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MANAGEMENT INTEGRATION IN A MATRIX SETTING

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Abstract: Effective project management requires that all planning management control activities be fully integrated: planning must encompass operational, tactical, and strategic considerations; functionally oriented efforts must be properly blended into a unified whole; and project technical performance, cost, and schedule parameters must be integrated into a systemic composite. Viewed from this perspective, integrated management has both an organizational component and a program component that are distinct yet interrelated. This paper explores the conceptual basis of these two components of integrated management from a system viewpoint and provides insight into that interrelationships involved.

I. INTRODUCTION

TRADITIONAL functional organizations, typically, group specialists together to work on multiple projects while self-supporting project organizations, usually join generalists to work on individual projects. Matrix organization is designed to constructively blend the program orientation of project staffs with the speciality orientation of functional personnel in a new and synergistic relationship.

In this organizational setting, two forms of organizationrelated management integration occur. The first is a vertical integration that occurs naturally in functional organizations due to chain-of-command relationships. This form of integration occurs vertically in each individual functional department and assures that functional organization objectives are given proper recognition. The second form of integration is a horizontal integration that is induced in the matrix by project organizations. This integrative process stems from the intensive management associated with project management and focuses on integration of functional activities associated with achievement of project objectives.

Program concerns in project management typically are categorized in terms of technical, cost, and schedule performance parameters. These three elements or parameters are used to plan project activity and to control project accomplishment. Used individually, they accurately reflect planned and actual values of the three subsets of project activity. Used collectively, they form the systemic perspective critical to informed decision making.

These two major components-the organizational component and the program component-comprise integrated management as used in this paper. These relationships are depicted at Fig. 1.

In a matrix organization, the project manager is usually solely responsible for attainment of project objectives and is, therefore, responsible for assuring that the integrated management process is successfully accomplished. The focus of the exploration of this process in this paper is from a project rather than a functional perspective for this reason. The paper thereby provides insight into a project manager's compelling role as program integrator [1] .

II. PERSPECTIVE

Achieving total program integration in a matrix is no mean task. Put in perspective, total program integration is concerned not only with securing requisite resources in the proper proportions for the project, but also with achieving a unity of individual and group effort from an array of disciplines and interests. Both of these must occur in a competitive environment of less than sufficient resources and in an organizational setting designed to encourge conflict [2] .

The project manager's integration role in this Catch 22 is nowhere more visible in its application than in the management both of project resources and project interfaces. The project manager's goal in these critical

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activities is proper integration of diverse individual project inputs and efforts into the totality or wholeness of the entire project be it goods, services, or a combination of the two.

A. Resource Management

Managing resources effectively and efficiently is important to a project manager for several reasons. First, if sufficient resources are not secured, the project may suffer undesirable consequences such as underachievement of technical objectives and schedule delays. At some point, this condition may lead to project termination. Second, if greater than sufficient resources are obtained, 3 the project management team is likely to tinker-particularly with a hardware system-in an effort to make good enough even better. This condition not only deprives other projects in competition for the same resources from receiving their fair share, but the tinkering may become an end in itself at significantly increased cost and only marginal system improvement. Third, ineffective and inefficient use of adequate resources is wasteful, in general, and also deprives other projects of resources as mentioned previously. This condition may also cause the same undesirable consequences that are associated with insufficient resources.

Major resources are many and varied and several general categorizations exist [3] . 4 For purposes of this discussion, major project resources are defined as follows:

people;

time;

1 The emergence of integration as a function of management was reported well over a decade ago in [1J.

2 For excellent discussions on the inherent conflict in matrix organization see [2] . 3 Although this situation undoubtedly occurs less frequently than its opposite in our world of scarce resources, it does occur. When the condition does occur, it typically applies to less than all of the diverse resources required by a project at any given time.

4 See for example [3].

money;

technology;

information;

facilities, material, and equipment.

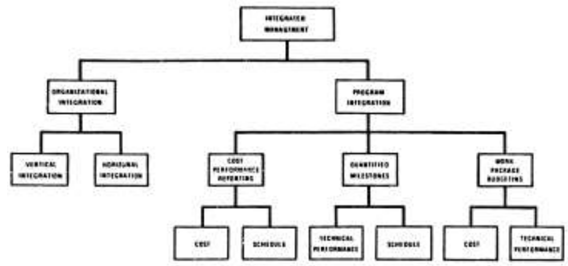

Fig. 1. Integrated management relationships.

The project manager is responsible for planning, organizing, and controlling these human and physical resources even though many are not directly managed by project office personnel.

The human resource may come both from corporate assets and through contract. Human resources within the corporate entity are usually considered project, functional, or staff depending on their assignment. Of the physical resources, time is quite unique. It is not reproducible; once it has passed it can never be reacquired, and it cannot be banked or stored [4]. Time is the common denominator of all other resources and is used to interrelate them in project planning. Money is the financial asset, it is subject to inflation and must be escalated or de-escalated accordingly when comparing money in one fiscal year to money in another fiscal year. Money is frequently used as a surrogate in planning and control for the resources it can buy.

Technology, as used here, is the recognized state-of-theart of scientific knowledge. It is the technical basis upon which the goods or services of the project are formed. The rate of growth and change of the technology in question as well as the risk associated with the technological elements of the project are just as important as the basic nature of the technology [5]. In fact, the proven maturity of the selected technology is the primary consideration in many applications. The information resource relates to the totality of the data associated with project activity converted through some process into a useable form that stimulates or induces human response and reduces uncertainty. Information is the written and oral resource which project personnel have for their use. Facilities, material, and equipment are the buildings, machines, test ranges, and laboratories used in the development, production, sale, and maintenance of the goods or services of the project.

The specific resources required, the amount of each needed, and the determination of constructive interrelationships among them is a function of the specific project mission requirements. How they are estimated, forecast, acquired, allocated, organization, and controlled is a function of the project manager's methodology and skill as an integrator.

B. Interface Management

A complex project has many interfaces, the principal ones being:

system interfaces;

organization interfaces;

contractor interfaces;

customer interfaces.

The interfaces, in many cases, are complementary and overlapping. They are not cleanly differentiated in practice and a project manager frequently operates in several boundaries at the same time.

System interfaces are defined by the nature or physical makeup of the project itself. If the project involves a product, the physical system interfaces include hardware, software, other systems, facilities, and equipment/human interfaces. Typically, system interfaces are associated with the form, fit, and function of the system. If the project is serviceoriented as opposed to goods-oriented, the interfaces assume a greater orientation toward human interfaces rather than equipment and equipment/human interfaces.

Organization interfaces occur across the boundaries of the functional and staff elements providing support to the project. It is at these junctures that the conflicts in a matrix organization are most obvious. Matrix management relationships are more complex than traditional functional management relationships and take on new vertical, horizontal, and diagonal relationships. The state of the health of the matrix is directly related to these relationships [8].

Contractor interfaces form from the contractual relationships that arise between the project office and its contractors. In many cases, much of the project output is obtained through industry sources external to the project and contracting is the means of achieving formal arrangements with these sources.

There is also an informal interface that must exist between the project manager and the contractual sources. It must be one of mutual respect, understanding, and integrity. Both the formal and the informal interfaces must be operative if the project is to meet its objectives, but many practitioners believe that it is these informal interfaces that make things happen.

The customer interface exists between the project and the users of the goods or services provided by the project. The project office must be committed to meeting customer requirements, for without a customer there is no need for the project. A project office that mishandles or abuses this interface clearly needs to reassess its priorities.

Interface management is critical to most projects for interfaces are boundaries of jurisdiction that are fertile spawning grounds for incompatibility and misunderstanding. In the systems context, interfaces are defined in terms of form, fit, and function. People interfaces involving organization, contractor, and customer boundaries are described in terms of responsibility, accountability, authority, and mission.

III. ORGANIZATIONAL INTEGRATION

Organizational integration occurs through both a vertical and a horizontal component. The former is underscored by intrafunctiona! hierarchic relationships while the latter is highlighted by interfunctional peer associations.

A. Vertical Integration

The vertical integration occurring naturally in a matrix is primarily attributable to the functional segments of the organization structure. It is directly related to the organization hierarchy and is. therefore, vertical in nature. It flows along, and in accordance with, prescribed organization channels and its form is dictated by institutional policy and procedure. It is conceptually akin to a work breakdown structure wherein more detail is encountered as one goes lower into the work breakdown structure. Conversely, as one rises in the work breakdown structure, substance becomes broader with each lower level being summarized or integrated into the next higher level.

Vertical integration is, in effect, a proct. f "hierarchic referral" [9) with upper management concerntrate with strategic values, middle management concerned with tactical values, and first-line management concerned with operational values. As plans, concerns, or decisions move along this continuum from operational through tactical to strategic, the issues become increasingly more general in nature with lower level plans, concerns, or issues integrated into each higher level. Then, as decisions are reached or strategic choices established, the feedback process in the organization assures that long-range concerns are systematically broken-out into more detail at the tactical and operational levels. The fact that some individuals may operate across all three levels in some aspects of the functional specialty leads to a form of "self-integration" [10]. There is also" aif element of cross-pollination among projects within the functional specialty, but this is a functional and not a systemic integration. Thus a closed-loop system operates within the organization that facilitates vertical integration of information up and down the hierarchic chain.

Strategic considerations, generally, relate to long-range or broad time horizons involving macro program elements. Strategic considerations normally relate to large commitments of resources and relatively inflexible or essentially irreversible courses of action involving major program elements. Strategic concerns typically have a high degree of uncertainty associated with them and may represent the boundary of interaction of the organization with its environment [11].

Tactical concerns usually relate to near-term time horizons. Program elements involved tend to be more micro in nature than at the strategic level. The magnitude of the resource commitments tend to be smaller, courses of action present greater flexibility and less sensitivity to outside factors, and the degree of uncertainty is lower. The operational level in the organization hierarchy attaches to activity or process and is driven, in large measure, by the philosophies and actions emanating from the strategic and tactical levels.

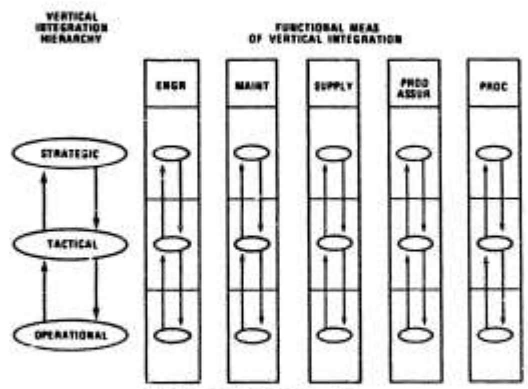

Fig. 2. Vertical integration.

Fig. 2 portrays the concept of vertical integration in the functional elements of the matrix. It may be seen that the vertical integration hierarchy is related to the organization hierarchy and that the concept is closed-loop.

B. Horizontal Integration

Horizontal integration must be induced in the matrix by the project office, for it does not occur naturally. It is related to the work flow of the project across major organizational boundaries and is horizontal in its effect, paralleling the horizontal orientation of project emphasis in a matrix organization.

It is this interfunctional integration that assists the project manager in fitting the pieces of the project together into a complete whole in much the same

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manner that an individual puts together a jigsaw puzzle. The manager, like a person working a jigsaw puzzle, must work with subsets of the whole, but must never forget the big picture [12].

Fig. 3 is a graphic portrayal of horizontal integration. The pieces of the project puzzle are supplied by the functional supporting the project, but it is the project manager that must be able to conceptualize the whole and put the pieces togetherintegrate them-properly. The functionals must be kept constantly abreast of status through feedback from the project manager. The closed-loop system operative in this horizontal dimension is conceptually similar to the closed-loop process in th'j vertical dimension.

It should be noted that the integrative process is iterative and must take into account the life-cycle aspects of the project. This suggests that integration must occur not only among the functional pieces of the project puzzle at any given point in time, but must also occur among all phases of the life cycle. Thus project initiation must be integrated totally with the development, maturation, operation, and phase-out life-cycle phases. All phases of the life cycle must be precisely synchronized through proper ordering of all project activity over time. This responsibility rests with the project manager.

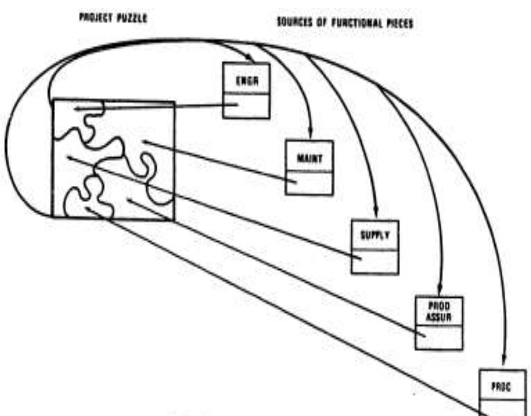

Fig. 3. Horizontal integration.

IV. PROGRAM INTEGRATION [13] 7

The task of program integration is simplified if major program variables are related to the cost, schedule, and technical performance parameters of the project. These elements or characteristics of program activity, when measured and analyzed, provide pervasive insight into the health, status, and progress of the project. As generic management control variables, these parameters are common to most projects.

A. Technical Performance Parameter

The technical performance parameter relates to product design requirements and specifications, and the technology base of the project. It is a means of establishing technical objectives and determining technical program progress. It is concerned directly with the engineering and scientific considerations of the program such as attaining design objectives and product effectiveness, product assurance, test and evaluation, production and operations management, system logistics support, safety and human factors, and system operational availability. The degree to which specified product capabilities are achieved is a measure of its practical utility and worth.

B. Cost Parameter

The cost parameter refers to the monetary resources budgeted for and spent on the project program. While the project manager normally treats the cost parameter as if it had only a fiscal dimension, it actually represents all purchasable assets. Thus the cost parameter is also a surrogate for such resources as people, materials, buildings and facilities, equipment, and other goods and services that may be allocated to only one alternative at a time [14].

C. Schedule Parameter

The schedule parameter refers specifically to the time resource planned for and consumed in project execution. Program schedules depict the time phasing of and interrelationships among the numerous activities and events associated with the accomplishment of program objectives. A meaningful indicator of performance,, the schedule must be controlled if the project manager is to influence the ultimate destiny of the program.

D. Cost-Performance Reporting[15]

A basic premise upon which cost-performance reporting is founded is that schedule data are

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converted to and expressed in dollars. The conversion process involves a time-phased fiscal budget plan reflecting the budgeted cost of world scheduled. The technique employs the work breakdown structure as the tool for identifying discrete elements of the program effort, whether they be goods or services. This technique represents an integration of the cost and schedule parameters and is depicted graphically in the Venn diagram of Fig. 4.

In the work breakdown structure, work packages are the lowest level individual breakout of program effort, and the sum of all work packages must equate to total program effort. The cost parameter is related to work packages by allocating program dollars appropriate to the definition of the task to be performed. Any of a number of accepted cost-estimating techniques may be used for this purpose. Since the individual work packages sum to total program effort, the fiscal budget allocation sums to total program dollars less that amount designated for management reserve. The fiscal budget held for management reserve is a contingency to minimize program risk. Cost performance is assessed by measuring the actual cost of work performed and comparing it to budget.

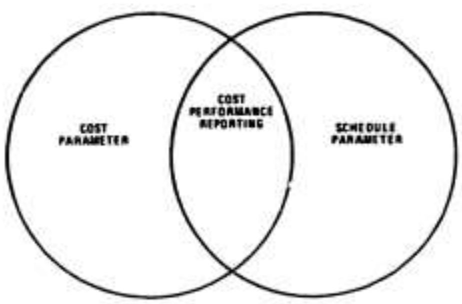

Fig. 4. Cost-performance reporting.

The schedule parameter is related to work packages through the use of networking techniques, milestone planning and control, or similar scheduling techniques. All work required by work packages must be scheduled in a manner that will permit accurate evaluation of performance against plan. Work package schedules must permit rollup into higher level schedules, ultimately linking the summary master schedule. The conversion of schedule data to dollars is accomplished by determining the fiscal budget applicable to the work scheduled to be performed within the specified time frame. Management control is exercised by comparing budgets to actuals.

F. Quantified Milestones

Quantified milestones 9 integrate the schedule and technical performance parameters as depicted graphically by the Venn diagram in Fig. 5. Quantified milestone represent major decision points in the accomplishment of the program. They are events of technical significance strategically placed throughout the program. Properly established, quantified milestones occur at sensitive points in the program life cycle and provide a quantitative means of measuring and evaluating technical performance.

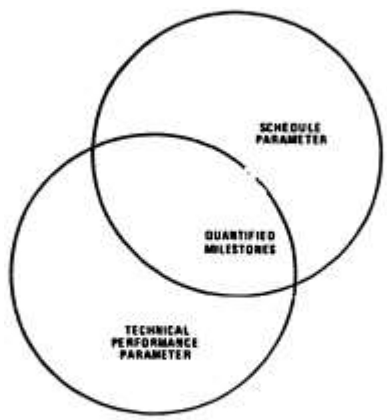

Fig. 5. Quantified milestones.

The thrust of quantified milestones is to emphasize technical performance. The schedule data are used primarily to determine where to locate the quantified milestones. The key to the technique is accurate quantification of technical requirements at strategic points in the project or task being controlled. The dimensions of quantification must be minimum essential requirements of mandatory technical characteristics. The dimensions must be so defined that failure to demonstrate ability to meet objectives is sufficient cause to curtail further work until the performance capability can be successfully demonstrated or an adequate work-around plan can be formulated.

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F. Work-Package Budgeting

Work-package budgeting is a means of interrelating the cost and technical performance parameters and is depicted graphically by the Venn diagram in Fig. 6. It also uses the work breakdown structure as the tool for identifying discrete work packages. Both the cost and the technical performance parameters are related to the work breakdown structure work packages by the same techniques described above for cost-performance reporting and quantified milestones.

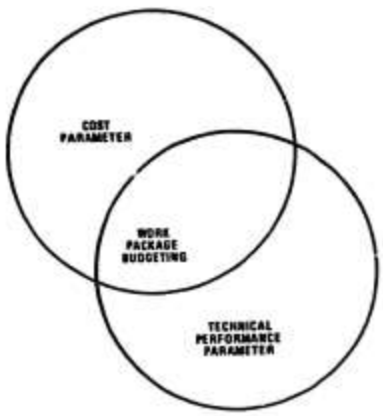

Fig. 6. Work-package budgeting.

G. Conceptual Basis

The conceptual basis for program integration may now be - illustrated graphically by combining Figs. 4-6 into a single Venn diagram as depicted at Fig. 7. It will be noted that Fig. 7 portrays the three program parameters, the three subsets of each pair's combinations among the three parameters, and the single subset common to all three parameters-program integration.

V. INTEGRATED MANAGEMENT

Integrated management in a matrix organization is a subset common to both organizational integration and program integration as depicted in Fig. 8. Because of these relationships, it is influenced both by the organizational dynamics of the matrix and the program dynamics of the project. Also, because of these mutually supportive relationships, the potential for management synergism is increased significantly over nonsystemic non integrative techniques.

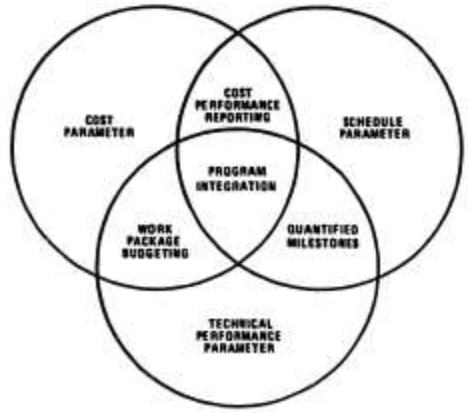

Fig. 7. Program integration.

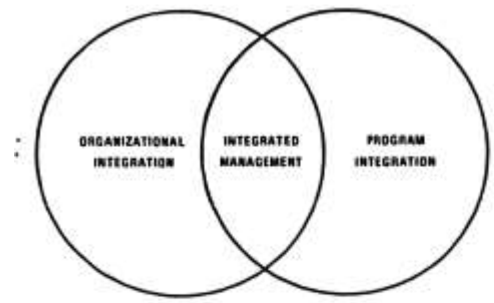

Fig. 8. Integrated management.

Integrated management is a cohesive force stressing unification with, rather than detachment from, the systemic wholeness of project objectives. It underscores team effort rather than individual performance, emphasizes proactive management rather than reactive firefighting, and spotlights interdependencies rather than diminishing them. Through integrated management, project managers may seek more meaningful explanation, develop more accurate predictions, and establish more effective management control.

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