Motivation of Scientists and Engineers

A REPORT ON CURRENT CORPORATE PRACTICE

The Graduate School of Business
Stanford University
April, 1959

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Motivation of Scientists and Engineers :

A Survey of management policies and practices in selected companies ...

This research project was conducted by a group of twelve Stanford University Fellows as a part of their participation in the University's Executive Management Program

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PREFACE

On January 6, 1958, the Graduate School of Business at Stanford University launched a unique educational venture. Its fundamental purpose is to provide an appropriate intellectual experience for a small group of carefully selected young men who give unusual promise for business leadership. One half of the group is made up of business executives in the age bracket of 30 to 37 years, and the other half of the group is composed of doctoral candidates in the same age range who are dedicated to a career in business education.

Continuous progress of our complex industrial society depends in large measure upon our ability to develop and then utilize the full potential of the relatively small number of exceptionally able young executives who will be called upon to assume major responsibility within their companies and communities in the years ahead. Equally important is the need to provide a continuous flow of outstanding teachers who will, in time, provide the proper climate for professional business education within our universities and within business itself.

It was to meet this joint objective that the new Stanford Program in Executive Management was conceived. Its realization has been made possible through a generous grant from the Alfred P. Sloan Foundation, Inc.

Certain features give uniqueness to this Program in addition to the composition of the twelve selected Stanford Fellows who make up the group of participants. For a full academic year these young men are in continuous and close association through many parts of the Program, enabling them to exchange and challenge viewpoints. A series of sixteen seminars conducted by the senior faculty of the Graduate School of Business provides one of the means by which intensive discussion of business policy and practice is stimulated. Bi-weekly field trips to the facilities of industrial, transportation, utility, and communication companies provide opportunity to discuss at first hand the top management activities, as well as the operating problems of business.

In addition to the seminars in the field of business, the group participates in a series of seminars conducted by outstanding members of the University's School of Humanities faculty. The disciplines covered are philosophy, literature, American history, art and architecture, international relations, and anthropology.

A significant as well as distinctive feature of the Program is the joint research effort undertaken by the twelve Fellows. In planning the Program it was felt that the participants would derive unusual and lasting values from selecting, organizing, and conducting a group research project in contrast to making individual studies.

During the early weeks of the Program the group gave much deliberation to the research subject which was to consume considerable time and effort during the entire eight and one-half months' session. From an original list of twenty-two worthwhile projects, the Fellows finally decided to explore the policies and practices of leading industrial corporations in motivating scientists and engineers.

It was immediately and conclusively apparent to the group of Fellows that firsthand discussions with corporate executives and other management people directly concerned with scientific and technical personnel would be the only feasible method of obtaining worthwhile information. Hence the mailed questionnaire approach was discarded in favor of a program of extensive field interviews.

The Fellows selected a list of companies strongly oriented to research and development and selected on the basis of the eminence of their scientific activities. An imposing group of twenty-two participating companies with appropriate geographical and industrial representation attests to the timeliness of the research subject and to the high degree of enlightened corporate management found in American industry. For the complete and generous co-operation of these companies deep appreciation is hereby acknowledged.

In the pages that follow the twelve Fellows who constituted the first members of the Stanford Program in Executive Management present their findings. The Graduate School of Business takes understandable pride in publishing their report.

Professor PAUL E. HOLDEN, *Director*
The Stanford Program in Executive Management

Stanford University
March 1959

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INTRODUCTION

ENGINEERS AND SCIENTISTS are important members of a modern business organization. Current and prospective shifts in technology promise to increase the importance of the role they play. Any additional knowledge, therefore, which will shed light on the problem of providing incentives to maximize the quality and quantity of their output is of extreme importance.

The purpose of this investigation is threefold:

1. To determine the extent to which management believes there is a special problem in providing adequate recognition and incentives for scientists and engineers.
2. To explore the specific policies and practices currently employed in industry to provide recognition and incentives for scientists and engineers.
3. To make an appraisal of these policies and practices based upon the results reported by the managements of the participating companies and the evaluations of the study teams.

Scientists and engineers are defined as those individuals who possess at least a B.S. degree in a natural science or in a branch of engineering and who currently spend over seventy-five percent of their time working in their technical specialty. This study gives special emphasis to those of this group who will not go into administrative work in the future—either because of an individual preference for scientific or engineering work or because the company feels that the individual can make a more valuable contribution in his technical specialty. Recognition and incentive must be provided to these individuals in ways other than advancement into administrative positions.

Managers in twenty-two companies were interviewed to obtain the data. In selecting these firms, the study group diversified the sample by geographical location, number of employees, and industry. All the companies are industrial concerns, and in the judgment of the study group they are leaders in research and development activities. The firms are located throughout the United States, with the heaviest concentration in the eastern part of the country. One-third of the companies have less than 10,000 employees, one-third have between 10,000 and 50,000, and the remainder have from 50,000 to over a quarter of a million. Fourteen industries are represented: aircraft, radio and television, petroleum, electronics, chemicals, glass, steel, office equipment, communications, photographic equipment, industrial machinery, tire and rubber, electrical equipment, and food processing.

A two-man team, composed of one industry representative and one Ph.D. candidate, visited each of the companies. The visits were from one to three days' duration and included interviews with as many as fifteen executives per

company. The executives interviewed ranged in position and responsibility from the president to section leaders in an engineering or research and development department. The interviews were most extensive, however, in the research and development function of the companies. Tape recorders were used during most of the interviews to provide a complete record.

A questionnaire as such was not used during the interviews, but each team had an interview guide to insure that comparable information was secured from each company. The items included in the interview guide were based on an extensive search of the literature on the subject. The interview guide and a selected bibliography are included in this report in Appendices A and B.

The data contained in the transcripts and notes of the interviews were reduced and analyzed by means of a series of summaries prepared by various two-man teams. The initial summarization was on a company basis, and was made by the particular team which had conducted the interviews. A second set of summaries was made on a topical basis by assigned teams whose scope was the total sample. This technique produced a report which merged, both on a company basis and on a total sample basis, the various opinions and practices reported by the investigators. The details of the methodology are summarized in Appendix A.

The report is organized along the lines suggested by the three purposes set forth above. The first section following the summary sets forth management's view of the problem. The next ten sections deal with specific problem areas. Each of these sections includes the typical pattern of observed practice, any significant deviations, and the study group's appraisal of the topic. A final section presents the conclusions of the study.

SUMMARY

FINDINGS

Management considers the problem of providing recognition and incentives for scientists and engineers to be an important one, but executives generally believe that it can be solved without preferential treatment. Following is a summary of typical company practice in the areas that management considers important to the problem:

Promotion: Three-fourths of the companies use a parallel ladder—a series of technical positions that do not entail increased administrative duties. This enables scientists and engineers to be promoted and yet to remain at work in their technical specialties.

Employee Appraisal: All the firms conduct some form of employee appraisal. The primary purpose is to let the individual know where he stands and to aid his development.

Salary Administration: Most companies use a salary structure with considerable spread within the ranges and overlap between adjoining ranges. This flexibility permits the salary to fit the individual's contributions. In most cases, the salary review is made by the immediate supervisor. Most concerns restrict disclosure of salary information to the individual's present salary range and the next higher one.

Supplementary Compensation: Scientists and engineers generally receive some type of overtime pay. In most cases they may share in the company's success through profit-sharing, bonus, or stock purchase plans.

Training and Education: In-company training and opportunities for graduate study are available in all the concerns.

Professional Activities: All the firms encourage the individual to participate in professional societies. The incentives typically include time off for meetings and reimbursement of some expenses.

Communications: Executives generally believe that management of scientists and engineers entails special communications problems. These involve providing information on technical development and the general activities of the company. Informal communications channels are used extensively to solve these problems.

Supervision: Most firms stress technical competence in selection of supervisors, believing that this quality is vital to creating an atmosphere conducive to research.

Job Interest and Freedom in Work Assignment: Scientists and engineers usually enjoy about the same degree of freedom as do other white collar workers. Executives believe that routine research and development

assignments provide sufficient challenge to maintain the individual's job interest.

Informal Recognition Practices: The participating companies employ a wide variety of practices that do not fit into any one category, but that are considered important to the overall problem. Typical of these are efforts to identify the individual with his successful projects in order to enhance his feeling of accomplishment.

COMMENTS

The study group considers that the most serious defects in current practice are in the areas of promotion, appraisal, communications, and job interest and freedom in work assignment. The following comments summarize the observations on these areas and the evaluation of management's approach to the overall problem:

Promotion: One shortcoming in many parallel ladders is that the positions are not actually equal to corresponding administrative positions in salary and prestige. To achieve maximum benefit the parallel ladder should be given wide publicity and be offered as a positive incentive for all scientists and engineers. Several companies do not publicize it, but reserve it for individual problem cases.

Employee Appraisal: The apparent failure in many companies to discuss fully the appraisal with the individual is not consistent with the stated purpose of the appraisals.

Communications: Only a few companies appear to have solved adequately the communications problems. They have established special communications channels, and several have separate groups working to improve internal communications.

Job Interest and Freedom in Work Assignment: The prevailing opinion that all research and development work is challenging does not give sufficient weight to differences in individual interests. Most companies might benefit from establishing an inventory of approved projects from which the individual might select his assignment.

Management's overall approach to the problem: Most companies do not recognize the importance of all the factors that seem to influence the problem. As a result, many practices that are important to recognition and incentives occur as by-products of programs directed toward other goals. These by-product practices may have a negative effect on the company's positive efforts to provide recognition and incentives. A comprehensive program including all facets of the problem is the best assurance that an optimum solution to the problem will be found.

MANAGEMENT'S VIEW OF THE PROBLEM

THE EXTENT OF THE PROBLEM

In order to define precisely the extent to which management believes there is a special problem in providing adequate recognition and incentives for scientists and engineers, it is necessary to distinguish among four separate and distinct ways in which the problem can be viewed:

1. How important is the problem of providing adequate recognition and incentives for scientists and engineers?
2. Is it necessary to give scientists and engineers special or preferential treatment to provide them with adequate recognition and incentives?
3. What are the problem areas in the management of scientists and engineers which are particularly significant and important in providing incentives and recognition?
4. To what extent have existing policies and practices failed to provide adequate incentives and recognition, thus leaving the problem still to be solved?

These questions are considered below.

The Importance of the Problem

The enthusiastic co-operation received throughout this study attests to management's regard for the reality and importance of this problem. Company executives at all levels spared neither time nor effort to provide the information requested and to share their experiences and opinions on the subject. They uniformly expressed a keen interest in any attempt which might help them to find better solutions to what they regarded as a difficult problem. The reason most frequently cited for this importance is related to the impact of the company's research and development efforts on its future welfare. Many executives believe that the future is largely dependent on their ability to develop new and improved products and processes. Adequate incentives and recognition are vital to insure that engineers and scientists working in this area produce to the maximum of their creative ability.

No Preferential Treatment of Scientists and Engineers

Executives consider that variations in job requirements and differences in educational backgrounds may require that scientists and engineers be treated differently from other employees. The majority, however, do not believe that this differential treatment is, or should be, preferential to that given other employees. These executives feel that differences in the treatment of scientists and engineers are merely a reflection of the need to treat all employees as individuals in order to properly motivate them.

Significant Problem Areas

The specific problem areas which management rates particularly significant in providing recognition and incentives to scientists and engineers are the subject of this report. Many of the policies and practices described herein may appear to represent preferential treatment for scientists and engineers. Management's view is that they may differ in some ways from the policies and practices used for all employees, but that they reflect basic company policies toward all employees and so are not preferential.

When discussing incentives for scientists and engineers, most executives distinguish between two categories of policies and practices. One group is necessary in recruiting and holding employees and in creating in them a favorable attitude toward the company; the second group includes those policies and practices which are especially productive in encouraging the individual scientist or engineer to his maximum creative effort. There is not uniform agreement on the classification, but the first group includes policies and practices toward professional activities, training and education, communications, promotion, appraisal, and compensation. The second group includes the quality of supervision, freedom in work assignments, and the topics included in informal recognition practices.

Management Hopes for Better Solutions

None of the companies indicated that their policies and practices had failed to provide recognition and incentives to engineers and scientists to the degree that it was a serious day-to-day problem. All of the companies, however, hope that even better solutions to the problems can be found in the future. Most executives would categorize the problem as one of long range importance which will demand better solutions in the future, but which is not serious right now. This should not imply, however, that the companies are not currently working on the problem. For example, one company announced the establishment of a "parallel ladder" (see section on Promotion) during our visit, and a second company had established a parallel ladder only three weeks prior to our visit.

INFLUENCES ON THE PROBLEM

Before proceeding to a discussion of individual problem areas it is desirable to point out that each area is not isolated, but rather is an integral part of the management of the company's scientists and engineers. The seriousness of any problem and the difficulty of its solution are greatly dependent on what the company is doing in the other areas; they are also very dependent on a variety of other influences which together make up the environment in which the engineer or scientist works. Three of these other influences are of sufficient importance that they will be considered at this point.

Place of Research and Development in the Organization

Most of the participating companies place the research and development function high in the organizational structure. The function is usually headed

by a vice-president who in some cases is a member of the executive council. Many executives stress the importance of giving some organizational autonomy to the research effort. In several cases this has led to the establishment of separate research subsidiaries; other companies have set up an autonomous research and development function in each of their geographical divisions. These steps are aimed at preventing research and development from becoming submerged in the current of pressing day-to-day company problems; however, an important by-product is the status and recognition accorded to the scientists and engineers.

Professional Unions

Executives in the three participating companies that have a professional union consider that the presence of the union increases the difficulty of providing recognition and incentives for employees in the bargaining unit. Union proposals present the paradox of trying to elevate the status of the scientists and engineers on the one hand while making trade-union type demands on the other. In several instances executives commented that they wanted to recognize some high-level nonsupervisory engineers or scientists as a part of management and include them in management communications channels, incentive plans, and other managerial affairs; however, they were precluded from doing so because the individual's position was part of the bargaining unit.

Cultural Activities

Most executives believe that proximity of the research and development activities to universities and centers of cultural activity has an important influence on the problem of providing recognition and incentives. Several companies that are unfavorably located in this respect have suffered in their recruiting efforts and have experienced a high turnover of personnel. Exit interviews have confirmed that absence of these facilities was an important factor in the turnover of scientists and engineers. In these companies the problem of providing adequate incentives and recognition in other ways assumes added importance.

SPECIFIC PROBLEM AREAS

PROMOTION

Promotion is one of the most tangible means with which management can provide recognition and incentive to scientists and engineers. Their promotion, however, may present special problems, since the normal lines of advancement include increasing amounts of administrative work at each succeeding level. As indicated in the introduction, this study focuses on individuals for whom this problem is most acute—those scientists and engineers who are not logical candidates for positions with increased administrative duties. These men remain in nonadministrative positions either from a conviction of management that the individual can make a more valuable contribution in his technical specialty, or from a desire on the part of the individual to avoid administrative responsibilities. In either case, promotion through normal lines of advancement is eliminated as a device for recognition and incentive if the best interests of employer and employee are served by leaving him in his technical position. Indeed, promotion into an administrative position may gain the company a poor administrator at the expense of losing an outstanding specialist.

Typical Pattern

Three-fourths of the companies interviewed attempt to solve this problem by using some form of parallel ladder device. In the parallel ladder a new and distinctive line of promotion is established, consisting of a progression of scientific or engineering positions without the addition of administrative duties. In setting up the ladder, positions and titles are created to correspond to the administrative levels in the organization, and the pay and prestige of the new positions are equated to those of the corresponding administrative positions. Within the companies using this device there is variation in the extent to which the technical ladder has been adopted and in the way in which it is administered.

The form of parallel ladder most frequently observed includes three or four steps, extending from a position equivalent to the lowest administrative level to a position equal to, or one level below, the department manager. In the other companies the ladders in use vary from one in which only two levels are used to one in which the highest position is one level above the department manager. The number of individuals actually occupying positions on the technical ladder may be as low as one or two in companies that have just established the ladder or in those that make little use of it. In other firms the ladder is more effectively utilized, with positions at all levels filled and the number of individuals at each level decreasing as one progresses up the ladder.

In the majority of the concerns using the parallel ladder, promotion of the individuals holding positions on the technical ladder is administered by the same procedures used for other scientists and engineers. In a few companies, however, the men in the higher positions on the technical ladder are given considerable influence over promotions of individuals to lower positions on the ladder. In most companies individuals on the technical ladder are given much personal freedom to work on projects of their own choosing, and they act more in the capacity of consultants to the line organization than under its direct supervision. One reason for this arrangement is the difficulty which some firms have experienced when a scientist or engineer on the technical ladder reports to someone on the administrative ladder at the same or lower level than his own position.

The companies using the parallel ladder face a problem in the promotion of men who have reached the top of the technical ladder and with others on the technical ladder who desire to switch to the administrative ladder. Some firms permit the individual to transfer to the administrative ladder into a position on the same level as he has occupied on the technical ladder. Others consider that the transfer should be made into a position one or two levels below the technical ladder position. In most cases, however, company policy is not rigid and each case is decided on the abilities and experience of the individual involved.

Significant Deviations

The companies which do not use the parallel ladder fall into two categories. One group believes that it is more of a problem to find good administrators than good scientists or engineers, so they prefer scientists and engineers with administrative ability and encourage them to go into management. These firms generally believe that most scientists and engineers want to go into management, since the recognition and incentive provided by a parallel ladder rarely compares with the prestige within the company associated with a managerial position.

The other group of companies not using the parallel ladder is made up of firms with large research departments which have little formal organization and no formal salary structure. These concerns minimize not only the value of the parallel ladder, but also of any device which tends to stratify or formalize their organization. The need for promotion of a scientist or engineer is obviated by making the scope of his job coincident with his individual talents and permitting it to expand as these talents develop. The individual's salary is periodically adjusted to recognize the increasing value of his contributions.

Comments

The few companies which can alleviate the promotion dilemma by maintaining an unstructured organization without formal salary structure may be especially fortunate. For the many companies, however, which find more formal organization and salary structures essential for control, the parallel ladder offers great promise for success in dealing with the promotion prob-

lem. It offers the opportunity to provide recognition and incentive without sacrificing the individual's technical abilities by burdening him with administrative duties.

The administration of the parallel ladder in many of the firms visited does not appear to yield maximum benefits for management. In many cases the positions on the technical ladder are not actually on the same level as the corresponding ones on the administrative ladder. This is sometimes true of the salary ranges, and more often it is true of the many small elements of prestige which go with a managerial position. This situation lessens considerably both the recognition and incentive value of the position on the technical ladder. Several companies have recognized that this problem exists and have taken steps to remove the differences.

Another shortcoming in the use of the parallel ladder in some concerns is the degree to which it is publicized and the purposes for which management uses it. A maximum benefit to company and employee in the form of both recognition and incentive for the individual would appear to require that opportunities for promotion along the ladder be given wide publicity. In several companies this is not done. In these companies management seems to regard the parallel ladder as a device for taking care of a few problem individuals rather than as an avenue of advancement for any engineer or scientist who merits it. The following example is extreme, but it points up a potential difficulty involved in failing to publicize the technical ladder in order to reserve its use for individual problem cases. One team interviewed an engineer who had been promoted to a position on his company's technical ladder. He stated that he initially felt that the promotion and the resulting reduction in his administrative duties was but the first step in his eventual discharge from the company.

EMPLOYEE APPRAISAL

Executives of the participating companies generally agree that the appraisal process can be a powerful incentive to the individual scientist or engineer. At the same time the appraisal is useful to management by providing information to be used in subsequent salary reviews and in selecting candidates for promotion. From the viewpoint of the individual, the appraisal first assures him that his efforts are not in vain—that his capabilities and accomplishments are being watched and that deserved rewards will be forthcoming. Second, and dependent on the degree to which the results are discussed with the individual, the appraisal assists the individual in his self-development. It enables him to know where he stands and to chart a course for his future development.

Typical Pattern

All of the participating companies conduct some kind of employee appraisal. In most cases the immediate supervisor is responsible for making the initial appraisal. Typically, the next higher level of management reviews the appraisal, and then the supervisor is supposed to discuss it with the individual concerned. Most firms do not, however, make specific efforts to insure that this discussion takes place, and many executives indicated their doubt that appraisals are discussed thoroughly, if at all.

Most companies appraise new employees at six-month intervals and more senior men annually. About half the concerns use a standardized appraisal guide. These forms range in complexity from sheets for recording comments on a few broadly defined factors to those which require detailed comment on a variety of specific factors. Most executives agree, however, that scientists and engineers can best be appraised by considering the individual's general characteristics and traits, rather than by attempting a detailed analysis. This is in part caused by the difficulty of measuring the productivity of a scientist or engineer, paricularly in more basic research activities.

Most companies use the appraisal information for both salary and counseling purposes. The majority stated, however, that the primary purpose is to let the individual know where he stands and to help him in his future development.

Significant Deviations

A few companies do take positive steps to insure that appraisals are fully discussed with the individual. This is done by requiring the individual to sign the appraisal form after the interview or by requiring the supervisor to report the results of the discussion in a space on the appraisal form. It is noteworthy that executives in these companies place great emphasis on the incentive value of the appraisal process.

Two firms attempt to minimize individual bias by having a committee make all appraisals. The committee typically includes the immediate supervisor, the department head, and a representative of the personnel department. Another company makes extensive use of self-appraisal in the research and development department. This self-analysis is weighted heavily in the final assessment of the individual.

Comments

Executives' statements that the primary use of appraisals is to assist the individual's development do not seem to be consistent with the apparent failure in many companies to discuss fully appraisals with the individual. Much of the incentive value of the appraisal is dependent on this discussion. Consignment to the personnel files without this joint consideration causes even a flawless appraisal to lose much of its effectiveness. The use of the appraisal is certainly as important as its content and quality.

Executives generally implied that much of the difficulty in a full discussion of the appraisal was in the hesitation of supervisors to undertake the task. Unquestionably, such discussions require considerable skill and tact to be fully effective. This may well be an area of supervisory training that calls for additional emphasis. An understanding of proven techniques for conducting such sessions and a little experience should dispel the hesitation which most supervisors display.

SALARY ADMINISTRATION

Of all the problem areas associated with incentives and recognition, none attracts more attention, or arouses the emotions more profoundly, than the matter of salaries. Both the absolute level of salaries and its relation to salaries paid elsewhere are subjects of grave concern to the scientist and engineer and to management. Some executives go so far as to say that the problem of incentives and recognition is primarily a question of adequate compensation. Those who disagree with this view admit that if compensation is not above a given minimum level it may assume overriding importance. Executives in both groups consider that *money as such* is not important but that monetary rewards have come to be regarded as indispensable as a symbol of status and a recognition of individual performance and progress.

Management considers that compensation as a form of personal recognition must be closely related to the individual contributions of the recipients. This view is even more emphatic when higher positions are involved; as one progresses to successively higher positions the emphasis shifts from measuring the job to measuring the man in the job. This desire to reward individual contributions poses two problems. The first is the necessity of maintaining sufficient flexibility in the salary structure to permit the salary to fit the individual and yet to enable management to retain control of salary expenses. The second is the very real problem of determining the value of the individual's contribution and of satisfying him that the evaluation is a fair one. What is an appropriate salary for a man whose invention lays the foundation for a new industry or whose discovery crosses the threshold of scientific knowledge? Management is acutely aware that in the past men who have made contributions of this stature have not been rewarded accordingly. As one executive expressed it . . . "When Dr. ——— invented the ————, he was actually paid less than the driver of a beer truck in Chicago."

The value of salary as an incentive compels management to consider the problem of internal distribution of salary information. Obviously, the incentive value is dependent in some degree upon the individual's having some knowledge of his income potential. Many executives, however, consider that distribution of salary data that is too generous may divert the individual's attention from the requirements of the job and attract men who are interested in nothing but money. Management must find some middle course which serves the needs of both employer and employee.

Typical Pattern

A great majority of the participating companies have some formalized salary structure for scientists and engineers. The typical structure includes a number of salary or merit ranges which provide for recognition of individual differences. The number of these ranges varies from five to twenty-six. The

spread between the top and bottom salaries in the individual ranges varies from 30–55% of the lower figure. As might be expected, wider spreads occur in the higher ranges, reflecting the need for recognition of greater variation in individual performance. Additional flexibility is provided in the salary structure of most firms by substantial overlap between successive salary ranges.

Nearly all of the concerns use some type of job descriptions to assist in job evaluation and assignment to a salary range. Most firms make extensive use of published salary surveys and studies as well as intercompany exchange of information to assist in setting salary ranges and to check the placement of individual positions within the salary structure. Most companies place great emphasis on meeting prevailing rates while some have a policy of surpassing them. Each company, however, interprets outside information on salaries in the light of its own salary history and the supplementary methods of compensation which it uses.

The companies generally consider maintenance of the salary structure to be a continuous task. They frequently review it to make adjustments for changes in job content and for shifts in the prevailing levels of salaries in the same and other industries. They also review the actual salary distribution of the individuals in the organization to prevent internal inequities from developing as a result of different policies among the various supervisors.

The evaluation of individual contributions seems to be a matter of very genuine concern among management personnel having jurisdiction over salaries of scientists and engineers. Almost all the companies charge the individual supervisors with the responsibility for evaluating the individual's progress and for determining appropriate salary increases. The supervisor is discouraged from using any mechanistic approach to the problem. He is encouraged to grant increases on the basis of actual contributions and not on the basis of seniority.

Most firms maintain control over the supervisors by setting limits on the total merit increases to be granted. They also establish guide lines for the size and frequency of salary increases. The average of the normal increases reported by the participating companies is 6 percent per increase. The highest reported typical increase is 10 percent. Four companies have a maximum allowable increase of 15 percent. The frequency of salary reviews varies from 3 to 18 months and generally decreases as the salary level increases. Almost invariably management exercises a final form of control over the supervisor in the form of a salary review board or committee. This group insures that company policies are followed in all salary reviews and authorizes deviations from established policies when individual cases warrant it. In a few cases, two levels of review are used.

There is wide disagreement among the participating companies and even among executives within the same company on the question of internal distribution of salary information. In order to bring the area of disagreement into focus it is first necessary to state those aspects of the problem upon which there is general agreement. It is generally agreed that the company should disclose its policy to establish and maintain a formal salary structure. Executives feel that this is an area of common knowledge, anyway, so a policy of

attempting to conceal it would be a practical impossibility. Most executives, therefore, consider that the company should try to establish an understanding of this policy by employees.

Most executives also agree that it is not desirable to disclose all salary ranges within the company. They consider that such disclosure would be a needless invitation to curiosity and ill will. The extreme of going one step further and disclosing individual salaries meets with universal objection. Executives point out that the process of salary determination is a very subjective one, and disclosing individual salary differences would inevitably lead to misunderstandings.

The area of disagreement, then, narrows to the question of disclosing to the individual his own salary range and those to which he might realistically aspire. Some executives feel that the "psychological impact of knowing one's own salary range would not be a good one." The prevailing attitude, however, is that some disclosure is necessary. The proponents of the latter idea maintain that the information bears so heavily on the individual's career that it cannot rightfully be denied him. Most companies that disclose salary ranges, however, do so only if the individual concerned requests the information. Normally the information is available from the man's supervisor. The supervisor is usually allowed some discretion in disclosing the information since he is presumed to be in the best position to judge any adverse effects which might result from the disclosure. These companies normally restrict the information to the individual's present salary range and sometimes the next higher one.

Significant Deviations

As noted in the section on promotion, two large firms do not maintain a formal salary structure for scientists and engineers in the research organization; there are no salary range restrictions on the salary of any individual. These concerns believe that this arrangement simplifies the job of rewarding individual contributions with an appropriate salary. The scope of the individual's job is largely determined by his personal abilities so it would be difficult to fit any one job into a single salary range.

A few companies reported difficulty in the administration of funds budgeted for merit increases in salaries. Sometimes the funds have been used to grant general increases to all employees. For instance, this might happen when all salaried employees were given an increase following a wage increase for hourly paid employees. To prevent these difficulties and to restore the emphasis on merit, one company has completely abandoned all general increases for scientists and engineers so that available funds can be spread according to merit. The plan was initially received unfavorably, but the company reported that this reaction had given way to enthusiastic acceptance.

One company has recently distributed to its employees a 74-page brochure which presents in detail the company's salary structure and the philosophy underlying it. One executive in this concern expressed the thought that "it is no longer necessary to have any unanswered questions on salary structure."

COMMENTS

The procedures for the administration of salaries in the participating companies are generally consistent with management's desire to use salaries as a means for recognition of individual contributions. It appears, however, that some companies might benefit by liberalizing their policies with respect to disclosure of salary information. A policy of disclosure upon request has many arguments in its favor. It is the minimum policy consistent with the use of salary as a positive incentive. A company which has sufficient flexibility in its salary structure and adequate opportunity for the individual to advance should have little to fear from disclosure of specific range limits.

SUPPLEMENTARY COMPENSATION

In the section on salary administration it was noted that management desires to compensate each individual in such a way that his individual contributions are properly rewarded. There are several methods of supplementary compensation available which may allow management more flexibility in arriving at the individual's total compensation. Among these methods are overtime pay, various plans to enable the employee to share in the company's success, and patent awards. Despite their widespread usage, some executives maintain that these methods of supplementary compensation do not accomplish their objective and, indeed, may even have a negative influence in the company's attempt to provide adequate recognition and incentives to its scientists and engineers.

Typical Pattern

Despite the fact that most executives consider overtime pay for scientists and engineers to be inconsistent with professional status, the majority of the participating companies do provide some overtime pay for these groups. The reasons cited for this situation are competitive pressures, contract provisions, legislation, and in three cases the presence of unions. Overtime pay is also used where overtime earnings of other employees are so high as to cause an unbalance in total compensation unfavorable to the scientists and engineers. The overtime pay rate normally decreases as one progresses higher in the organization. As the individual advances in responsibility and salary, he is expected to become increasingly conscious of the requirements of the job and to be willing to put in whatever time is necessary to satisfy those requirements. This is particularly true when the periods of overtime work are short and relatively infrequent. Of the companies that do not make direct payment for overtime work, several have effective plans to provide compensating time off.

Two-thirds of the companies have some plan whereby the scientists and engineers can share in the company's success. Stock purchase plans are the most common, but profit-sharing and bonus plans are also used. Several firms use two plans concurrently. Normally the companies do not limit the plans to scientists and engineers. In some cases the plans are company-wide, while others were initiated for the benefit of management personnel and were subsequently extended to include scientists and engineers. Executives in concerns that use these plans believe that they serve to reinforce the individual's interest in the success of the company in addition to providing a direct incentive.

A great majority of the participating companies do not attempt to reward individual patents with a cash award based on the value of the patent. Most of these firms do not make any type of patent award; the others provide a

nominal cash award. This cash award is not designed to reward the individual for the patent. Rather it is intended to provide an incentive for the individual to file the necessary papers and work with the patent department to secure a patent after a patentable process or invention is developed.

Executives in the companies that do not make an award based on the value of the patent cited many reasons for this policy. Among those mentioned most frequently are the unfairness to individuals who work in areas which do not offer patent possibilities but which are equally valuable to the company; the danger of the individual's concentrating on quantity instead of quality and on projects which offer patent possibilities; and possible ill will over the size of the award or the selection of the individual or team to receive the award. These executives summarize their views by saying that it is the job of the scientist and engineer to be creative and to develop patentable ideas, so the proper reward should be salary increases.

Significant Deviations

One company has developed a stock option plan designed particularly for scientists and engineers. The contributions of all scientists and engineers are reviewed annually by a committee of the Board of Directors. If a contribution deserving of an award has been made, the individual is given the annual Director's award which carries with it an attractive stock option.

Several firms make patent awards to the individual inventor through which they share the returns from the patent with the individual. Two types of plans are used. In one, the company gives the individual an award based on the dollar value of the patent to the company. In the other type, the inventor is permitted to exploit the patent himself, limited only by an obligation to grant a nonexclusive license to the employer if requested.

Comments

Increased use of stock option, bonus, and profit-sharing plans designed specifically for scientists and engineers might offer management an effective means of attaining its goal of rewarding individual accomplishment. With such plans management can properly reward the individual for his current accomplishments without the danger, frequently voiced by executives, of raising his salary to a level which will not be commensurate with his future contributions. These plans have an advantage over patent awards in that they can recognize unpatentable developments which are of value to the company.

TRAINING AND EDUCATION

Management and scientists and engineers have a mutual interest in training and educational programs. These programs serve management in two ways. First, and in management's view more importantly, they increase the individual's capabilities for productive work. Second, by virtue of the employees' keen interest in them, they represent a valuable way of providing incentives. The programs have come to be regarded as almost essential by scientists and engineers in their desire to broaden their knowledge and increase their technical competence. The personnel director of one company stated that in interviewing prospective scientific and engineering employees, the question most frequently asked by these prospects was "Can I take graduate work if I come to work for your company?"

Typical Pattern

An overwhelming majority of the participating companies have some form of in-company training programs. In about half of the firms the responsibility for training programs is assigned to a staff officer. In these concerns the programs are numerous and formally administered. Where the responsibility for training is placed with the research or engineering supervisors, programs tend to be more informal and to be more varied. In over half the companies training is not restricted to technical subjects but includes such topics as communications, report writing, reading proficiency, and getting along with people.

Many different practices are used for training purposes. The selection of specific programs depends on the needs of the employees and the company and the time and facilities available. Most of the companies stress on-the-job training. Frequently, for example, a new employee is given a problem to solve under the guidance of a more experienced associate. Wide use is also made of technical seminars, conferences, lectures, short training courses, visits by university professors, intercompany visits, and job rotation. Executives often comment that the intellectual stimulation provided by great scientists and professors in these training programs is vital to a research organization.

All the participating companies offer some plan whereby scientists and engineers can further their graduate education. Most of the firms require that courses be taken on the employee's own time. They all pay a part or all of the costs, typically between 50 and 100 percent of tuition and any incidental expenses. Companies typically do not restrict courses to technical subjects, but permit any which will contribute to the development of the individual. In most cases extended leaves of absence are granted for education. Individual policies are very flexible, and arrangements with each individual depend on the circumstances of the case.

Significant Deviations

In this area deviations exist not in the approach to the problem, but rather in the degree to which the programs are carried. For instance, one company has found additional education to be of such importance that it has made arrangements with a nearby university to establish a branch campus on its grounds for the exclusive use of its employees. It is possible to complete several different graduate degrees through this branch. Another large corporation has developed relationships with 26 major colleges and universities to enable its employees to take additional courses. A final example is a company which will send a scientist to a university of his choice or to Europe with full pay and expenses if he proposes a worthy project. Only a few top scientists, however, have actually been able to take advantage of this offer.

Several companies encourage their scientists and engineers to work closely with a nearby university. They may serve on advisory committees of the schools or act as part-time instructors. The companies feel that such a program provides a continuing education even for a scientist with a Ph.D. They regard as equally important, however, the prestige which accrues to the individual and the value to the university and to the community at large.

Comments

Most companies have recognized the importance of intellectual stimulation and of opportunities for personal development for scientists and engineers. The training and educational programs in use are well designed to meet this need. There are several companies, however, in which some executives voiced the fear that training and educational programs were emphasizing management development to the detriment of professional development. This situation usually occurs where the responsibility for training and educational programs is in a staff officer outside the research and development or engineering departments. Both management development and professional development are essential, so management must insure that a proper balance is maintained between the two.

PROFESSIONAL ACTIVITIES

Virtually all of the companies believe that participation in professional societies is extremely important in the minds of scientists and engineers. They feel, also, that active participation in these organizations is useful from the standpoint of individual development, professional status, and heightened interest in work. Many directors of research stated that participation is important because it affords an opportunity for the individual to associate with stimulating colleagues. They indicated that meetings of the societies provide an opportunity to discuss current projects and to keep abreast of new developments. This enables the individual to receive the approbation of his peers and to achieve greater professional recognition. The presentation of a paper may also add to one's professional stature. For the younger scientists and engineers the meetings are equally stimulating since they provide an opportunity to meet the eminent men in their field and to strengthen their identification with their professional field of activity.

Typical Pattern

An overwhelming majority of the companies provide specific incentives for participation in professional societies. They normally place no restrictions on the number of local meetings that may be attended. If they occur during working hours, attendance is on company time, and the companies generally pay incidental expenses. In all but a few instances, the concerns restrict the number of regional and national meetings that may be attended. Frequently, expenses are paid for only one national or regional meeting per year, and then only when the subject matter is relevant to the company's activities or interests.

Slightly over half of the firms pay all or a part of the cost of membership in professional societies. Of these companies, two-thirds impose virtually no restrictions on the type of organization joined, while one-third will pay dues only in the societies that they consider related to the work of the company.

Significant Deviations

The most significant deviations in this problem area are several companies which give even more encouragement to participation in professional societies than the normal pattern. One large corporation regards active participation in the learned societies as so important to its scientists that it places no restrictions of any kind on the number of societies with which its scientists may affiliate. The company pays all dues and expenses in connection with such membership. It places no limitation on the amount of time which may be spent on professional society activities, feeling that they are of vital importance to the company and to the employees. The firm's only restrictions apply to society meetings in Europe. Advance approval must be secured to

attend these, and the individual's request must indicate the relevance of the topic under discussion.

A second concern actively encourages participation in the societies by distributing to its personnel an excellent brochure describing in detail the values to be gained from membership. The brochure expressly states that professional status involves the obligation of active membership in at least one learned society. It suggests several means for effective participation.

The director of research of one large company expressed the view that the publication of professional papers is by far the most important incentive for scientists in his company. This company gives its scientific personnel every possible encouragement in the writing of technical papers. The research laboratory feels that it has an obligation to contribute to the general store of knowledge from which it draws so freely. It believes that the scientists in its employ have a genuine interest in pushing back the frontiers of the unknown. This research organization is reputed to be one of the best in the world, and significantly, it indicated that it has little real competition in attracting top flight scientific personnel.

The slightly less than half of the companies that do not pay dues in the professional societies represent a significant deviation in the other direction. These firms regard active support of a professional society to be an obligation of the scientist or engineer and the payment of dues to be a personal matter. One company in this group explains that all real desire for professional development must come from within the individual himself; therefore, it concludes that the payment of professional dues would be in the nature of a subsidy, something totally unnecessary.

Comments

Companies that encourage membership in professional societies find that a high percentage of their personnel participate. There is no conclusive evidence that company reimbursement of dues increases the number of society memberships among its employees. There are indications, however, that scientists and engineers do attend more meetings and participate more actively as firms make more time available for that purpose. The benefits of society membership to the company and to the individual suggest that managements which have given less encouragement to participation would benefit by liberalizing their policies.

COMMUNICATIONS

Most executives of the participating companies believe that special communications problems arise as a part of the need to provide incentives and recognition to scientists and engineers. The latter must be provided not only with information required for their specific duties, but also information not specifically related to their job. This additional material can be classified into two general categories. The first category arises from the necessity of keeping the scientists and engineers informed of technical developments, both within and outside the company. This need is closely related to the need for participation in professional activities discussed in the previous section, but it also deserves attention as a special problem of internal communications. The second category of additional information concerns the general activities of the company and the effects of economic conditions on these activities. Management has a problem to insure that the scientist or engineer is provided with both types of information.

Typical Pattern

The majority of the companies interviewed rely on established communications channels to provide scientists and engineers with information on technical developments and general activities of the company. Most firms emphasize informal communications channels, depending primarily on casual meetings and person-to-person contact for the transfer of information. This informal transfer is supplemented with more formal meetings and company house organs to provide technical information. The house organs, the annual report, and newsletters help provide information on the company's operations.

Significant Deviations

A few companies deem it necessary to provide special communications channels to satisfy the need of the scientist and engineer for information beyond the confines of his job. One device used is to distribute to all scientists and engineers the technical reports prepared in various departments of the company. Another is to prepare and distribute abstracts of pertinent technical articles appearing in the scientific and engineering literature. Among these concerns, the favorite method of informing the scientists and engineers of the company's overall operations is an informal meeting or dinner with representatives of top management. The frequency of these meetings varies from weekly to annually, with three or four times a year being a representative figure. These firms may also use detailed newsletters to publicize their operations, directed not to the supervisory levels as in most companies, but rather to the nonsupervisory scientists and engineers.

Two companies have established separate communications groups to facilitate the flow of information within the company and to study communications problems. In one of these firms, and in a third, management periodically checks the lower levels of the organization in order to determine the degree and accuracy of the information flow to these levels. One company does this by interviews conducted by company employees, while the other brings in an outside group to perform the survey.

COMMENTS

The companies that deviate from the typical pattern recognize that special efforts are required if they are to insure that the individual scientist or engineer receives the information management considers desirable. They recognize that normal communications channels, particularly the informal ones, tend to be filled by routine information on day-to-day operations. They also realize that the brief and general exposition which appears in the typical house organ, annual report, or newsletter has little chance of satisfying the special needs of scientists and engineers for information on technical developments and operations of the company.

The firms that have established special groups for improving communications have identified some of the difficulties inherent in the communications process. Despite the best intentions of management, filtration and distortion inevitably impede the flow of information through the enterprise. The lower level supervisor is particularly important in this regard, occupying a key position in the informal, oral communications channels. If he is one who considers it a supervisor's prerogative to withhold information from his subordinates, he can nullify the best intentions of management to keep the individual scientist or engineer informed.

SUPERVISION

The companies interviewed are in general agreement that quality of supervision has an important influence in providing incentives and recognition for scientists and engineers. One executive, a scientist himself, expressed the idea in these words:

> "What I am working on; whom I am working with; salary and location . . . all these are what contribute to my happiness as a researcher. But happiness is not the same as creativity. Knowledgeable and enthusiastic leadership is by far the most important thing in motivating creativity among research groups."

The problem faced by management is to determine what personal qualities will enable a man to provide the kind of supervision best suited to scientists and engineers. At one extreme is the belief that recognized technical ability is the only important quality; at the other extreme is the idea that anyone skilled in handling people can be an effective research manager, even without a technical background.

Typical Pattern

The qualities that management regards as important for supervisors of scientists and engineers can be grouped into two broad categories—technical competence and managerial ability. Almost one-half of the companies rate technical competence more important in the selection of supervisors. One-fourth of the concerns rate the two categories of equal importance, and the remainder consider that managerial ability is more important.

The firms that stress technical competence are usually among those which are engaged in basic research or activities closely related to basic research. Companies stressing technical competence usually consider that the supervisor's most important job is to create an atmosphere conducive to scientific inquiry and to stimulate each individual to his maximum creative effort. These companies believe such an atmosphere can exist only where the individual scientist or engineer is able to respect the technical ability of his supervisor and look to him for guidance and leadership.

Most concerns that emphasize technical competence in their supervisors attempt, wherever practicable, to relieve the supervisor of administrative details. Some do this by using several staff assistants, while others concentrate all the administrative activities within a department under one administrative assistant to the department manager.

If separation of administrative and technical functions were carried to the extreme, an administrative manager of research or engineering would be organizationally equal to the technical manager. This is known as the "dual-manager" type of organization. This extreme arrangement encounters almost

universal opposition in the companies visited. Among the reasons cited for this antipathy are the desirability of focusing responsibility in one individual, the problems of dual reporting for subordinates in the department, and the lack of success of this arrangement in the few cases where it has been attempted.

Significant Deviations

As noted above, slightly over one-fourth of the companies rate managerial ability more important than technical competence in the selection of supervisors. In this group, however, as in the other concerns, the normal policy is to promote from within the ranks of scientists and engineers; so the supervisors do have a technical background.

In these companies the opinion is often expressed that "a supervisor is a supervisor, no matter where he is." Executives' opinions concerning the most important aspect of the supervisor's job differ from those expressed in the companies that stress technical competence. One frequently mentioned as being the most important is to treat scientists and engineers as individuals and to provide individual recognition for them. Another important part of the job is to bridge the communications gap between the scientist or engineer and management people in other departments and to sell the research and engineering program to them.

Comments

A successful supervisor must represent the embodiment of many complex qualities in order to discharge effectively the varied functions demanded of him by management. Management, however, places a special premium on those qualities that enable the supervisor to stimulate his associates to their maximum creative effort. What these qualities may be, how they may be detected and fostered, and how they may differ in the future are matters worthy of management's closest attention. However, few companies indicatd that they are studying the question of what qualities are currently required of supervisors of scientists and engineers. Only two report that they are studying the future requirements. Those managements pursuing such investigations acknowledge the difficulty of finding specific answers, but they consider the solution one of the most serious challenges confronting industry today.

JOB INTEREST AND FREEDOM IN WORK ASSIGNMENT

Management considers a challenging work assignment to be one of the most vital incentives for a scientist or engineer. High salaries, outstanding facilities, and expert leadership are described by one executive as "just so many frills, if you can't give them work they are interested in." Closely allied with the problem of providing challenging work is the problem of how much freedom to allow the scientist or engineer to select his own project. Management must maintain adequate control over research and development expenditures. It must channel the research and development output into useful products and processes. Often this requires that many less interesting and less challenging assignments be undertaken and completed by research and development personnel. Management's problem is to achieve a degree of balance between these conflicting aims.

Typical Pattern

In a great majority of participating companies, engineers and scientists enjoy about the same degree of freedom as do other white collar workers. Their work programs are usually spelled out in considerable detail and results are periodically evaluated through progress reports. The individual works under close supervision and guidance with a minimum of discretion left to his own imagination and ingenuity.

Executives of these companies stated that they have no problem in giving their scientists and engineers challenging tasks since all or most of the work done in the research and development department represents a challenge. These executives feel that a more critical problem is to obtain personnel competent to handle the challenging problems which they have waiting to be solved.

Significant Deviations

Two companies consider freedom for the individual in his work assignment to be vital to real creativity and to genuine research. They have two of the largest and most productive research laboratories in the nation. The scientists in these laboratories have almost complete freedom in their work—in selection of projects, methods, and equipment. These firms seek to hire experts in the various disciplines who are assumed to know where the frontiers of knowledge lie and the most promising areas in which to extend these frontiers. The two companies also permit their scientists considerable freedom with regard to working hours. These concerns reported that the men do not take advantage of this freedom; indeed, the typical scientist frequently works on his project long into the night and on week ends.

Two other firms have experimented with a policy of freedom in work assignments with less apparent success. In one of these the plan has been in effect for less than two years and management regards a full assessment at this time to be premature. However, executives did offer tentative conclusions that "there has been no increase in creativity or productivity" and that "the individuals seem somewhat lost and ill-at-ease." The second company is a small one in which the engineers are working on applied research. The firm had a policy of complete freedom for the individual engineer, but it was forced to impose a system of specific work assignments when the engineers did not adjust to this atmosphere.

A few companies that do not allow their scientists and engineers such complete freedom have used a different approach to the problem of challenging work for the individual. In these concerns the scientists and engineers submit recommendations for projects to a research or product committee for screening. From these projects an inventory of possible assignments is established which reflects the interests of both management and the individuals. When a scientist or engineer finishes an assignment he is free to select any of the approved projects, regardless of the relative priority which may have been assigned to each. The companies that have used this approach have done so for groups that are working in basic research or activities closely related to it.

COMMENTS

Companies that do not make special efforts to provide each individual with interesting work are assuming an unnecessary risk. The attitude that all company work is challenging does not give sufficient weight to the variability of individual interests. Some procedure to provide an inventory of approved projects from which the individual can choose his assignment without regard for priority appears to be an adequate solution to the problem. It meets the needs of the scientists and engineers and yet enables management to retain control over the direction of the research and development effort.

Under certain conditions a policy of freedom in work assignments appears to be a solution to the problem of maximizing job interest. It is particularly effective for those individuals who are engaged in pure or basic research, and in companies that are large enough to afford the luxury of discoveries that may have no immediate commercial application. In these areas on the frontiers of knowledge a maximum of creative ability is required of the individual; to restrict this ability by a policy of less than complete freedom would be unfortunate.

There has been much concern in the scientific community regarding the long-run effects of an absence of individual freedom and the pressures of conformity in our society. Many scientists believe that the hiring processes of many companies tend to weed out competent men and that organization pressures tend to restrict the output of others. This is a subject that should be a great concern to industry and to the nation. It is a subject on which there is little factual material but which merits detailed study.

INFORMAL RECOGNITION PRACTICES

In addition to the ways of providing recognition and incentives for scientists and engineers described in the preceding sections, there are a number of informal practices in use which do not fall conveniently into any one category. Some of the practices cited here are the same as those which provide individual recognition for all employees. This is consistent with management's view that scientists and engineers should be treated in the same general way as other employees. The practices outlined here are by no means universal because company efforts in this direction do not follow set patterns; they do, however, illustrate the types of programs that the participating companies consider important.

Typical Pattern

All the companies emphasize the importance of the individual's having a feeling of accomplishment in his work. Many executives pointed out the desirability of enhancing this feeling by informing the scientist or engineer of the role which his projects play in the company's total operations. Some firms do this with extensive efforts to keep the engineer or scientist informed of the status and progress of his projects after they leave research and development or engineering. In the case of less successful developments, the individual is informed of the contribution that his work made to other products that are successful. Other companies make particular efforts to have the individual scientists or engineers present at the dedication of new facilities in which their work has played an important role. Many concerns make wide use of house organs and news releases to newspapers and magazines to publicize the personal successes of their scientists and engineers—whether they be inventions, discoveries, or more personal matters such as promotions.

Significant Deviations

There is a wide variety of other practices that individual companies have found to be successful means of providing recognition. One firm has a program whereby it will make a gift to the alma mater of any college graduate employee. The gift is made in the employee's name and amounts to $500 for each year that he attended the school. Another company gives special recognition to all scientists and engineers who have published papers; it annually reprints all of them in a handsome bound volume which is then given wide distribution. A third concern makes a practice of having engineers and scientists make reports to the Board of Directors. Although someone else might be able to present the report equally as well or better, the company feels the practice is important in giving recognition to the individual's work.

COMMENTS

It is important for management to give adequate consideration to the numerous informal practices within a company that affect its scientists and engineers. These practices can be designed to enhance the individual's prestige. On the other hand, carelessly planned practices can inadvertently deny recognition and status for the individual. A failure of this kind can offset the best of intentions and programs in other problem areas.

THE NEED FOR A COMPREHENSIVE APPROACH

The final objective of this study is to appraise the policies and practices currently used to motivate scientists and engineers. The individual problem areas have been evaluated in the preceding sections. This section will present an appraisal of management's overall approach to the problem.

The predominant emphasis so far has been on the positive aspects of management's policies and practices. In each section the programs of the twenty-two individual companies have been merged to present a typical pattern of practice. It is important to note that the collective picture presented here has no counterpart in any single one of the participating firms. Most companies do not even consider that the problem of providing incentives and recognition encompasses all the specific areas discussed here. They all think of the problem in terms of more than one individual problem area; but they sometimes do not have an awareness of the overall implications of all the specific factors that affect the problem. As a result, company policy and practice in some areas are often established to serve quite different goals of the firm. These programs may not adequately provide recognition and incentives.

The complexity of the problem was described by one of the executives interviewed as follows: "There is no single important factor . . . There are diminishing returns with respect to *all* factors . . . with differing curves for each individual." Viewed from this standpoint, the problem is one of optimizing the combined effects of a whole array of factors for each individual, with the solution requiring that no one factor be entirely neglected or left to chance.

A comprehensive program which includes all the factors that bear on the problem is the best assurance of achieving an optimum solution. Without such a program and without a conscious awareness of all the facets of the overall problem, many of the company's actions that relate directly to recognition and incentives are essentially by-products of other programs. The individual scientist or engineer, however, views these actions in the same way that he views the company practices which are designed specifically to promote recognition and to provide incentives for him. The cumulative effects of these influences may be in the best interests of the company. On the other hand, harmful effects of by-product programs may reduce or completely counterbalance the effects of the well-directed efforts of the company. Management cannot afford the risk of this negative effect. A comprehensive program will reduce the chances for it to occur.

Only two of the participating companies appear to have approached such a comprehensive program to deal with the problem. For the remainder of the firms, this approach offers promise of added gains. Perhaps in some cases it would be helpful to state the program in writing. This step would

facilitate clarification of objectives, definition of responsibility, co-ordination of effort, and evaluation of results. It would reduce the possibility of overlooking important facets of the problem. A well-planned and comprehensive approach to the problem of recognition and incentives is the best assurance to management that the most effective use is being made of the limited knowledge currently available.

APPENDIX A

METHODOLOGY

This study was conducted in three stages: (1) preliminary investigation, (2) data collection in company visits, and (3) preparation of this report.

Preliminary Investigation

The first step in the study was a survey of the literature on motivation of scientists and engineers. A committee prepared a bibliography, and each member of the group read a number of references. Additional sources that were revealed by the first group of references were also investigated. Over 150 separate items were included in the survey. The important points of each reference were summarized on file cards, and the reports of all pertinent sources were mimeographed and distributed to members of the group.

The next step was the preparation of the interview guide. The guide was initially prepared by a four-man committee, and it was subsequently revised through discussion with the entire group. In preparing the interview guide, the group included questions on all subjects that the literature survey indicated might be relevant to the problem. The purpose of the guide was to insure that comparable information on these important subjects would be obtained from each company.

The selection of twenty-two companies to be visited was also made during this phase of the study. In selecting these firms, the study group diversified the sample by geographical location, number of employees, and industry. All the companies are industrial concerns, and in the judgment of the study group, they are leaders in research and development activities. The firms are located throughout the United States, with the heaviest concentration in the eastern part of the country. One-third of the companies have less than 10,000 employees, one-third have between 10,000 and 50,000, and the remainder have from 50,000 to over a quarter of a million. Fourteen industries are represented: aircraft, radio and television, petroleum, electronics, chemicals, glass, steel, office equipment, communications, photographic equipment, industrial machinery, tire and rubber, electrical equipment, and food processing.

Company Visits

A two-man team, composed of one industry representative and one Ph.D. candidate, visited each of the companies. Each team visited two companies and then the team assignments were changed before the next visits. During the second series of visits, four teams visited two companies each, and the remaining two teams visited one. The visits lasted from one to three days and included interviews with as many as fifteen executives per company. The number of interviews varied from seven to ten in most companies. The executives ranged in position and responsibility from the president to section leaders in an engineering or research and development department. The interviews were most extensive, however, in the research and development departments of the companies. Tape recorders were used during most of the interviews to provide a complete record. Where this was not possible, the interviewers kept notes of the interviews.

During each company visit the teams discussed all the topics on the interview guide with at least one executive. Many topics were discussed with several. In each case the discussion was developed to fit the interests and background of the man being interviewed.

The interviews were not limited to topics in the interview guide; the executives also were encouraged to discuss problems and practices that were not included.

PREPARATION OF THIS REPORT

The first step in summarization of the data was preparation of summary reports of the visits to individual companies. These reports included the material covered in the interview guide as well as additional topics offered by the companies. Teams were then organized to prepare each section of the final report. These teams studied the appropriate parts of the reports from all twenty-two companies and made a draft of their assigned sections. These drafts were read by all members of the group, and the findings and conclusions were discussed at group meetings. Each individual also submitted written comments and suggestions on all topics. Each section was then rewritten by the responsible team. Finally, one member of the group modified the individual sections, as necessary, to produce an integrated report.

INTERVIEW GUIDE

To be used in conjuction with the research project
being conducted by a group of Stanford Fellows
as a part of the
Program in Executive Management
made possible by a grant from
The Alfred P. Sloan Foundation, Inc.
under the auspices of the
Graduate School of Business
Stanford University
Stanford, California

MOTIVATION OF SCIENTISTS AND ENGINEERS

The purpose of this project is to determine and evaluate what industry is doing to motivate scientists and engineers. The specific group of scientists and engineers we are interested in are those who will not go into administrative positions for one of two reasons:

(1) The individual prefers to remain in scientific or engineering work.

(2) The company feels the individual can make a more valuable contribution in his technical specialty than in an administrative position.

For purposes of the project, a "professional" is defined as a scientist or engineer who spends over 75% of his time working in his special field of interest.

Data for the study will be gathered through a series of visits by members of the Stanford Program in Executive Management with selected companies across the country.

The questions on the following pages will serve to guide the interviews in order that the following objectives might be attained:

1. To determine the extent to which motivation and providing adequate incentive and recognition for professionals is a problem.
2. To determine the specific programs, practices, and other devices that the companies employ to solve this problem.
3. To determine the results of the programs of the various companies and how these results have been measured.

I—GENERAL INFORMATION

1. Approximately what percentage of total employees is represented by "professionals"? ..... Total number of company employees? .....
2. Has a study been made of the probable future requirements for professionals? If so, what is the estimated number needed, and what qualifications are required?
3. What is the estimate of the approximate cost of hiring and training a professional employee? Regular employee?
4. Is there any significant difference in the turnover of salaried employees, company-wide, and the turnover of professional employees?
5. For all salaried personnel, what is the ratio of supervisory to non-supervisory employees?
   (a) What is this ratio in the research area and has it been changing?
   (b) If it is changing, how much, in what direction, and to what reasons are the changes attributed?
6. Do the professional and technical employees belong to a union?
   (a) If so, what conditions led to the formation and recognition of the union?
   (b) What matters are negotiated with the union?
   (c) What percentage of the "professionals" belong to the union?
7. Are there any particular problems in providing incentives and recognition for your professional and technical employees?
   (a) Has a company study been made of these problems?
   (b) Have the practices of other companies been checked?
8. What is the basic organizational structure in company research and development groups, i.e., plant or manufacturing departments, according to specific purposes, or according to research techniques?
   (a) Copy of company organization chart.
   (b) Copy of research division organization chart.

II—ADMINISTRATIVE PRACTICES

1. On what basis are the administrative personnel of research activity selected and how do these criteria differ from those used in selection of administrative personnel in other areas of company?
   (a) How important relatively are such factors as technical knowledge, leadership, managerial ability, professional status?
   (b) What features of the research manager's job are considered to be the most important? Least important?
2. Has an analysis been made of the kind of management that is needed (or will be needed in the future) to supervise professional employees? Has this analysis indicated the need of a change in selection standards, and if so, in what ways?
3. Does top management generally regard professionals as being identified with the management team? How is this manifested?
4. Is the research manager considered to be part of the executive team? By virtue of representation on the board; as a member of executive committee; by participation in overall company policy decisions; other.
5. What is the feeling toward dual managers of research, i.e., an administrative manager and a technical director? Has this been tried? Results?
6. Is communication between management and the professionals considered to be a significant problem? What methods are used to facilitate these communications—company newsletter, department bulletins, department meetings? Does this communication

include advising the professionals regarding other company activities, business conditions, and current practices relating to the specific product or service with which the particular professional is concerned, general business outlook, etc.?

7. What means are employed to check the effectiveness of the communications program?
8. Are professional employees given the services of assistants, such as technicians, clerks, stenographers, etc.?
   (a) Basis.
   (b) Extent.
   (c) Primarily as means of increasing efficiency or as a motivational device.
9. What *special* efforts are made to create a physical environment that will serve to motivate the professional employee?
   (a) Private offices, personal telephone, etc.
   (b) Have these efforts been successful?
10. Are professionals encouraged to secure registration under state laws where applicable? How?
   (a) Does company pay registration fees?
   (b) Is registration a factor in appraisal?
   (c) Does company encourage employee to sign his work and indicate professional status thereon?
   (d) What percentage of qualified employees are registered?
11. Are professionals encouraged to participate in professional societies? How?
   (a) Does company pay dues?
   (b) Does company provide time off with pay to attend meeting?
   (c) Does company pay expenses of employee attending a meeting; even if employee is not an active participant in meeting?
   (d) What percentage of employees belong to societies? Attend meetings?
12. Is a "managerial attitude" on the part of the professional considered to be desirable (or essential) even though he may not wish to become a manager? How is this promoted and evaluated?
13. What consideration is given to the possibility that the professional may have gone "stale" in his job and would respond favorably to new duties and/or great responsibilities?
   (a) Are work experience records maintained?
   (b) Is an attempt made to vary assignments?
14. Is there any definite planning done with respect to providing an inventory of challenging tasks for the professional?
15. How are work assignments made?
   (a) Specific or general in scope, detail, schedule, etc.?
   (b) Extent of progress reporting expected?
16. Are informal organization methods used to fit a particular job to the available personnel? For example, changing from project groupings into groupings of individual technical specialities and vice versa.

III—PERSONNEL PRACTICES

1. What methods or procedures are followed in evaluating the performance of professional employees?
   (a) Plan.
   (b) Administrator.
   (c) Frequency of evaluation.
   (d) Use of appraisals.

2. To what extent are the results of performance appraisals discussed with professional employees?
3. Is participation in civic activities encouraged as a means for personal development of the professional employees?
4. What is the feeling about applying a separate ladder of advancement for professional employees paralleling the promotion structure for other salaried employees?
   (a) Is such a ladder necessary?
   (b) What elements should it include?
   (c) What advantages or disadvantages will accrue from such a ladder?
5. Are job descriptions maintained on professional positions?
   (a) How are these descriptions developed?
   (b) To what uses are they put?
   (c) How valuable have they been with regard to motivation of professional employees?
6. What qualitative and quantitative factors are considered in evaluating the performance and potential of professional employees?
7. Do personnel practices with respect to professional employees differ in any way from those applicable to other salaried employees?
   (a) In what ways do they differ?
   (b) For what reasons do they differ?
   (c) Have these differences paid off?
   (d) Has any friction developed as a result of these differences?
8. What procedures are used to recognize the misplacement of a professional employee, and what action is taken to remedy the situation?
9. Are any special records, applicable only to professional employees, maintained in the personnel files?
   (a) What do these include?
   (b) How are they used?
10. Has an attitude survey been made among your professional employees?
   (a) When?
   (b) How many professionals included?
   (c) For what purpose was the survey intended?
   (d) What were the general results?

IV—COMPENSATION

1. How are salaries established for professionals?
   (a) Sources of information.
   (b) Methods of rating positions.
   (c) Number of salary ranges.
   (d) Salary spread within and between ranges.
   (e) Comparison with ranges for other salaried employees.
   (f) Total spread between bottom and top professional salaries.
2. What is the salary review plan for professional employees?
   (a) Rate of increase.
   (b) Frequency of increase.
   (c) Method of determination.
3. Are special outside surveys used to determine how career opportunities, in terms of pay and recognition, compare for professional employees within your company and elsewhere?
4. What distribution is given to salary schedules among professionals?

5. To what extent are professionals paid on an hourly basis?
6. When extended overtime work is required of professional employees, how are they compensated?
7. In what ways are inventions, suggestions, technical papers, etc., rewarded?
8. What other compensation plans are provided for professional employees?
   (a) Profit-sharing.
   (b) Bonus.
   (c) Stock purchase.
9. To what extent do professional unions or associations influence the determination of professional salaries?

V—TRAINING PRACTICES

1. Who has the direct responsibility for the development and supervision of training programs?
2. Does the company have any type of in-company formal training programs for professional employees?
   (a) Length.
   (b) Subject matter.
   (c) Sources of instructors.
   (d) To whom given.
   (e) Percentage of employees who have completed.
3. What other devices or practices are used within the company for training purposes? How much time is devoted to each and what level employees participate?
   (a) Lectures by outsiders?
   (b) Visits to other organizations?
   (c) Seminars led by company employees?
   (d) Conferences?
   (e) Job rotation?
   (f) Other?
4. Does the company have any type of indoctrination program for new professional employees?
   (a) Is it part of formal training programs?
   (b) Length?
   (c) Subject matter?
5. Does the company have a program whereby professional employees can attend classes at local universities?
   (a) Tuition paid by company or employee?
   (b) Courses taken on company time or employee's time?
   (c) How many employees have taken?
   (d) Are courses restricted to technical ones?
   (e) If not, what others are included?
6. Does the company offer leaves of absence for extended periods of advanced study?
   (a) With or without pay?
   (b) Length?
   (c) Restrictions?
7. To what degree does the company feel that its training programs motivate its professional employees?
   (a) Which program seems to provide the most in the way of motivation?
   (b) What is the basis for this judgment?

APPENDIX B

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