the director, who must develop a programme and procedures for all operations required to meet the objectives. He may choose to appoint an advisory body of deputies, section heads, and key members of the administrative staff, or he may establish a staff functional group, operating under his supervision, to assist him in this task, but as chief executive he must accept full responsibility for planning.

Project formulation is assigned to competent individuals in the organization who are responsible for proposing specific projects as components of the total programme. The director or his deputies are responsible for approving the proposals. The director, his deputies, or the section heads may act as project leaders (or as project team members), but when they function in this capacity they should adhere to the appropriate policies and procedures rather than exerting the administrative prerogatives of their positions in the organizational hierarchy. There is a need to develop a co-operative team spirit in distinction to authoritarian control of technical matters.

Project execution is the responsibility of the individual project leaders, and their performance is subject to such levels of approval as the director may delegate to his deputies and section heads.

Client contact policy, which includes contracting procedures, is established by the director, who may call upon his deputies, section heads and project leaders for advice.

Client contacts at the executive level, including the negotiation of contracts or agreements, are the responsibility of the director, who may delegate responsibilities to his deputies and section heads and who may arrange for participation of the project leaders in matters concerning their individual projects. Client contacts at the working level are the responsibility of the project leaders, subject to the approval of the director, who may delegate responsibility for overseeing the contacts to his deputies and section heads.

Personnel policies are the responsibility of the director, who may seek advice from members of the senior echelons, and the general principles are subject to the approval of the board of directors. Personnel procedures are the responsibility of the designated administrative executive, subject to the approval of the director. Personnel policy execution is the responsibility of the director, who may delegate responsibilities to his senior associates.

Public relations policies are the responsibility of the director, with general principles subject to the approval of the board of directors. Public relations execution is often assigned to an administrative executive, whose acts are subject to the approval of the director; the director and his deputies and section heads will usually participate in implementation of the policies.

Financial policies are the responsibility of the board of directors, which delegates responsibility for their implementation to the director. Financial procedures are developed by the designated administrative executive, subject to the approval of the

director. Financial control, subject to the approval of the board of directors, is the responsibility of the director, who may delegate responsibilities in defined areas to his senior associates.

Board of directors

Composition

The board of directors, preferably consisting of an odd number of members, may serve under an appointed chairman or may be empowered to elect its chairman. It will nearly always include representatives of the founders. Its strength can be increased by the inclusion of leading members of the business community and government agencies. It may be rated by the following criteria:

(a) Degree of interest in affairs of the institute;

(b) Stature of members;

(c) Extent of representation of business and of government agencies;

(d) Size conducive to efficient operation.

Operations

The board need not hold frequent meetings, three or four per year usually being adequate, except during the initial period of organization of the institute. It may be desirable to establish an executive committee empowered to take interim action. The board should have a regular order of business, with documented agenda circulated in advance. Minutes of meetings should be maintained and a mechanism instituted for follow-up on implementation of decisions.

Major subjects requiring detailed study for formulation of recommendations may be expedited by the use of standing or *ad hoc* committees. The functioning of the board can be evaluated on the following basis:

(a) Frequency of meetings;

(b) Organization of meetings (agenda, minutes, follow-up);

(c) Use of an executive committee, where advisable;

(d) Use of standing or *ad hoc* committees.

Basic responsibilities

Two basic responsibilities of the board are the selection and general supervision of the director and his senior executive staff and the supervision of financial affairs. Additional functions are the study and acceptance of the general principles of the director's recommendations for policies, technical objectives etc. as given in the preceding table. The board may be rated as regards the following:

(a) Financial stability of the institute;

(b) Method of reviewing the director's recommendations for general operating policies and procedures;

(c) Method of reviewing the performance of the director and his deputies.

Additional areas of activity

The board usually should not concern itself with individual projects, except on request of the director, because to do so might infringe upon the privacy of relations with clients. There are other broad areas in which members of the board can assist the institute, and its performance rating may include an evaluation of what it does along the following lines:

(a) Assistance in selecting growth areas for services;
(b) Aid in promoting contacts with potential clients;
(c) Stimulation of sources of income to meet new needs for in-house development, including contacts with founders;
(d) Improvement of internal morale by visits and tours to the institute;
(e) Assistance in public relations.

Director

Major responsibilities

The director, acting under the general guidance and approval of the board, has a wide range of responsibilities, as was indicated in table 4. As the institute grows in size and scope, it often becomes necessary for him to appoint one or more deputies with assigned areas of responsibility. These areas often relate to internal operations, thus leaving the director more time to devote to external relations.

A director may be rated on the following points:
(a) Leadership;
(b) Policies and operating procedures he has established;
(c) Public image;
(d) Character of relations with the board of directors and the founders;
(e) Character of relations with industrial, government, and financial executives.

Additional criteria of performance

Certain more specific aspects of the director's administrative ability should be mentioned:

(a) Ability to plan activities systematically, including effective planning of his own time;
(b) Ability to attract personnel of high competence;
(c) Ability to maintain good morale, through establishment of organizational relationships that create respect for the individual;
(d) Willingness to accept other points of view and to effect compensatory changes;
(e) Ability to create opportunities for development of staff capabilities.

Executive staff members

The functions of executive staff members and their areas of responsibility and extent of authority should be defined by the director, to whom they report. These definitions are best accomplished through job descriptions. Normally one member of the executive staff is appointed to act for the director during his absence, and there may be one or more alternates, whose order of precedence should be established.

When the director delegates responsibility and authority to members of the executive staff, he should, although necessarily supervising their performance, respect the division of authority he has made. If he does not do so, the staff will be confused, and in extreme cases he will end up making all decisions, even minor ones.

A rating scheme for the appointment and supervision of an executive staff should include the following points:

(a) Logical distribution of administrative functions;

(b) Manner of delegating responsibility and authority;

(c) Methods of supervising performance;

(d) Observation of managerial principles in maintaining the integrity of delegated responsibility and authority.

Administrative executives

Financial affairs

A director, even in a small institute, usually finds it necessary to appoint an individual with administrative responsibility for financial matters that require regular attention. These include receipt and disbursement of funds; preparation of financial statements and budgets; establishment of accounting procedures and maintenance of the accounting system; handling of payrolls and expenses; supervision of purchasing commitments; checking of contract proposals, negotiations and observance of terms; and analysis of financial performance. This executive may be given the title of treasurer, secretary-treasurer or comptroller, or some other title acceptable to the director and the board.

In a technical organization, the purpose of an accounting system is to perform the necessary functions of recognized financial control in such a manner as to interfere least with the performance of professional activities. Excessive detail in assembling costs and charges is irritating to the technical staff, of doubtful usefulness, and diverts professional time from productive work.

Library and information service

A major resource of an institute in a developing country is its collection of books, journals and other information, and its ability to use this information to handle internal and external inquiries. A librarian is therefore high on the list of specialized personnel to be appointed. Evaluation of the function is discussed in other sections of this study.

Other administrative functions

As the institute grows, the administrative burden on the director becomes too heavy for him to bear alone. If he is to devote proper attention to the major areas of his responsibility, he must delegate certain functions to others. These functions include the following, in the order in which they are likely to become susceptible to delegation:

(a) Internal services, such as housekeeping, maintenance, supervision of shops, storekeeping.

(b) Personnel administration, including the more routine aspects of handling applicants, supervision of non-technical personnel, development of proposed personnel policies and implementation when they are approved.

(c) Project evaluation, which may be performed by a staff group assembled to carry out engineering, marketing, and economic feasibility studies. A group of this type often starts supplying services to clients on a contract basis in addition to carrying on its internal functions because of the demand by enterprises and government agencies in developing countries for these services.

(d) Public relations, including preparation of plans for major promotional activities; assistance in preparing speeches, manuscripts and exhibits; implementation of approved plans for systematic promotional programmes.

(e) Editorial functions, which may be assigned to the library or public relations staffs, but sometimes become sufficiently onerous to require the full-time services of one or more individuals.

When an institute reaches an intermediate size, these administrative functions which have usually been clustered informally around the director will require some delegation though they would still not warrant delegation to particular individuals or groups. A first step for the director to take is to assign responsibility for supervising selected activities to one or more of his executive staff on a part-time basis. The use of committees from the senior technical staff to advise those given responsibility has much merit because it improves general morale and often results in increased efficiency. Examples are: safety committees, library committees to advise on selection of books and journals, stockroom and equipment committees, public relations committees.

Evaluation of handling of administrative functions

Questions to be examined in evaluating the handling of administrative functions are the following:

(a) Description and analysis of importance of functions;

(b) Allocation of effort in proportion to importance;

(c) Delegation of responsibility and authority;

(d) Impact of policies and procedures on technical performance;

(e) Impact of policies and procedures on morale, particularly of the technical staff.

Administration of technical staff

Detailed discussion of the selection of the technical programme and the management of technical activities is presented in chapters 7 and 8 while chapter 9 deals with personnel administration. The present section is concerned with the broad aspects of general administration as it affects the performance of professional work.

Internal image of the management

The conduct of the director and his executive staff has a great influence on the atmosphere of the institute. Points to be evaluated include the quality of leadership and efficiency of management.

Quality of leadership reflects the personal characteristics and operating practices of the director and his executive staff. The top executives should inspire the rest of the staff with the conviction that they are pursuing a logical and systematic path leading to a better performance, greater prestige, and increased effectiveness of the organization in the future. Quality of management is exhibited by firmness, fairness, decisiveness, and understanding in dealing with the rest of the staff, the clientele, and with the community at large. The director and executive staff need to set a pattern of administrative skill which serves as a model for the rest of the staff.

Orientation towards professional efficiency should be obvious in all administrative plans, policies, objectives, and procedures. If high morale is to be maintained, the management must find a means of assessing the impact of its decisions on the technical climate within the organization.

Organization of technical staff

Technical staff members do not usually concern themselves with the details of organization unless organizational matters interfere with their work. Unless they know clearly the channels of responsibility and authority through which to seek answers to their professional and personal problems, they become confused. If they do not understand which decision-making powers have been delegated to personnel at various levels, all matters focus on the director, who has too heavy a burden to become the source of all decisions.

Three managerial devices can do much to clarify personnel relationships: *(a)* meaningful and realistic organization charts; *(b)* job descriptions outlining responsibility and authority at various levels; and *(c)* internal administrative manuals defining the proper course of action and procedures to be followed in pursuing inquiries.

Policies and procedures

The general policies and procedures of the institute should be made known to the staff to the degree necessary for performance at the various levels. They should be described in writing so far as this is possible, for example, in the administrative manual mentioned above. Manuals of this type do not meet all the requirements,

however, first, because some topics do not lend themselves to the purpose, and, second, because they are difficult to keep up to date in all particulars.

Hence it is desirable to have additional channels for informing the staff of the status of plans and operations. Periodic memoranda to the staff are an important means of internal communication. But occasional meetings, adjusted to the needs of different organizational levels, are a valuable channel of communication through which the director and executive staff can keep the entire staff acquainted with the current situation.

Communications

One of the most difficult aspects of management is the establishment of effective internal communications. Because of the high degree of specialization in professional work, organizations tend to become cellular, with limited cross-relationships between cells.

Procedures for external communications can be set forth in administrative manuals; but unless constant care is taken they tend to become observed in the letter rather than in the spirit. Contacts with clients, professional organizations, and other outside organizations must be continually cultivated.

Internal communications, except for written reports and memoranda, are often taken for granted, and hence are given insufficient attention. The use of multidisciplinary project teams, which cross formal organizational lines, is one of the most effective schemes for ensuring improved professional and personal relations in the organization. Inter-group seminars and discussions are desirable to produce cross-fertilization among different disciplines and skills.

One of the frequent complaints in a technical group is that the members do not know what is going on in the rest of the organization. It is a sign of good management when this source of frustration is minimized.

Programme orientation

The morale and sense of responsibility of technical personnel are fostered by evidence that management has planned the directions of growth logically and systematically. This subject is discussed in detail in chapter 7.

Project management and evaluation

The programming, execution, and continuing review of individual lines of work have an even more direct impact on the efficiency of professional staff. This topic is reviewed at length in chapter 8.

Meetings and group discussions

Much group time is wasted when meetings are not properly organized and conducted. The following are recommended as general policies for the orderly handling of such gatherings:

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(a) Notices of meetings should be distributed well in advance of the date set; they should state the time, place, list of individuals expected to attend, and probable duration.

(b) Agenda should be distributed in advance, giving probable order of discussion of the items listed, and accompanied, where possible, by supplementary details of subjects to be considered.

(c) Call to order should be prompt, subjects should be handled in sequence unless there is an important reason to alter the sequence, and adjournment should be as close as possible to the announced schedule.

(d) Minutes should be kept and distributed to the participants for information, action, or comment.

(e) Decisions reached should receive appropriate follow-up to make sure that the required actions are taken, and the results should be reviewed at the next meeting.

While these procedures are particularly important when the meetings are large, the same principles apply to meetings of a few individuals. The senior participant should decide on the subjects to be considered and should stipulate the order and amount of time to be devoted to the session. Management should set a good example to the rest of the staff by insisting on effective presentations and discussions.

SELECTION OF PROGRAMME AREAS

Motivation for diversification of programme

In earlier chapters the use of numerical data on financial performance and work performance has been discussed as a means of forecasting trends in areas in which an industrial research institute is already active. The present chapter is addressed to an analysis of opportunities for expanding the programme in new directions. Because the institute often does not have direct experience to guide its choices, decisions must necessarily be subjective.

A primary consideration is the policy of the management, either expressed formally by the board of directors and the institute's director or tacitly reflected in their attitude, regarding the need to undertake new types of services to assist industrial development. The extremes of attitudes may be characterized as static or aggressive, with many intermediate positions.

A static posture exists when the institute believes that its present activities offer ample opportunity for expansion at a rate satisfactory to the board and the director, and that these activities fulfil the objectives of the founders. An aggressive attitude arises when the management believes that the organization needs to provide a broader range of services in order to make the dynamic contribution to industrial development expected of it.

The decision to diversify services need not involve much expansion of the organization. Instead of continually taking on staff, the institute can reduce emphasis on older, less productive lines of work and introduce new ones. The management in many institutes in highly industrialized countries believes that when the staff has grown to beyond 300 the administration becomes less efficient; it would prefer not to exceed this number, and if there is need for an additional volume of independent technical assistance, would favour the establishment of additional institutes. Some of the larger institutes in developing countries have adopted a somewhat analogous philosophy by participating in the organization of more or less autonomous "industry centres", although they may maintain a considerable degree of administrative control over such centres, in order to satisfy more effectively the needs of some sector of industry.

Basic principles in diversification

The steps outlined in this chapter resemble the procedures used by sophisticated organizations in highly industrialized countries to plan their directions of growth. In earlier decades when enterprises and establishments decided to diversify, their decisions were often based on opportunism and individual opinions; but the results were often disappointing, and more rational methods of analysing the potential of new areas were developed.

The most advanced methodology involves four important steps:

(a) Objective appraisal of the existing strengths and weaknesses of the organization;

(b) Analysis of the industrial sectors which offer possibilities for diversification;

(c) Analysis of the degree of correlation between the industrial sectors and the skills and resources of the enterprise;

(d) Cross co-ordination between *(b)* and *(c)* to select the most promising sectors of industry from the point of view of using the skills and resources of the enterprise.

Appraisal of strengths and weaknesses of an enterprise

As a first step towards planning for the future, an organization should take stock of its total resources. Surprisingly enough, this is often not done thoroughly and objectively. To ensure objectivity, organizations sometimes call in outside groups to make the appraisal.

The major resources of an enterprise are the following:

(a) Management–capability at various levels for additional responsibilities; depth and extent of utilization of managerial talents; organizational problems restricting optimum functioning;

(b) Marketing–characteristics of present marketing area; capability of staff to handle new fields; special advantages or handicaps;

(c) Technology–strength and breadth of technical expertise; managerial skill in the use of new and improved technology;

(d) Raw materials–degree of direct control or dependence on outside sources; possibility of improving raw material position;

(e) Manufacturing–condition and flexibility of facilities; potential for extension of processes and know-how to new applications;

(f) Potential for growth–economic outlook for present types of products or services; other directly or indirectly related areas for consideration; competitive position in the particular sector of industry;

(g) Financial position–resources for maintaining present position; ability to finance new undertakings.

Merits of systematic internal review

The results of this comprehensive appraisal provide the raw material for developing an orderly plan for the future, which should include means for strengthening desirable aspects of the present position and general criteria for examining the merits of new courses of action.

Appraisal of capabilities of an institute for expanding its programme

The preceding section outlined briefly a systematic methodology for evaluating capabilities for diversification of an individual enterprise or establishment. In the next four sections this methodology will be applied to an industrial research institute. The present section is devoted to an appraisal of internal strengths and weaknesses in the following areas:

(a) Management;

(b) Client development;

(c) Technical capabilities;

(d) Facilities and equipment;

(e) Growth potential of present and related areas;

(f) Financial resources.

Management

The adoption of policies and plans for expansion and diversification depends to a large extent on the attitude of the board of directors. Without its co-operation and encouragement the management of an institute will find it difficult to move into new fields.

Assessment of the internal management requires consideration of the present capabilities and load of administrative duties to determine whether management is able to assume new and demanding burdens arising from entry into additional or enlarged areas. Additional responsibilities can be delegated, depending on the depth and versatility of managerial talents at the primary and secondary levels.

If there is not a sound procedure for delegation of responsibility and authority, any notable expansion of activities will merely add to the problems of decision-making at the senior level, which may be already overloaded and therefore not in a good position to devote the necessary time and attention to new lines of work.

Table 5 lists the chief points in an evaluation of managerial capability from the point of view of expansion of the programme.

TABLE 5. CAPABILITY OF MANAGEMENT WITH RESPECT TO PROGRAMME EXPANSION

Points to be evaluated	*Deficient*	*Adequate*	*Good*	*Excellent*
Attitude of board of directors				
Capability of senior echelon				
Work load of senior echelon				
Capability of intermediate echelon				
Specialization of intermediate echelon				
Managerial capability of junior staff				
Management development programme				
Organizational structure				
Delegation of responsibility and authority				
Planning procedures				
Project control				

Procedures for project control are discussed in detail in chapter 10.

Client development capabilities

If an institute is to undertake new types of service successfully, it must have an orderly system for establishing contacts with potential industrial or government users and for creating lasting and productive relationships with them. This corresponds to the marketing capabilities of an individual enterprise or establishment.

In this discussion, the term "client" is used to denote "potential industrial or government users" of the services, but this does not necessarily imply that individual enterprises; agencies or organizations will pay fees, at least until they have determined that they have problems on which they wish to have work done. In entering a new area, however, the institute will usually find that it has to provide "free samples" of its abilities in order to convince some of the units in the market area that it can be useful. If the objective of the institute is to earn a substantial part of its income, the management will try to determine as rapidly as possible which services are likely to be in demand and who the potential clients are.

The development of contacts with potential clients should therefore proceed according to an orderly plan. It will normally include both a "shotgun" and a "rifle" approach. The shotgun procedure is to reach as many enterprises as possible through a public relations programme that includes publicity on the services being offered

through mail, addresses to industrial groups, seminars and other channels such as industrial associations. The rifle approach is to identify, among the numerous organizations reached through broadcast information, those that express interest or are believed for other reasons to be susceptible to a direct approach.

The shotgun procedure is therefore a type of screening to determine how best to concentrate efforts to develop productive relationships. By itself it will probably result in very few direct requests for assistance, at least immediately. To choose the most appropriate information materials, to present them effectively, and to evaluate their impact on individual recipients requires skill, objectivity and perseverance.

When a list of prospects has been developed through public relations and systematic analysis of other types of information, the procedures for conversion of contacts into prospective clients come into play, i.e. the rifle approach. The cost in time and effort to follow up on unit prospects is an important consideration. To avoid unproductive efforts, time spent in analysing the likelihood of success and in deciding on the type of presentation is well justified.

The effort required to develop a clientele for new activities has much in common with the procedures for obtaining clients for established lines of service, but demands greater creativity and emphasis. If the institute has not shown a satisfactory performance in creating a demand for existing technical programmes, it should analyse the reasons for this before attempting to undertake new types of work.

Table 6 presents a scheme for evaluating ability to create a clientele in new areas.

TABLE 6. ANALYSIS OF ABILITY TO CREATE A CLIENTELE IN NEW AREAS

Points to be evaluated	*Deficient*	*Adequate*	*Good*	*Excellent*
Performance of existing activities				
Public relations				
Conversion of contacts to clients				
Ability to create demand for new services				
Public relations				
Follow-up of contacts				
Ability to analyse success in client development				

Technical capabilities

As a guide to the industrial areas in which the institute is capable of rendering effective service, management should conduct a comprehensive and objective review of the capabilities of its staff. This involves analysis of both the types of activity in which its personnel are proficient, and the sectors of industry to which their experience is pertinent.

The list of technical areas chosen for such a review may well be the same as that proposed in chapter 4 (see table 3) to facilitate cross-reference and co-ordination. The headings are shown in table 7.

A comprehensive evaluation of technical capabilities must take into consideration that the technologies of industrial sectors vary within a considerable range. The list of sectors may be the same as that described in the next two sections, in which branches of industry are evaluated from the points of view of inherent characteristics and degree of correlation with strengths and weaknesses of the institute.

It should be pointed out that the degree of practical experience becomes increasingly important as the type of activity becomes shorter in range. For example, "technical service to manufacturing and sales", consisting usually of short-term assignments on very practical problems, requires that the staff members engaged in it have detailed knowledge of the technology and commercial practices in individual sectors of industry because otherwise their approach might be considered naive by clients. On the other hand, while general familiarity with a branch of industry is desirable for longer-range work, any deficiencies in this respect may be counterbalanced in part by the competence of the staff in basic disciplines and by the advantage of a broader approach than the traditional technology of the particular industry.

Table 7 presents one way of tabulating the results of such a review.

TABLE 7. ANALYSIS OF TECHNICAL COMPETENCE FOR DIVERSIFICATION OF TECHNICAL ACTIVITIES

Industrial sectors	*New industrial operations*	*National or regional surveys*	*Managerial projects*	*Small and medium-sized enterprises*	*Studies on industrial operations*	*Technical service*	*Analysis and testing*	*Information services*

Scoring: H = high
M = medium
L = low

The evaluation may be made more comprehensive by listing separately areas of special expertise in which the institute has a high degree of competence, e.g. plant design for food products, analysis of fertilizers and pesticides, market research on textile products, product development of lubricants etc.

Facilities and equipment

In making plans for diversification or expansion, an institute needs to take into consideration the limitations or advantages of its building space and equipment. Any new major activities requiring extensive facilities or additional instruments or apparatus have to be evaluated in terms of the ability to provide them while also providing for growth of the existing programme.

The nature of a study of this type should be self-evident, and therefore no table is provided for the purpose. However, when the analysis is made, attention should be devoted to the advantage that might be derived through curtailment of space or better utilization of equipment devoted to existing programmes in order to accommodate promising new lines of activity.

Growth potential of present and related activities

Before plans for new activities are formulated, the potential rate of expansion of existing lines of work and of closely related areas should be evaluated. Hence findings from the scheme for the evaluation of technical productivity discussed in chapter 3 should be incorporated in any study of the merits of establishing new types of service.

Entry into new fields puts heavy demands on management, the staff, facilities and finances. The desirability of entering new fields must be weighed against the desirability of increasing present activities or undertaking closely related activities. It is sound practice to concentrate on successful activities that have been established rather than to expand in other directions in which the outcome is less predictable. These statements are not to be construed as recommendations for maintaining the *status quo*. They are in the nature of a warning that excessive preoccupation with new programmes may lead to neglect of present opportunities that can be exploited with less effort and risk.

Financial resources

In considering opportunities for entering new areas of service, institutes frequently pay insufficient attention to the probability of drain on finances. The potential field is technically attractive, but to exploit it successfully may be very expensive. Initially, there will be the cost of developing expertise or hiring new personnel. Efforts to secure a "clientele" will certainly require expenditure of funds, with little return, for a period of months or even years. Even moderate success may demand new building space and equipment. Many grandiose plans for entry into a new field have collapsed because they were beyond the capacity of the institute to finance or because the prospects for getting an adequate return on the investment were poor. Even many that have presented less obvious risks have still turned out to be disappointments.

A logical policy is to follow the pattern successful enterprises have adopted in planning for diversification. They first determine their requirements for funds to maintain existing activities on the projected scale of growth. By comparing these requirements with estimates of total income, they can determine the amount of money available for exploiting new opportunities.

Screening of characteristics of industrial sectors

Codification of industrial sectors

If an industrial research institute in a developing country is to make the greatest possible contribution to economic development, it must analyse systematically the technical needs of various industrial sectors in relation to their national importance.

For this purpose it is necessary to consider the relative positions of an array of sectors of industry. To ensure the most useful classification, the system employed by the Government for collecting statistics on industrial manufacturers is preferred. This usually consists of a dozen or so gross categories, such as chemicals, electrical equipment, forest products and foods. In many countries these major categories are broken down still further into a much larger number of more homogeneous classes; for example, under foods come bakery products, canned goods, dairy products etc.

To evaluate opportunities for technical assistance, the detailed classification is desirable because the pertinent characteristics of the smaller groups will be more revealing. In a given country improvement in the dairy industry may offer an especially important challenge in comparison with other branches of the food industry, a situation that would not be apparent from gross information on the major category.

Even much finer classifications are employed in very sophisticated techniques for selecting diversification opportunities in highly industrialized countries. Lists of several hundred categories in the chemical industry have been employed, for example, in order to provide a basis for more meaningful evaluation. In developing countries the total list of sectors in all manufacturing industry will usually run to about 50 to 100 items because information is usually not collected on a more detailed basis.

Criteria for screening opportunities

The purpose of the proposed screening procedure is to examine the array of industrial sectors from the point of view of a client who may be considering establishing an enterprise or increasing his stake if he is already active in a sector. Is the investment climate in this sector attractive, or should he consider entering another sector? From the point of view of the institute, if the economic health of the sector is not good, the chances of carrying out a successful project for a client are poor.

The ratings made under these criteria are necessarily qualitative. Although first attempts to develop a tabulation will undoubtedly have some weaknesses, a systematic evaluation of industrial opportunities is sound as a basis for expansion and diversification of technical activities. In any case the tabulation will need periodic revision, both because more detailed information will become available and because the situation in a given sector may change with time.

The criteria proposed are five in number:

(a) Government policies, where applicable;

(b) Growth rate;

(c) Economic return;

(d) State of technology;

(e) Ease of entry.

Government policies

In many developing countries government policies are reflected in lists of industries that are favoured by national plans. Inducements such as tax reductions

may be available to new enterprises. Where lists of this type have not been prepared, general statements of policy may be issued, such as encouragement of upgrading raw materials and reducing imports.

Growth rate of sector

Analysis of government statistics and other factual surveys will provide a basis for qualitative evaluation of growth potential of the industrial sector. Growth may be reflected in physical volume of production, total sales, employment figures, capital investment, or number of enterprises. To decide whether the growth rate is favourable, the data should be compared with the national averages for all manufacturers.

Economic return

The probable profitability of a new enterprise is, of course, a key factor in inducing entrepreneurs to act, and may be of considerable interest to government agencies. It is not easy to obtain such information in many countries, and the conclusions to be drawn from it may be questionable. The best sources of opinion are bankers, industrial association executives, government departments, and well-informed industrialists. Other evidence may be obtained from financial reports of individual enterprises or records of business failures. The conclusions, however, need to be examined critically. For example, a new enterprise with a radically improved operation may expect a good return, whereas one using current technology may be unattractive.

State of technology

For a new venture, an appraisal of the technical level of existing enterprises is important. What is the present and probable rate of change? Is new technology already available? Can it be acquired from abroad? Can it be generated by internal technical staff, or should it be developed through some other agency such as a local industrial research instutute?

Ease of entry

A number of factors may be involved in an evaluation of the opportunity to enter an industrial sector. The market may be dominated by a few strong companies that would resist a new competitor. The investment for a plant of a minimum economic size may be high. It may be difficult for the institute to provide the technical services required by customers.

In addition to the five criteria discussed above, other data from government or public sources may be of interest, particularly with regard to the relative size of sectors. Government statistics frequently include total physical volume or value, number of employees, number of enterprises etc. A factor that is frequently of concern to government planning agencies is total investment per job opportunity. This is a measure of capital intensity, which is of value in formulating national policies to create industrial employment.

Screening procedure

The end result of application of these techniques is a tabulation of the type shown in table 8.

TABLE 8. EVALUATION OF NEW OPPORTUNITIES IN VARIOUS INDUSTRIAL SECTORS

Industrial sector	*Government policies*	*Growth rate*	*Economic return*	*State of technology*	*Ease of entry*

Scoring: H = high
M = medium
L = low

It should be emphasized that this screening is carried out for the purpose of analysing industrial sectors from the point of view of clients. Such screening is of direct help to the industrial research institute, since it provides information on those sectors of industry that should attract new enterprises and that should offer an opportunity to create a clientele. Finally, judicious use of the tabulated information, which would be a proprietary asset of the institute, should create valuable confidence and goodwill on the part of private clients and government agencies when applied to individual projects. In carrying out such studies, the institute may use a modified list of criteria that provides a more critical evaluation of the much smaller list of opportunities that emerges from the screening.

Screening of sectors in terms of institute capabilities

The preceding section relates to inherent characteristics of industrial sectors. The capability of the institute to service projects in the various sectors remains to be determined. This requires a second screening of the same list of industrial sectors as would be included in table 8, in terms of the institute's technical competence, ability to create and service a clientele, and facilities and equipment.

For convenience, this second screening may be added to the list of characteristics of individual industrial sectors shown in table 8. The combined tabulation is shown in table 9.

TABLE 9. SCREENING OF INDUSTRIAL SECTORS IN TERMS OF INSTITUTE CAPABILITIES

Industrial sector	*Ratings of characteristics of industrial sectors*					*Ratings of industrial sectors in terms of institute capabilities*		
	Government policies	*Growth rate*	*Economic return*	*State of technology*	*Ease of entry*	*Technical competence*	*Ability to service clientele*	*Facilities and equipment*

Scoring: H = high
M = medium
L = low

Selection of promising sectors for institute services

The previous two sections have provided the basic information for the selection of the most attractive areas for expansion or diversification of the programme of an industrial research institute. On the one hand, there are ratings of the economic and technological status of a comprehensive array of industrial sectors, and on the other, an estimate of the degree of correlation between the institute's capabilities and the needs of these sectors.

Comparative analysis of the two sets of ratings will permit selection of those sectors of industry that show attractive characteristics and, at the same time, are those for which the institute is competent to provide services. For example, a limited number of sectors will probably show excellent or good prospects for expansion and also represent technical areas in which the institute has competence. Some sectors, no matter how attractive in growth potential, will have to be dropped from consideration because they do not offer opportunities which the institute is able to exploit. Still others may show only modest promise from the point of view of entrepreneurs or government agencies, but could make such good use of the institute's services that they should be given serious consideration.

As a result of this analysis, perhaps ten to twenty industries will be found to merit further scrutiny. At this point a more detailed study should be made of the needs of these categories for services that are within the scope of the institute's capabilities. Some industries may show promise only for short-range technical services or for analysis and testing as a means of establishing a foothold. Others may be in a more advanced state of technology with internal resources for more routine activities, but lack competent staff for product and process development or improvement. Still others are quite sophisticated but are judged to be susceptible to projects for market research, engineering studies, or managerial problems, with the understanding that the institute has staff with background and experience to handle such assignments successfully. Finally, there will probably be some in which more detailed study will be needed to clarify the opportunities.

The management may well find that more areas offer scope for expansion than it can handle at the time. It then becomes necessary to set priorities and to decide on the amount of effort it can devote to each without detriment to existing programmes.

It is essential in carrying out evaluation schemes of this type that the ratings be kept up to date by periodic review. The situations will change in some sectors of industry. The competence of the institute may also undergo modification in some directions. Hence the system for selecting promising areas of service must be dynamic to allow for both internal and external change.

General principles for evaluating programme selection

The procedures outlined above may be criticized as being too elaborate for application in many industrial research institutes in developing countries. In reply it may be stated that this is a workable system offered as an example, but any other scheme should be valuable as long as it provides a logical basis for selecting areas of service representing the country's needs and the institute's competence. In the tabulation at the end of this section the essential points are stated in general terms.

Admittedly, the establishment of an evaluation system will require considerable effort at the start. It is doubtful, however, that in the long-run, more total time will be necessary to set it up than would be spent in diffuse discussions of potential directions of growth when no criteria have been framed by which their relative advantages and disadvantages can be judged. Some form of appraisal, in which not only the senior management but also more junior staff members can participate and accept, gives the entire organization a sense of purpose and orderly direction.

The essential points for selecting directions of effort are summarized in table 10.

TABLE 10. METHODOLOGY FOR PROGRAMME AREA SELECTION

	Score
Internal appraisal	
Technical areas of competence	
Industrial areas of competence	
Ability to obtain and service clientele	
External appraisal	
Criteria for evaluating industrial sectors	
Systematic screening of opportunities for service	
Co-ordination of external opportunities with internal capabilities	
Detailed analysis of promising activities	

Scoring: H = high
M = medium
L = low

Chapter 8

ADMINISTRATION OF TECHNICAL ACTIVITIES

The primary resource of an industrial research institute is the composite of its staff's skills. Management's major responsibility is to utilize these skills to make the optimum contribution to industrial development and thereby to achieve the institute's objectives. All policies and procedures should be shaped to this end.

This chapter will deal with the organization of work, the staffing of work assignments, the control of programmes, and the reports and communications to disseminate the results.

Selection of projects

General principles

Most industrial research institutes, as well as other technical organizations, subdivide their activities into specific lines of work, which are usually called projects. Frequently, these are described in written project outlines. Some organizations do not have a formal system of this kind, but rely on supervisory staff to assign problems and to maintain guidance towards objectives. The use of written project outlines has been found to be advantageous in so many technical groups that it will form the basis for the present discussion.

Each project outline in an industrial research institute should include a description of the goal; the justification, i.e. an estimate of the project's importance or value; a description of the proposed course of investigation; an estimate of input of effort; and an assignment of responsibility for supervision of the work.

The preparation of an outline usually requires exploratory work, either in the library or in the laboratory. A fixed amount of time may be set for this work; otherwise it may go on too long, since explanation tends to become diffuse rather than oriented towards a defined objective. After the project has been authorized and work is under way, it is customary to make periodic reviews of progress to determine whether it should be continued, modified, or abandoned.

All major lines of work are usually covered by authorized projects. In total they will account for two thirds or more of all technical manpower available in the organization.

In-house projects

Nearly all industrial research organizations undertake some projects without having to obtain outside approval and support. Successful contract research institutes regard these projects as a means of developing new skills in technical areas in which they desire to expand, or even to secure a proprietary position for which they can later secure client support. Hence the criterion of entrepreneurial feasibility mentioned earlier should be accorded considerable weight in selecting these lines of work.

In some industrial research institutes in developing countries, however, there is a tendency to choose projects of technical interest that are assumed to be in the national interest without a critical assessment of whether or how the results will be utilized. Unfortunately, this lack of objectivity may lead to diversion of skills into work that is unproductive from the point of view of industrial development.

Sponsored projects

The probable usefulness of projects receiving support from enterprises, associations, or public agencies is often more clearly defined than it is for in-house projects. If the projects have not been adequately justified from the point of view of utility, the reputation of the institute as a resource for industrial development will eventually suffer. As a result, the institute will find it more difficult to secure new industrial or government clients.

Another weakness that may occur in sponsored work is failure to specify the exact goals of the projects at the outset. The client may enlarge the objective during the course of the investigations, with the result that the institute may find itself committed to a larger programme than that described in the original agreement or contract.

Organization of projects

The operation of project systems has been described in many reference works Here only particular aspects pertinent to the management of industrial research institutes in developing countries will be mentioned.

Staffing of projects

Project outlines should include an estimate of the amount of technical effort required to complete them. Preferably, responsibility for supervision of the work should be assigned to some competent individual. If he is to be given this responsibility he should participate actively in the preparation of the outline. It is not reasonable to hold him responsible for a programme he did not help to design. Hence, for a project sponsored by outside parties, the supervisor should be selected at an early stage and should participate in the negotiations.

There is a distinct trend in research and development to use a broad spectrum of technical skills on projects in order to ensure a comprehensive approach to a

problem. Some organizations carry out all their work through multidiscipline teams, and more are beginning to use this managerial technique because of its advantages. The subject has been treated in detail in other publications and will not be further discussed here.[2]

Even for organizations that do not employ the multidiscipline technique regularly, some of the advantages can be obtained by appointing consultants from other groups in the institute to participate in project team discussions or other periodic reviews. For example, those assigned to develop a new product will benefit from advice from market research specialists and project engineers, who can assist in defining requirements for satisfactory product specifications and manufacturing procedures. They can also be of great help in preparing a project outline.

Procedures for allocating professional effort

It has become common practice to keep track of the distribution of the effort of the professional staff, usually by means of a periodic time card (weekly time reports are most frequently used) showing the number of hours each member spends on each project on which he is working, and the system is often extended to activities of a general nature. An estimate of the time to be expended by various individuals on a given project is an essential item in a good project outline.

The submission of time cards is often regarded as an unnecessary nuisance by the staff when time controls are first instituted. If the system is to achieve its objective, the managerial importance of data on time distribution should be made obvious to all concerned.

Establishment of project budgets

The true cost of a project consists of the salaries of the personnel engaged in the work; a proportionate share of the total overhead of the organization; and other expenses associated with it, such as supplies, equipment, and travel. Salaries of professional staff usually amount to at least 40 per cent, and often 50 per cent, of the total operating cost of an industrial research institute and hence of the true cost of any individual project.

For the estimation of project budgets, the total cost of a technical man-day is a convenient unit. This consists of direct salary per day, the figure often being computed with fringe benefits included, plus an arbitrary percentage for overhead based on the experience of the organization. Many industrial research institutes find that the overhead is in the neighbourhood of 100 per cent of direct project salaries. To reduce accounting time and paper work, many organizations do not charge individual projects with small items of expense, such as normal amounts of supplies and equipment, but distribute such costs on a *pro-rata* basis in proportion to technical salaries; larger items may be debited against projects. It is still necessary, of course, to carry the usual detailed accounting records of financial transactions.

Various practices are followed in calculating the cost of a technical man-day. Some institutes use the actual salaries of individuals as a basis, while others use the averages for categories of personnel or for the entire technical staff. Using the

[2] See United Nations (1970) *Industrial Research Institutes*. Sales No.: 70.II.B.21.

averages for categories is a convenient procedure and avoids disclosure of the exact salaries of individuals, which may be desirable, depending on circumstances.

When an estimate of the number of technical man-days has been prepared as an essential item in the project outline, it can easily be converted into a financial forecast for the work by applying the proper factor. Additional sums may be added to the budget to take care of large items of supplies, equipment, travel, or special services.

Estimates of project costs provide management with data for evaluating input-output relationships, i.e. whether the value of the results of a given investigation is worth the cost of the effort to carry it out. Use of standard cost-estimating procedures reassures clients that work on their behalf is being charged at a proper rate, which may be a point in question in negotiations because many enterprises and government agencies are not acquainted with the expense involved in technical programmes.

Administrative control of projects

Effective management of technical activities requires that a formal, comprehensive review of progress, cumulative expenditure of effort, budgetary performance, adherence to schedule, and adherence to objectives be carried out periodically. As a result of this review, the goals may be reassessed and the programme revised. For long-range work, reviews are often made on a monthly, bimonthly, or quarterly basis. For projects nearing application of results on a commercial scale, the reviews should be more frequent, at least monthly and perhaps weekly.

The character of the review should be adapted to the stage of the project and the requirements by which the results have to be judged. In the early stages of the work, technical feasibility is the chief criterion. As commercial implementation approaches, engineering, marketing, and economic assessment, and even review of entrepreneurial feasibility with the client, becomes more important.

The effectiveness of the reviewing process depends on the quality of the documentation prepared by the team leader and his associates. If they have prepared suitable analyses of progress, expenditures of time and budget and an assessment in terms of stated objectives and justification, the meetings for review will be orderly and productive.

Review of technical progress

An assessment of technical progress usually starts with an examination of the detailed plans of activities that were drawn up before the work began. These plans show the proposed course of the investigation that at the time was believed to be the best for reaching the defined objectives. This outline would naturally have been revised as results were obtained. The review should also include a comparison of actual performance with the original estimates of professional effort, cost, and schedule.

The plan of investigation and a summary of the results provide a systematic base for evaluation of progress. They permit revision of estimates of technical feasibility, better plans for the next stages of the work, and readjustments in manpower requirements, budget, and schedule.

Review in terms of objectives

While technical progress is being reviewed, the course of the work should be compared with the objectives defined in the original project outline. Experience shows that often the professional interest in unexpected findings will divert the investigation from the directives set up when it was authorized. Careful review may result in modification of the objectives in order to take account of new information. For in-house projects, changes can be approved internally. For sponsored projects, the client's approval of the changes should be obtained before the work proceeds.

Reassessment of feasibility

A periodic review of feasibility from all points of view (technical, engineering, marketing, economic, and entrepreneurial) should also be conducted. This may be combined with the review of technical progress and objectives.

The feasibility review will become more significant as the work progresses. The new information collected will permit a better definition of the end result expected and hence an improved basis for comparison against the criteria for feasibility.

Reporting and communications

Reporting systems

Reporting is regarded by the great majority of research and development personnel as a disagreeable chore. Actually, those who derive most benefit from good reports are those who prepare them. Reports enable the writers to systematize their thoughts and information so that they are in a better position to plan future work. They provide one important basis by which supervisors can judge the professional performance of individuals. They influence favourably the acceptance and approval of ideas and courses of action which the writers wish to pursue.

A gradual improvement in the quality of reports of the institute is a sign of good management. To achieve this objective, conferences with individuals on report writing and group training courses can be organized. Sometimes other schemes are used, such as using a staff editor to bear the brunt of the training, or appointing reviewers to work with the individual staff members. Reporting procedures should be described in the administrative manual of the institute. There are many handbooks on the preparation of reports, and therefore the discussion here will be confined to a few salient points.

The most common weakness of industrial research reports is that they often reflect the concerns of the writer and thus fail to serve the needs of the reader.

Research workers tend to think of their work in historical perspective, pointing out in sequence the difficulties they had to overcome and the ways in which they overcame them. The user of the report, however, is concerned only with the final conclusions and the information necessary to confirm its validity and with methods of application; he assumes that there must have been obstacles during the course of the work, but his interest is concentrated on end results.

The reporting system starts with the keeping of notebooks. Poorly kept notebooks indicate negligent management.

Reports for internal use usually consist of a weekly (or monthly) summary to inform the supervisor of the state of progress, more lengthy reports on a monthly or quarterly basis to present and analyse all pertinent information, and final reports at the conclusion of a project or a major phase of an investigation. A good reporting system maintains a balance between providing too little and excessive information. Time spent on exhaustive reports that may never be read is wasted. If the interim reports are well organized, the subsequent summaries can be much shortened by cross-reference to material already in the files.

Reports for use by clients or other external agencies have great importance because they represent the embodiment of what the funds were used for. They are, so to speak, the "product" of the industrial research institute. They should be prepared in a form suitable for a succession of readers at various levels in the client organization. The senior executive will be interested only in a concise statement of the utility of the results. The next echelon of management will wish to examine in more detail the basis for the conclusions. Finally, at the technical level, the reader will need all the details pertinent to successful use. Hence the organization of the report will usually be in the form of a very brief summary; a somewhat more detailed presentation of the conclusions and primary supporting data; and a lengthier discussion of data, methodology, and method of application. Comprehensive tables of data or analyses and justification of methodology are often placed in appendices in order to keep the body of the report a smooth and concise record of essential information.

Internal communications

Internal communications are important for several reasons. The progress of an investigation is facilitated when it is possible to draw on information from individuals with a variety of backgrounds and experience. The greater the interchange of views among the staff of an organization, the more unified the organization will be. The morale of the staff is improved by the feeling of being a part of a larger team. The ability of an individual to take part in discussions with the outside community, particularly with clients and technical colleagues, is improved by the experience he gains inside the organization.

Internal communications present a problem in technical groups of all sizes, even fairly small ones. They can be improved through: encouragement of interchange between groups by arranging for presentation of individual projects for discussion in small or large groups and circulation of certain reports to a wider circle; regular staff meetings of the entire organization or of smaller groups to present a broader picture of institute activities; informal concultation with other groups in project reviews; use of multidiscipline project teams. The senior staff of the institute can do much to promote interdisciplinary communication by suggesting or arranging appropriate discussions.

External communications

As mentioned earlier, some contract research organizations require the leader of each project to have some form of communication with his client on a regular basis, perhaps once a month. This promotes mutual acquaintance, understanding and co-operation. It may consist of a personal visit, interim report, letter, memorandum, or telephone call. The aim is to let the client know that someone has a personal interest in the work being done on his behalf.

The quality of contacts by institute personnel should be under continual scrutiny by the management. The staff should receive training in the techniques of making forceful, well-organized, and courteous presentations. They should be encouraged to make outlines of what they propose to say and to prepare illustrative charts or diagrams where these will be helpful.

Senior members of the staff who accompany more junior personnel can assist in this training by making the latter responsible for parts of the presentation and by discussing in private afterwards how performance could have been improved.

Chapter 9

PERSONNEL ADMINISTRATION

Because the technical staff of an industrial research institute is its chief resource, a primary responsibility of management is to assemble, organize, and guide the personnel in such a way as to ensure optimum performance. The procedures used for these purposes profoundly influence the morale of the staff and their motivation towards productive work.

Orientation of the individual towards the organization

Each individual should understand his function in the organization. Unless he knows what is expected of him and the sources of leadership and advice available to him, he will be unable to do his job well.

Administrative manuals

After they have been in operation for a certain period, most research organizations find it desirable to issue administrative manuals setting forth the objectives of the institute, the details of conduct expected of the staff, and the administrative functions established to assist them in the performance of their assignments.

Organization charts

Although many managers of research organizations do not like to use charts outlining the scope of functions and the designation of areas of responsibility, the great majority find them useful. Three major weaknesses should be avoided. First, charts suggest rigidity, which is hostile to the interplay of skills so desirable in technical work. Second, they are often allowed to become out of date, with consequent confusion. Finally, they often portray a situation that does not actually exist. Even with these limitations, charts have the value of showing the normal channels of communication and authority.

Job descriptions

As a supplementary description of functions, responsibility, and authority, many organizations find it useful to develop job descriptions for positions at different levels. These are especially helpful in defining the interrelationships between echelons. It is an axiom of good management that when responsibility is assigned, the authority delegated should be proportionate. A good set of job descriptions is valuable for the purpose of defining this relationship.

In actual operation, however, the senior staff of a technical organization need to be continually on guard to prevent erosion of the authority of the supervisors at lower levels. Senior staff having extensive dealings with junior personnel should keep in mind that if they continually make decisions that should have been formulated at a lower level, eventually all decisions–small and great–will fall on them; they will be so heavily involved in all details that they have inadequate time for the broader aspects of their duties. They will also fail to develop managerial skills, which are essential to effective performance at lower levels. Job descriptions are also a valuable tool for salary administration.

Recruitment procedures

Methodology of recruitment

Large technical organizations have developed several techniques for making recruitment more systematic. They often use job descriptions of a position to be filled so that the qualifications of candidates can be analysed on a logical basis. They may set up for the candidate a series of inverviews with various individuals in the organizations so as to provide a cross section of opinions. Because the whole process of securing information and references, scheduling interviews, and checking opinions on candidates is time-consuming, organizations frequently delegate responsibility for these activities to a personnel officer. A wise policy to follow is to make sure that the individual to whom the new employee is to report is a key member of the interviewing team.

Indoctrination of new personnel

New employees should be given a suitable introduction to the organization when they report for duty. This is usually the responsibility of the individual to whom they are to report. He sees to it that they are provided with the necessary information about the institute, such as the administrative manual and their job descriptions, and he introduces them to the people with whom they will work. Failure to provide a cordial induction into the organization can make an unfavourable impression on new employees that may lead to maladjustment.

Management of staff

The spirit in which personnel are treated by the senior management leaves a strong imprint on morale. The relationships should be courteous, objective, fair and considerate. For example, one hears complaints that the senior staff are prompt to criticize, but rarely give credit for work well done. The example set by the management often pervades the entire organization.

Periodic reviews of performance

To ensure that there is adequate evaluation of performance, many organizations have adopted the procedure of a comprehensive review of each individual's activities in the form of an interview at some regular period, for example, once a year. These interviews should be frank, objective, and constructive. Often a team of two will participate in a session–one, the man's direct superior, the other, someone from another level or group. A good technique is to set the person being interviewed at ease by discussing favourable aspects of his work. This is followed by a review of his weaknesses, such as inefficient working habits, lack of objectivity and poor relations with colleagues. The atmosphere should be one of constructive criticism to help the individual make the most of his abilities.

Handling of separations

One of the unpleasant tasks of a manager is to arrange for the resignation or dismissal of individuals who are not performing satisfactorily. The longer this is put off, the more difficult it becomes. Delay in handling an obvious case is harmful to the image of management, the morale of the rest of the staff, and to the future of the man himself.

If there has been a periodic performance review of all personnel, it is to be expected that the individual who is to be separated will have received warning that his performance has been deficient in some particulars. Hence the ground will have been broken for taking steps to terminate his employment. The termination interview may well include guidance as to the type of position the man is best fitted for and the changes in attitudes or work habits he should strive to make. Still better, it is sometimes possible to suggest definite job opportunities and even to take preliminary steps to arrange interviews for him with other employers.

It is sometimes necessary for an industrial research institute to discontinue some area of activity and to let a group of individuals go. Actions of this type require careful planning of procedures so as to preserve the respect and morale, not only of those to be separated, but also the rest of the organization. Information about the proposed change should be kept as confidential as possible in the senior management group, in order to prevent premature leakage, which is demoralizing for the rest of the staff.

When the individuals to be separated are notified of their impending dismissal, management should endeavour to be considerate and constructive. There should be a well-worked out schedule of separation payments and a programme for assisting the employees to find other positions. The news should be transmitted suitably to the

rest of the staff so as to relieve the apprehensions of those who are to be retained. At best, the separation of groups of employees for managerial reasons beyond their control is a trying situation, and if it is not well handled it can cause deep-seated resentments and unhappiness throughout the organization.

A word should be said about procedures for voluntary separations. There should always be a terminal interview to try to find out why the individual is leaving, not only as a courtesy, but also because the reasons he gives may reveal important weaknesses in the institute's policies or activities that render it unattractive to employees.

Salary administration

The procedures used in setting schedules and individual salaries should be systematic and fair. To ensure fairness, many organizations use charts in which salaries are plotted against a criterion such as years of professional experience (or age). When the salary of one individual is changed, this scheme permits critical evaluation of the merits of the case in comparison with the rest of the staff.

Announcement of a salary change to an individual can best be made when his performance is being reviewed. The monetary award is thus coupled with the way in which he has carried out his responsibilities.

Each individual should have his salary reviewed at some regular period, for example, once a year. Although changes in salaries of senior staff occur less frequently, perhaps every two or three years, their salaries should also be reviewed regularly even though no changes are contemplated.

Professional development

Because an industrial research institute in a developing country occupies such an important position as a national technical resource, its function as a training centre for improving the technical skills of its staff is a recognized contribution to the public welfare. The management therefore needs to appraise carefully the best means of carrying out this vital function in conformity with the policies and objectives of the institute.

The types of activities may be classified according to two main objectives: *(a)* improvement of disciplinary or scientific skills, and *(b)* improvement in technological skills and knowledge of sectors of industry. Obviously these two types cannot be sharply differentiated because advanced training in a new scientific technique, for example spectroscopy, will often expose the individual to applications of this technique to industrial problems, while a period of experience in some field of industry will encourage a familiarity with new techniques.

The policy of the institute in providing opportunities for improvement of skills should therefore strike a reasonable balance. If the emphasis is too heavily on the academic side, the scientific stature of individual members of the staff will be enhanced, but their ability to handle practical problems may not be increased. On the other hand, if all training is confined to technological areas, the absence of the

leavening effect of new scientific concepts may restrict the approach to problem solving to conventional habits of thinking.

Another aspect of training policy is the depth of penetration into the staff as a whole. Some means should be found to give suitable opportunities for training to staff at various levels of seniority, so that more junior personnel can feel that they have a responsibility to improve their professional skills.

It does not appear that any formal classification of training activities would serve a useful purpose because each institute has to select the pattern that best suits it. Therefore, this section is concerned with presenting a comprehensive list of means by which the broad objective of improving professional capabilities can be attained.

Provisions for outside study

Scholarships, fellowships, or grants for foreign study offer the most attractive possibilities for professional development. These may be for academic work in a general area or for concentrated study in a particular field. They may be for the purpose of gaining experience in the practices of some branch of industry or in managerial techniques in one or more highly developed countries.

On the local scene, there are numerous educational opportunities, such as supplementary study in educational institutions and attendance at scientific or technological conferences or lectures. Some institutes encourage such activities by granting the necessary time from regular duties for participation and by defraying part or all of the expense. It may be a policy to encourage all members of the technical staff to attend local scientific meetings, for example, by paying some part of the regular dues in professional societies and the cost of meals when these are involved.

Internal training activities

Many technical organizations carry on a series of lectures, seminars, or discussion groups within the institutions. They may invite guest speakers to address specialized courses. In this way they can select the subjects they believe to be most pertinent from the point of view of increasing the capabilities of the staff. Such activities are very beneficial to internal morale because they reflect management's interest in encouraging professional growth.

Training by counterpart staff

Many industrial research institutes have the advantage of direct association with counterpart staff provided by foreign organizations or by the United Nations or other multinational bodies. While these counterparts give prestige and additional competence to the institute's programme, their major value often lies in the opportunity for transfer of skills from foreign experts to selected members of the internal staff.

Training through in-house projects

A consistent policy of using in-house projects as a means of cultivating new skills can contribute to professional growth. Critical assessment of the extent to which supporting funds are being used for this purpose should be carried out. The tendency in selecting such projects is to choose those which are technically attractive to management and staff and are assumed to be susceptible to practical application. They often require, for the most part, the exercise of existing skills in extension to other related applications. In many cases they do not result in direct use by industry because they are not aligned with entrepreneurial interests.

An alert management will therefore weigh the advantages of using at least part of the in-house projects for developing new staff capabilities. If these are carefully selected on the basis of probable usefulness in providing new areas or types of service, the potential contribution of the institute to industrial development will be enhanced.

Managerial development

Until recent years, little organized training was provided for managers of research and development. Often their selection was based on professional performance, with the result that some good technical men were elevated to positions in which they became mediocre managers.

The present section is based on three premises: *(a)* managerial principles can and should be applied to technical programmes; *(b)* these managerial principles apply at all levels in the organization, from the director to the junior technical category; *(c)* so-called "on-the-job training" of technical managers is often not training in the true sense, but merely a series of unrelated dealings with specific situations in which the general principles are not enunciated.

Organized training procedures

Management of an industrial research institute will find it beneficial to organize lecture courses, seminars, or discussion groups appropriate to the various levels of staff responsibility. Junior personnel can be given guidance on how to plan, organize, conduct, analyse, interpret, and report on their individual programmes. Section heads and project leaders need to know more about the general policies of the institute as they affect their responsibilities and about how to improve their leadership, training, and co-ordinating functions. The senior staff need opportunities to discuss their problems with technical directors from other organizations in order to develop policies and procedures best suited to their individual requirements.

Practical training in dealing with managerial problems

Much can be done to improve the definition and acceptance of policies and procedures if representatives of intermediate or lower echelons of the organization participate in their elaboration. They may be used in an advisory capacity in standing

committees or *ad hoc* groups. For example, they can be advisers on library acquisitions, purchase of new equipment, safety regulations, procedures for use of shop facilities, reporting systems, some aspects of personnel administration etc., without weakening the prerogatives of management. Some industrial enterprises in highly industrialized countries have sometimes gone so far as to appoint "junior boards of directors", with advisory powers only; this has resulted in improved communication and understanding between management and the rest of the organization.

Chapter 10

COMPREHENSIVE OUTLINE FOR EVALUATION

Objective

This chapter proposes a scheme for comprehensive evaluation as a means of calling attention to salient points in the preceding chapters and as a convenient form for a general assessment of past performance and future potential of an industrial research institute. It does not necessarily follow the details presented earlier, but it does represent quite complete coverage of major attributes and resources. Hence it presents to those responsible for the success of an institute a checklist for considering strengths and weaknesses of the organization.

It is to be hoped that institutes in different parts of the world will be willing to tabulate ratings for their operations. If this is done, the information would be valuable for establishing some preliminary conclusions about the successes and problems of this important type of national technical resource.

Suggested procedures for organizing evaluation studies

Selection of personnel for evaluation

If an evaluation is to be meaningful, it should be as objective and unbiased as the circumstances will permit. For obvious reasons, the director of an institute should preferably not be the source of evaluation of his own operation. Try as he will, it is difficult for him to offer objective criticism of his own handiwork. Even if he can largely omit his own biases, it should be most helpful to him to have his organization examined from a fresh perspective.

The most desirable answer would be to use an unprejudiced outside group consisting of a small number of competent individuals. These might be provided by a national agency, the United Nations, or some other international body. A somewhat less desirable solution would be a committee of members of the board of directors not directly involved with the operation of the institute. A final suggestion is for the director to appoint a small group of his senior colleagues in management. If none of these alternatives is feasible and the director has to do it himself, or in co-operation with a few senior fellow executives, the scheme would have the advantage of forcing

him to take a comprehensive look at his creation, even though his opinions may be lacking in objectivity.

The spirit in which an evaluation is undertaken is important for success. It should not be used as a medium for criticism of individuals. It should be regarded as a guide for improving future performance.

Rating scheme

It is recommended that for each criterion used in table 11 four qualitative degrees of scoring be used: U = unsatisfactory; S = satisfactory; G = good; E = excellent. These ratings should be made on the basis of reasonable performance under the set of circumstances which the institute faces, including the economic and industrial climate, limitations on financial support, and difficulty of securing competent personnel.

Even where quantitative information can be assembled such as for income and expenditure, work completed, staff size, facilities and equipment—there exists no quantitative norm for comparison. Hence the final judgement has to be based on subjective opinion.

Systematic outline for evaluation

Table 11 is proposed for rating performance in the major areas of managerial policies and controls. In the following paragraphs general comments are made under the principal headings as regards the more important considerations on which scoring is to be based. These summarize but do not include the details of discussions in preceding chapters.

Financial performance—general

The objective of this analysis is to determine how well the growth rate in income is meeting the expectations and plans which were the basis for establishment of the institute. If a guiding policy was to provide an optimum level of service to industry and Government through sponsored projects, how successful has the institute been in securing this type of work?

Sources of earned income

Are the general procedures for analysing earned income adequate to disclose the salient facts and trends? Is the present status of the level for types of sources, sectors of industry, and types of enterprises and services reviewed in terms of plans? Is adequate attention devoted to recovery of project costs through fees? Is the growth rate of these categories analysed to determine the validity of the plans? Does the management make systematic use of the results of the evaluation for formulating future plans?

Utilization of supporting income

Does the management have a plan and procedures analysing the use of supporting income to further the progress of the institute? Has it developed a classification of major areas of expenditure for this purpose? Are the results used to re-examine the pattern of expenditures in order to meet its objectives for performance?

Analysis of expenditures

Is there a system for critical examination of expenditures in terms of objectives? Are there procedures for controlling expense of sponsored and in-house projects and for estimating in advance the costs associated with them? Is the basis for calculating fees receiving adequate attention? Are overhead expenses under continual review to bring them into line with managerial policies and objectives? Does the institute operate with a balanced budget and does it endeavour to accumulate reserves for major purposes or emergencies?

Work performance

Are there managerial procedures for making a comprehensive review of work completed? Does this include a classification of sponsored and in-house projects that provides a basis for determining present allocation of technical effort to various types of activities? Table 11 may be expanded to include growth rate as well as present status. Are the data used by management for planning changes in emphasis to meet general objectives?

Staff capabilities

Is the growth rate of professional staff proportional to growth in income? Is the professional staff in proper relationship to supporting personnel? Is the rate of turnover of professional staff affecting the capability of the institute to carry out the programme? Is the technical competence of the staff compatible with the objectives of the institute?

Facilities

Are the working space, equipment, library, and service facilities suitable for the programme? Is the budgeting procedure for facilities adequate to provide for future requirements?

General administration

Has the director formulated suitable objectives, policies, criteria, and plans? Have they been suitably disseminated to the staff for guidance in the conduct of the work? Are the organizational structure and delegation of responsibility and authority appropriate for smooth working relationships? How active is the board of

directors in assisting the institute in performing its mission? Is the director distributing his efforts in accord with logical priorities? What is the attitude of the staff towards management? How constructive are relationships between management and other personnel? Are meetings and discussions handled efficiently?

Selection of programme areas

Have policies and criteria been formulated to systematize the selection of areas for expansion and growth? Have strengths and weaknesses of the institute been evaluated to provide a basis for determining its technical competence and ability to service a clientele in new areas? Is there a procedure for screening sectors of industry to determine their attractiveness for technical assistance? Have these potential areas of growth been evaluated in terms of the resources of the institute? Has there been a review of the types of service the institute would need to provide to make optimum penetration of the preferred industrial sectors?

Administration of technical activities

Have criteria been established for the selection of in-house and sponsored projects? Is the system for defining and organizing projects adequate? Are the procedures effective for staffing projects and for allocating professional time and budgets to them? Is administrative control of projects systematically performed? Is the reporting system adequate? Is sufficient attention devoted to the improvement of internal and external communications?

Personnel administration

Is there adequate effort to orient individuals to their institute environment through administrative manuals, organization charts, and job descriptions? Are the recruitment procedures well adapted to securing the best personnel and indoctrinating them? Is there a systematic programme for periodic individual reviews of performance of all members of the staff? Are separation interviews handled appropriately? Are the procedures for salary administration such as to ensure equitable treatment? Is there an organized policy and programme for professional growth? Is sufficient attention paid to improvement of managerial capabilities of the staff?

TABLE 11

I. Financial performance–general	*Score*
Average growth rate per year in:	
Gross income	
Supporting income	
Earned income	
Ratio of earned to supporting income	
Percentage of gross income represented by earned income after *X* years of operation	

TABLE 11 *(cont.)*

II. Sources of earned income
- Managerial procedures for analysis
- Present status in terms of plans
  - Major sources, i.e. public agencies, industrial enterprises etc.
  - Sectors of industry
  - Types of enterprises
  - Types of service
  - Project cost recovery
- Growth rate in terms of plans
  - Major sources
  - Sectors of industry
  - Types of enterprises
  - Types of service
  - Project cost recovery
- Managerial use of ratings for future plans

III. Utilization of supporting income
- Managerial procedures for analysis
- Present utilization of funds
  - Long-range in-house projects
  - Professional development, general
  - Development of new skills
  - Exploration of new areas of service
  - Provision of public service
  - Facilities and equipment
  - Adjustment of utilization to meet objectives

IV. Analysis of expenditures
- Procedures for analysis, general
- Control of project expense
  - Sponsored projects
  - In-house projects
- System for estimating project expense
- Basis for calculating fees
- Analysis of overhead expense
- Balancing of budget
- Accumulation of reserves

V. Work performance
- Managerial procedures for analysis
- Volume of sponsored project work completed
  - New industrial operations
  - Development surveys
  - Managerial projects
  - Assistance to small and medium-sized enterprises
  - Studies on industrial operations
  - Product and process development

TABLE 11 *(cont.)*

- Technical service
- Analysis and testing
- Information services

Volume of in-house project work completed
- New industrial operations
- Development surveys
- Managerial projects
- Assistance to small and medium-sized enterprises
- Studies on industrial operations
- Product and process development
- Technical service
- Analysis and testing
- Information services

Procedures for utilizing results of the analysis for future planning

VI. Staff capabilities
- Rate of growth of professional staff
- Ratio of professional to non-professional staff
- Rate of turnover of professional staff
- Technical competence of staff in terms of objectives

VII. Facilities
- Adequacy of working space
- Adequacy of equipment
- Adequacy of library facilities
- Adequacy of service facilities
- Budgetary procedures for facilities

VIII. General administration
- Definition of objectives, policies, criteria, and plans
- Definition of organization, functions, responsibility, and authority
- Activities of the board of directors
- Activities of the director
- Functioning of other echelons
- Internal image of management
- Relations with professional staff
- Handling of meetings and discussions

IX. Selection of programme areas
- Policies for expansion and diversification
- Evaluation of institute capabilities
- Procedures for evaluating growth areas
- Co-ordination of internal capabilities with external opportunities
- Detailed analysis of services the institute is competent to provide

TABLE 11 *(cont.)*

X. Administration of technical activities
- Criteria for in-house projects
- Criteria for sponsored projects
- Organization of projects
- Staffing of projects
- Project time allocations
- Project budgets
- Procedures for control of projects
- Reporting system
- Internal communications
- External communications

XI. Personnel administration
- Orientation of the individual towards the organization
- Recruitment procedures
- Periodic reviews of performance
- Procedures for separations
- Salary administration
- Professional development
- Managerial development

Scoring: E = excellent
G = good
S = satisfactory
U = unsatisfactory

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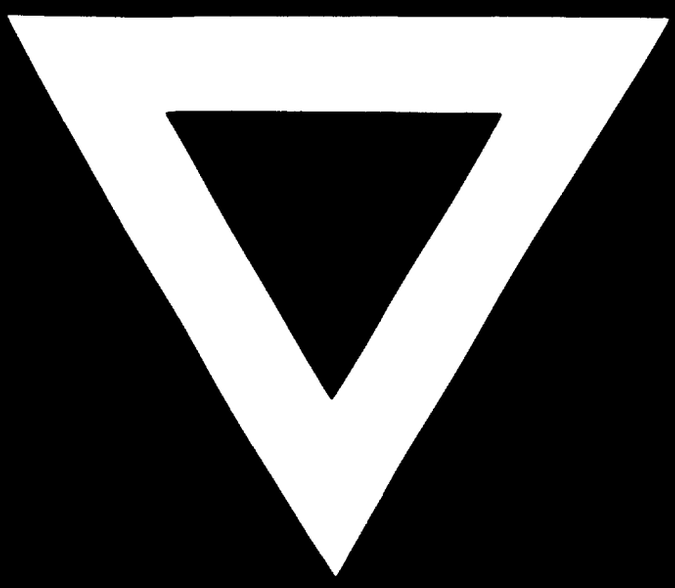

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