The Space Congress® Proceedings

1964 (1st) - Where Are We Going In Space?

Apr 1st, 8:00 AM

Personnel and Organization Development in an R & D Matrix Overlay Operation

Richard G. Lazar
ITT Federal Laboratories ,Mutley, New Jersey

Arthur D. Kellner
ITT Federal Laboratories, Mutley, New Jersey

PERSONNEL AND ORGANIZATION DEVELOPMENT IN AN R&D MATRIX-OVERLAY OPERATION

Richard G. Lazar and Arthur D. Kellner
ITT Federal Laboratories
Nutley, New Jersey

Summary

Increasingly, R&D companies are finding it desirable to adopt a "matrix-overlay" organization structure to accomplish project goals on a timely and efficient basis. In shifting from a straight functional organization to a combined functional/project form, some key changes must be made in responsibilities of Program Managers and managers of engineering "Capabilities Centers." New standards of performance and means for reward and advancement under the revised organization structure must be developed. Diverse management and social science experience are called upon in planning and implementing the matrix-overlay structure through the development of such standards.

Broadly speaking, there are two organizational structures for R&D work: the functional organization and the project organization. In terms of expected characteristics of the two organizational forms, it can be said that the functional organization encourages growth and development of technical experts while the project organization gets the job done and develops leaders at the working level. There are advantages and disadvantages of each type of organization, but no matter which form is established, the typical research and development operation eventually uses both arrangements with a resulting mix of advantages and disadvantages.

A major dilemma for R&D management is to combine technical people into working groups in such a way as to maximize application of their creative ingenuity while at the same time developing sufficient "end-item" orientation to achieve a practical payoff from the research effort. Organizing researchers into groups based on disciplines protects the integrity of specialized competence. It provides a homogeneous cluster of people which is relatively permanent, with close communication within common areas of interest. In the usual functional organization, however, such groups are inclined to become somewhat compartmentalized, with parochial interests and a continually narrowing purview of the over-all needs of the operation. Some loss of creative output is inevitable under such a setup, particularly where a closely managed, goal oriented R&D program is required.

The straight project management setup, on the other hand, divorces the technical man from his professional group. It places him in an operating environment that is too strictly "project" oriented. It removes him from the technical status relationships, "colleague authority," and scientific reference group identification which are important to development of good technical capability in an organization.

In order to achieve the advantages of both functional and project organization, many R&D organizations have been adopting a "hybrid" type of organizational arrangement, referred to interchangeably as a Matrix, crossbar or overlay organization. In the matrix organization a Program Management group is set up with the purpose of getting the job done by drawing upon the capabilities of functional or line groups, including engineering and support services. In effect, Program Management becomes a quasi-permanent line group. Individual staff members are temporarily assigned to a

particular program and upon its completion either return to home base (or "Capabilities Centers") or may remain in Program Management to work on new programs.

It has been found that the organizational changes which are made in implementing the Program Management concept result not only in the expected improvements, but some deleterious side effects as well, particularly insofar as employee motivation and interpersonal relationships are concerned. Thus it is particularly important that a company introducing the Matrix type of organization where a more traditional functional form existed should take steps to maximize the benefits and minimize the negative effects on its people.

Usually, in implementing the Program Management concept in its operation, the company publishes new organization charts and issues directives and bulletins to modify employee performance. Such methods are necessary, but more important, it is the establishment of clear standards of required performance, fair evaluation thereof, and setting up of reward and advancement systems which are responsive to the new needs of the Matrix organization, which help management to obtain the needed engineering acceptance and support.

Changes in Required Performance of Engineering Personnel

By definition, the Matrix organizational setup affects people in all reaches of the operation. However, it is engineering performance which is most crucial to the success of the new organizational approach. For this reason, the required changes in performance under the new management are discussed here primarily from the point of view of the technical element of the operation. A point worth making is that it is not the organizational structure per se that creates a change in the reward and advancement structure, but the accompanying differential performance requirements of higher management that do so. It is only to the extent that new performance requirements with respect to higher level engineering filter down to operating level engineers that it becomes appropriate to develop new standards of operating level engineering performance.

It is presumed that in most organizations operating under the Matrix concept the required performance of operating level engineers (non-supervisory) would be substantially the same as under any previous organization. These personnel continue to report to engineering project managers and, working at a relatively detailed and highly specialized level, do not become involved in changed working relationships as do the higher levels. In their case, standards of effective performance and accompanying rewards remain the same as earlier.

There are several ways in which the Program Management concept has been implemented in organizations, some effective, some much less so. For example, Program Management (or Program "Control" in this case) may be provided minimal authority wherein it is required only to monitor program schedules or provide PERT or Line-of-Balance (LOB) assistance to engineering managers. In this situation, minimal change is found in the program activities of the organization. Little cooperation and minimum results can be expected. On the other hand, Program Management may be provided maximum control and authority over engineering programs and projects with policy guidance and support required from participating engineering line groups. On programs under Program Management, senior engineering managers are seen as heads of support groups or "vendors" to Program Management. In this situation, changing to a Matrix organization (especially from a functional organization) can achieve good end results, but because it involves a more fundamental change in relationships, it usually has a more severe effect upon people and therefore requires maximum attention.

While some specific responsibilities for senior engineering managers drop out under the Matrix concept, and others change in degree of emphasis, one prime responsibility is added by top management requirements. That is the relationship of engineering line groups to the Program Management staff. Engineering groups are now required to be "Capabilities Centers." These Capabilities Centers are foci of capabilities which have a common basis and in which working relationships have been established. They are relatively permanent--the "home base" of the engineering specialist. It is there that he grows and develops professionally. They are "culture pockets" for development of the state-of-the-art within specific technological areas. These Capabilities Centers are required to support Program Management with: 1) skilled engineering talent (knowledgeable in new technologies), 2) facilities, 3) equipment. To make the most effective contribution, the Capabilities Centers must be continuously aware of and interact with present and future needs of Program Management. Clearly, Capabilities Centers must also develop with the aim of staffing for new programs and projects under their own direction. In either case, engineering managers are now, more than ever, to be evaluated by the extent to which they improve that state-of-the-art, infuse new talent, encourage new inventions and concepts or, in other words, maintain high quality Capabilities Centers.

Not all required performance of senior engineering personnel involves capabilities development in support of Program Management. In the typical "mixed" organization, some of these personnel have other programs or projects to manage (not under Program Management control) whereby they acquire or maintain responsibilities held under the previous organization. Standards of performance for these personnel are discussed in a later section.

Program Management's Role in Facilitating Better Engineering Performance

Program Management is seen as a Network of Activity. Its function is overlaid on the basic company structure. Performance required of these staff members relates to planning, coordinating and controlling the numerous activities involved in meeting a program goal. Performance requirements of Program Management should place emphasis on the ways in which it can facilitate the engineering product.

Successful execution of any program under Program Management depends upon successful interaction between the Capabilities Centers and Program Management. The word "interaction" is not an empty euphemism. It is an absolute necessity, inasmuch as Program Management acquires its capability (although it has authority under top management directive) almost entirely from and at the discretion of the Capabilities Centers. In order to perform its job, Program Management must assist engineering Capabilities Centers to perform their jobs. Program Managers must demonstrate their usefulness to engineering and not merely tell engineering how helpful they can be. Program Managers should seek to facilitate engineering in some of the following specific ways:

1. Give each engineering group manager a "manageable" job; one that requires solid engineering capability and is achievable. Provide engineering with all necessary inputs to do the job (e.g., specs., technical manuals, detailed requirements).

2. Develop a full understanding of the problem (possibly through a detailed statement of work and a subsequent bid response from each group) and the necessary capabilities to do the job.

3. Throughout a contract, try to free engineering from administrative paperwork, so objectionable to engineering. One way to achieve this end is to obtain necessary information for reports through meetings with engineering and have the Program Management staff actually write the reports.

4. Aid Manufacturing by performing liaison between them and Engineering by stimulating the timely and accurate receipt of engineering change notices and other drawings and reports. Where clarification of drawings or specs is necessary, Program Managers should provide it to Manufacturing.

5. Coordinate and arrange necessary trips and meetings between engineering and the customer.

6. Track down unauthorized or doubtful charges against engineering case numbers.

7. Ensure and conduct design reviews periodically to assure in-process design adequacy.

In summary, Program Managers must perform two major missions to aid in achieving improved engineering products: They should buy "time" for the engineering project managers to perform their technical work. They should direct engineering as to "what" is required and "when" while allowing engineering to determine "how" it is to be achieved.

Engineering Performance Standards on Programs Under Program Management

On programs under Program Management, the increased time available to engineering management is expected to enable the following emphasis on performance and the accompanying standards of performance:

1. Closer technical supervision. This includes closer cognizance over design decisions and drafting, enabling time for realistic design reviews and drawing reviews. Standards of performance include:

- Fewer engineering changes during R&D including reduced number and extent of changes as a result of design reviews.
- Reduced drafting and reproduction costs on the program.
- Closer adherence to specs during equipment qualification tests.

2. Closer liaison with manufacturing in order to assure compatibility of the engineering product with manufacturing operations. Standards of performance include:

- Minimum number and extent of drawing and spec changes for manufacturing purposes.
- Timeliness of delivery to Manufacturing of an engineering product in order to meet delivery schedules.
- Measured ability of engineering products to meet specifications over the full range of environmental tests.
- Decreases in scrappage (waste) costs which are incurred as a result of ordering against continually changing or inaccurate drawings.

3. Close attention to standardizing equipment circuit and component design. Standards of performance are evaluations as to the extent of engineering adherence to corporate standards (e.g., microminiaturization). Much money and time are needlessly lost in unnecessary replication of such things as flip-flop circuits and power supply design. Standards of performance include cost savings obtained through greater standardization in the following specific areas:

- Through placement of larger orders wherein cost advantages are thereby obtained.

- Through reduction in new tooling. Existing tooling can be utilized to a greater degree.

- Through reduced costs of training new operators.

- Through experience in producing similar products well.

- Reduction in rework or scrappage which in turn results in greater availability of capital equipment.

4. Greater opportunities for recruitment and development of high calibre engineers. Specific measures of performance of these responsibilities can be the following:

- Greater number and quality of high talent and advanced degree engineers.

- Greater number and quality of published articles.

- Greater number of state-of-the-art patents.

- Greater number of valid promotions.

5. Greater order input and billings. Engineering is at least partly responsible for order input and billings. Engineering performance is in large measure a factor in the amount of new and add-on business acquired. Three specific standards of performance are:

- Greater Yield rate (# of Awards/Quote).

- Reduced Expense-of-Capture rate (Expense/Award).

- Increased Percentage share of new and desired markets.

6. Greater recognition of engineering capabilities by outside professional groups and organizations, other corporate divisions and internal groups. Specific measures of performance include:

- Greater frequency of requests for and participation on key technical committees and at technical seminars.

- Greater numbers of requests for and contributions to other company elements.

- Greater numbers of requests for and contributions to other internal corporate groups.

It will be noted that these performance requirements place emphasis on technical excellence for engineering personnel, an emphasis which can easily be overlooked in this age of "massive engineering." The Matrix organization, in effect, makes it possible for the technical man to be a better technical man rather than be forced reluctantly into the mold of a manager.

Engineering Performance and Standards of Performance that are not Affected by Program Management

Since the typical organization applying the Program Management concept is "hybrid" (that is, the larger contracts are under Program Management, smaller ones are managed directly by engineering project managers), not all engineers can divest themselves of management responsibilities; nor are they likely to desire to do so. Those engineering managers who manage contracts not under Program Management will have responsibilities in addition to those mentioned above, with accompanying performance standards as follows:

- Achieve order input at projected $ levels.
- Achieve billings at projected $ levels.
- Meet delivery schedules on time and within costs.
- Maintain customer satisfaction through reduced frequency of complaints.
- Assure proper profit margin.
- Enter new markets in accordance with Corporate Business Plans.
- Administer General Development funds

  a) to achieve technical objectives within costs,
  b) to achieve short and long range payoff.

- Maintain low indirect/direct ratios.

These performance requirements are both business-oriented and technically-oriented responsibilities. They require the proper mix of management and engineering competence.

Areas of Overlapping Performance and Standards of Performance between Engineering and Program Management

To complete the picture, it should be pointed out that certain responsibilities must necessarily be shared by engineering management and Program Management. Standards of performance for these areas include:

- Meeting delivery schedules.

  Operating within budgets.

- Assuring customer satisfaction.
- Sales.

While the above standards are primarily required of Program Management or Sales (Marketing), it would be unrealistic to remove all responsibility and accountability for these standards of performance from engineering Capabilities Centers. We take specific note that interaction and cooperation between Program Management and engineering Capabilities Centers are a sine qua non toward satisfactory achievement of the above standards of performance.

Opportunities for Growth and Advancement for Engineering Personnel under the Program Management Concept

As stated earlier, rewards and advancement are affected by 1) changes in required performance and 2) evaluation of the extent to which accompanying standards of performance are achieved. At the higher levels, two distinct types of specialists will in time emerge from engineering Capabilities Centers as a result of the "mixed performance required of these centers. The first will be the top-notch engineering manager and the second will be the top-notch technical expert. The engineering manager will become an expert in running programs and projects in his own area. The technical specialist will be developed by the Capabilities Center and utilized appropriately by Program Management as well as by the Capabilities Center. The result is that an alternative path of advancement in Program Management (in addition to the path in the Capabilities Center) is now available to the competent engineering manager. In fact, the engineering manager can, as a manager, develop in two somewhat distinct directions: he can become a manager within the Capabilities Center or he can move into broader program management. In the first case he has supervisory responsibilities, yet remains closely involved in the technical milieu. This choice represents a clear compromise between the typical engineer's professional needs and organizational achievement. On the other hand, in choosing the Program Management route, the engineering manager broadens himself by gaining an overview of company operation. His management duties involve coordination of many functional areas in respect to his specific program: engineering, manufacturing, marketing, procurement, quality assurance, and so on. The man who wants to remain purely a technical specialist may pursue advancement through the Senior Scientist (or Scientific) hierarchy It is interesting to note that, while much attention has been given by R&D organizations to the need for a "dual hierarchy" of advancement for scientific personnel, the Matrix concept in the manner described above in effect provides three channels for advancement of technical personnel.

Where Program Management is established as an avenue of advancement for competent engineering managers, it should be equal to (but not greater than) that through engineering. This objective can be achieved through:

- Establishing sound financial incentives.
- Encouragement of the best engineering managers both within and outside the company into Program Management.
- Successful completion of programs; acquiring of new business. The best engineering managers will try to join a winner.
- Intensive selection of program managers and associate program managers based on past project management success and on managerial skills.
- Carrying out development programs specifically for the enhancement of engineering-management abilities.

Not the least reward for the program manager is the satisfaction of "making things happen." He achieves his goals through other people and faces the challenge of coordinating and integrating the efforts of people with widely varying skills and interests. His satisfactions derive from attainment of results which are relatively observable: meeting time schedules, completing work within established budget, attaining customer approvals through meeting specifications, and so forth.

For the technical expert, the "professional ladder" becomes the basis of reward and advancement. A Senior Scientist hierarchy of advancement can be established as one offering prestige and status, as well as economic reward. The professional employee, the technical specialist, is more likely to be inclined toward outside professional identifications and interests. These interests should not be considered incompatible with company goals. On the contrary, the Program Management concept, with its "Capabilities Centers" and emphasis on technical excellence in the engineering groups, requires that the technical specialist do all in his power to develop his technical capabilities. This development depends directly upon maintaining lines of interest and communication with outside specialist groups and the scientific community as a whole. There is some evidence that management does not fully recognize the extent of professional commitment of the technical specialist. Survey results tend to show that scientists and engineers are somewhat less satisfied with their jobs than are those who have moved up the administrative ladder. It is recognized that engineers for the most part do not perceive the technical area as their best, long-range bet. More money, recognition, opportunity to influence decisions and achieve power are available through management. To offset this tendency, many electronics companies are investigating means of motivating and rewarding scientists and engineers through their technical hierarchy of advancement. The establishment of an equally rewarding ladder of advancement within the Capabilities Center for the technical expert provides an excellent means for overcoming these motivational difficulties which, in turn, will help to ensure the success of a Program Management operation.

Following these observations, efforts to develop better technical engineers should include the following:

- Development of a clear path of entry into and good advancement potential within the scientific hierarchy for qualified engineers and scientists.
- Greater encouragement of and recognition for technical achievements (e.g., patents, technical papers, state-of-the-art design, etc.).
- Communication downward of the broad objectives of the organization including its aim toward furthering technical leadership.
- Strong training and development programs aimed towards improving technical excellence. These include tuition reimbursement, in-house seminars, company-sponsored graduate fellowships, and similar programs.
- Understanding and acceptance of revised standards for performance of engineers--standards placing emphasis on technical excellence.

The latter action area is perhaps most important, particularly in the context of this article. How can the revised performance standards best be implemented in the organization? The answer depends in part on existing organizational procedures and programs in the company. For example, performance reviews, if carried out on a periodic basis, should be based on standards such as those outlined above for senior engineering people as well as program managers. Another means for implementation of these performance standards is in formulation and statement of program plans, such as those prepared by Program Management. Also, such requirement should be spelled out in revised job descriptions, as appropriate. In the latter case,

it is particularly important that the revised job descriptions be made available to the individuals involved to help obtain their understanding and acceptance of job requirements.

Finally, a major area of implementation of performance standards is in a more or less formal goal setting program for higher level technical and managerial personnel. In such programs, which are being adopted more and more by industrial firms, individual job objectives are spelled out in writing for each key employee with yardsticks as standards for evaluation. Such a program provides an excellent means, first, for establishing an understanding of performance requirements and standards, and as a source of motivation for carrying them out as well. This is particularly true if the evaluation of results is linked in one way or another to a special financial reward such as a bonus or profit-sharing arrangement.

Most of the difficulties which are likely to arise from the changeover to a Matrix form of organization, with Program Management, result from misunderstanding concerning job responsibilities and standards for performance. Early recognition of the need to define new performance expectations, specific areas of responsibility (including overlapping or cooperative requirements), fair appraisal, and consideration of tailor-made reward and advancement systems will go a long way in facilitating engineering support in a change to the matrix organization.

References

Argyris, C. Interpersonal Competence and Organizational Effectiveness, Irwin and Dorsey, 1962.

Danielson, Lee E. Characteristics of Engineers and Scientists, Bureau of Industrial Relations, the University of Michigan, 1960.

Hower, R. M. and Orth, C. D. Managers and Scientists, Harvard University, 1963.

Kornhauser, W. Scientists in Industry, University of California Press, 1962

Opinion Research Corporation. The Conflict between the Scientific Mind and the Management Mind, Opinion Research Corporation, Princeton, 1959.

Peck, M. J. and Scherer, F. M. The Weapons Acquisition Process: An Economic Analysis, Harvard University, 1962.

Pelz, D. C. "Some Social Factors Related to Performance in a Research Organization," Administration Science Quarterly, December, 1956, 313-320.