

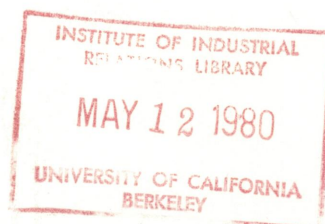
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ORGANIZATIONAL FORM AND NEW PRODUCT
INNOVATION SUCCESS: THE PARTICULAR
CASE OF MATRIX DESIGN

by
Harvey F. Kolodny

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Abstract

There are different stages to the new product innovation process and at the different stages different organizational forms serve the process best. This article breaks out the aspects of the new product innovation process that are most successfully achieved through function, product and matrix forms. Recent empirical and clinical evidence suggests that matrix organization serves the new product innovation process best in the area of successfully implementing new products within the organization's boundaries. Some hypotheses that might account for this success are developed. They refer (1) to the role of the project manager as product champion, and (2) to the structure of the matrix design that simultaneously offers scale economies and a tight product/project focus.

ORGANIZATIONAL FORM AND NEW PRODUCT INNOVATION SUCCESS:
THE PARTICULAR CASE OF MATRIX DESIGNS

Current concepts of organization theory suggest that there are many factors that determine the best organizational structure. We no longer believe in a universal "one best way" of organizing. However, there isn't total consensus on exactly what determines the best organization form for a particular firm or institution. Organizations heavily involved with research and development of new products have faced this kind of question often. Is traditional functional or specialist organization the best way to organize for research and development? Does the organization get a more directed product and market focus from a product or project type of organization? Can you finesse the problem and get the best of both worlds with a matrix organization design? Are there different alternatives: for example, 'team' or 'ad-hoc' or 'collateral' or 'free-form' or other structural arrangements that are particularly conducive to new product development situations?

This article addresses the issue of structural organizational arrangements that contribute to innovation. It is directed at bringing recent contingency approaches to organization theorizing into the innovation process by suggesting that different organizational forms may be more appropriate at different stages in the new product innovation process. In particular, this article examines recent clinical¹ and empirical² work that point to a very intriguing relationship, an apparent high correlation between matrix organization designs and very high rates of new product innovation, and attempts to explain that relationship.

Organizational Factors that Influence Innovation

There is considerable literature that examines the factors that influence successful innovation.³ Market responsiveness, effective research and development management, good project selection and evaluation techniques, appropriate use of outside technology, good fit between company strategy and product mix, and after sales service and user education are some of the "non-organizational" factors that have been identified. Some classic innovation studies⁴ rank organizational items below marketing or technological factors in accounting for successful innovation. Nevertheless, in sheer numbers, a preponderate portion of the factors that have been identified in the literature appear to be partially or unequivocally "organizational" ones.

Table 1 is a list of factors that have been identified in either empirical studies or innovation literature reviews as organizational in nature. The focus of this paper is on one specific set of those factors: organizational structure factors.

Table 1 About Here

Several different structural factors have been singled out as independent variables which cause or facilitate innovation. For example several researchers have pointed to the importance of good organizational linkages, either between marketing and research and development or between the different phases of innovation, and/or across different functional groups. Some researchers have suggested that an organically

structured management is most conducive to adoption of new ideas and products. Others point to the importance of good teamwork. Still others to project autonomy. Since this article examines the effects of one increasingly popular but quite complex organizational structural design, matrix organization⁹, on one particular type of innovation, new product innovation, it necessarily concerns itself with all the above factors; but other key organizational ones such as climate, communications, and collaboration (see Table 1) are not discounted in the analysis. The discussion is an exploratory one, and of a hypotheses generation nature.

New Product Innovation Success and the Level of Analysis

New product innovation success can mean technical success, commercial success or economic success.¹⁰ Since the focus of this article is on organizational arrangements, technical comes closest to serving as the criterion that defines successful new product innovation. If commercial success were the criterion, the marketing factors mentioned earlier, some of which are downstream in the innovation process, would be a necessary concern of the research. In similar fashion, risk propensities, rates of return and strategic factors would enter into considerations of new product innovation based on economic success.

The meaning of technical success, as used here, is a little broader than the term suggests. A large number of new product ideas and prototypes expire due to factors within the organization itself, factors ranging from resistance to change and "not-invented-here" beliefs to excessive time

delays and poor-inter-unit coordination; in effect, some of the factors described in Table 1. Hence technical success is taken to mean that the product has met its desired specifications and has secured the organizational support, involvement and readiness -- physical as well as psychological -- to proceed to the commercialization stages.

Most empirical studies of industrial innovation are conducted at the level of a "project". In these cases, for most purposes of analysis, project is equivalent to a "product" level of analysis. In innovation research, other researchers work at the level of the individual or team,¹¹ the level of the industry¹², and even at an inter-organizational level.¹³ There is a surprisingly limited amount of research at the level of the organization itself, which would be the appropriate level of analysis for this study. This is disconcerting for research that purports to relate a particular organizational form with its success or lack of it in the innovation of new products. As a result, in this article, we must often call on product and project level research to make the case for organizational level relationships.

A Contingency Approach to New Product Innovation

During its life cycle, a product passes through different stages of development. One generally accepted model of the product life cycle comprises the following stages: introduction, growth, maturity, saturation, decline.¹⁴ At each of these stages different demands are placed on the organization for type and quantity of resources and for type of coordination within and between different departments.¹⁵ Our subject of interest is new product innovation, i.e., the process that leads to the first of the product

life cycle stages, namely introduction. That process is itself a multi-stage activity. Idea-generation, technical gatekeeping, problem-solving, product development, product championing, project or program or team management and occasionally even market testing are among the stages or functions or steps or decisions involved in the new product innovation process.¹⁶

The contingency notion of new product innovation proposed here can be introduced with the following statement: for some of the processes or functions that make up the new product innovation process, functional or specialist organization is the most appropriate arrangement (e.g., for idea-generation or technical gatekeeping); for others, product organization is best (e.g., product development, market testing); for still others, matrix organizational arrangements are best (e.g., product championing, project management). Table 2 describes the strengths and weaknesses of each of these forms. Calling on the literature for support, the strengths and weaknesses of Table 2 can be elaborated to put substance behind the case for using contingency approaches to structural arrangements for new product innovation.

Table 2 About Here

Limited structure and wide span of control, informal communications and lateral relationships tend to characterize most R&D organizations.¹⁷ Despite these "organic" arrangements, what structure there is in most R&D organizations is arranged by specialist groupings, i.e., by division of labor principles. These functional organizational forms are anomalies in purely

theoretical terms. The basic structure is bureaucratic, but they don't practise most of the classical theorists' rules and procedures. In attempting to account for these anomalies, a better understanding of the main features of functional forms becomes evident.

Specialists are grouped together to gain scale economies and to develop a critical mass of competence in a particular expertise. The scale economies result from shared ways of functioning and thinking, a common knowledge and language base, shared goals and facilities, etc. The critical mass resulting from specialist grouping is necessary to bring to bear all the extant knowledge in the area of the specialist field and still have resources left to reach out beyond the boundaries of that knowledge to infuse fresh perspectives and develop new insights. This way of working is facilitated by reducing the barriers to communication between specialists, by openly exchanging ideas, challenging concepts and communicating freely. The process tends to be constrained by too much specific direction or control. Uncertain concepts are difficult to transfer and to share. Paperwork, rules, and structural arrangements that demand specificity make it difficult to work with uncertain and complex ideas or technologies that are necessarily so because they are at the leading edge of ideas or at the state-of-the-art technologies.

Project organization is goal directed. The mandate of a project or product group (or team program) is usually clear and circumscribed. Cost, schedule and performance parameters are defined and even when the mission is more broadly stated, e.g., to implement applications of a particular technology, it still has a higher degree of specificity than many of the more

diffuse goals of functional forms of organization.

Project organization is characterized by control. In the super-ordinate form of the boss as project or product manager, in the network methods of controlling events (PERT, critical path), in the physical proximity of team members are all the elements of tight control.¹⁸ Project organization pulls together the differentiated inputs of members with different specialist backgrounds and concentrates on coordination, control and clear tasks to integrate the differences and respond effectively. Because perspectives and orientations of the team members are different, the project manager can't call on a common culture to effect coordination, as in the case of functional organization. Rather, the controls mentioned above and a variety of processes are used: consensual decision-making, group problem-solving, conflict management and team-building skills, etc.

Matrix organization is designed to have the best of both project and functional worlds. It overcomes the weakness of poor task responsiveness on the part of functional organization by channelling the knowledge of the specialists through project and program teams. It overcomes the weakness of limited long term specialist competence development on the part of the project organization by keeping specialists closely connected to functional homes. The features of function and of project forms are maintained, but at the price of increased complexity in the managerial and coordinating roles, by extensive lateral communication demands that can overload an unprepared organization, and by demanding complex and difficult to learn new behaviors from two-boss persons and matrix managers.¹⁹

Matrix organization designs accommodate the phased aspect of developmental cycles very well. As projects work through different stages (idea generation, creation, prototype development, product development, tooling, production, testing) the required specialist resources can be called upon and released as appropriate. There is a functional home that operates like a large inventory department, making human material available when needed and taking up the slack when not needed. Projects aren't forced to use inappropriate resources because they are available and not easily disposed of, nor do they have to agonize too much over the psychological and emotional costs of resources that are expendable at the end of the particular project work.

A similar kind of release from major disruption is offered to the organization as a whole by the matrix design because it easily adopts the morphogenic properties of adding and eliminating new projects as needed.²⁰ New projects and programs are created and old ones dismantled and new functional specialties are added without major, and frequently psychologically traumatic, reorganization. Matrix designs are flexible.

As a final feature, we can point to the matrix design's adaptability to environmental change. More people straddle the organization's boundaries with its different environments than is the case with the function or project forms. In functional forms, the specialist managers monitor the specialist environments while top management interfaces with the client or customer or market groups. In project or product forms, the project or product managers face these latter constituencies and coordinated specialist

environmental interaction is often poorly performed. Hence matrix organization designs exhibit superior open systems characteristics.²¹

Having reviewed the features each of the function, product and matrix forms brings to the new product innovation process, we can venture into some summary statements. Functional forms are best for developing creative but generalized excellence in specialist areas, for advancing and maintaining the state-of-the-art in technology or specialist areas, for developing competence in a specialist area. Project or product forms are best for developing a particular solution to a particular problem. They provide specific focus and direction, in contrast with functional forms which are more effective in generalized situations. Tight integration of different inputs and responsiveness to external demands are part of the project/product strength of providing a focussed effort. Matrix forms are flexible. They can achieve the benefits of varied resources and not be obstructed by the differentiated sub-goals of the variety of units in a complex organization. Matrix can cope with many simultaneous activities in different stages of development and is adaptable to environmental change.

There is a limited amount of empirical evidence to support some of the statements made above. Marquis studied 37 projects in the aerospace sector.²² Within the sample, he identified four different organizational forms used to carry out these projects: function, project, and two versions of matrix - one with small project teams and large functional areas and the other with the opposite combination. Of the four, the matrix combination of small project teams with large functional units was significantly more successful than the other forms in achieving technical success. It

was, for example, even more successful than functional organization in achieving the projects' technical missions. Marquis explained the unexpected outcomes as follows:

The superior technical performance of projects with a functional organization was a surprise. For the last few years it has been assumed that the close coordination of all work, as is characteristic of the project type of management, would lead to technical excellence. But apparently, the close and constant communication with the other experts in one's area, and with one's functional manager, more than compensates for the loss of good interfunctional communication, which is the purpose of the project organization.²³

A study of some 100 projects by Jermakowicz came to some similar conclusions. The 100 projects were divided across seven organizational forms ranging from pure functional through to pure project with matrix in the middle and several staff-line combinations in between. Jermakowicz identified two outcome variables: "number of new products introduced in the organizational system" and "originality of new products". The author's own words explain the "curious interrelationships" observed:

[The investigations] show that the matrix structure provides the highest implementation rate, and the highest level of originality is provided by the pure project structure. Moving from the pure line production structure towards matrix structure both the number of projects implemented and originality increases; after passing the matrix structure [on an

ordinate that runs from line to project] the number of implementations decreases, while their originality continues to increase. A gap appears between the increasing quality of concepts and the number of projects implemented.²⁴

Restated, Jermakowicz found that of the three major forms he studied, (although he actually studied a spectrum ranging from function through matrix to project), matrix was most effective at ensuring the implementation or introduction of new products into the organization while project organization yielded the most creative solutions. His results for the project form agree with the traditional expectation, as Marquis states it above. The close coordination in a project grouping and the good fit achieved between the task performed and the project's proximity to the client or market ensure not only high cost and schedule performance but also creative excellence. Matrix, however, does a superior job in seeing that new products are "introduced in the organizational system".

Marquis claims that technical success is best achieved in a matrix with a strong functional content. If 'technical success' is equivalent to 'new products introduced in the organizational system', the studies concur. The earlier comments on the definition of technical success suggests that these two dependent variables are very likely being used similarly.

The empirical evidence is limited, but given the conceptual rationale and this limited evidence, it seems reasonable to suggest that the organizational form most conducive to new product innovation depends on the stage in the new product innovation process. Interestingly, the organizational

arrangements of many organizations involved with new product development confirm this conclusion; i.e., demonstrate that many organizations achieved this learning intuitively and have long implemented it via their own organizational arrangements. Hence before matrix designs were well known, many a high technology firm had its new products pass through distinct R&D, product development and product engineering phases (or equivalent departments) before becoming final products for production. Many firms still use this process which follows a pattern of organic organization to increasingly focussed organization. The product engineering stage is considered an integrative one²⁵ operating much as we might expect two-boss persons to function in a matrix organization design.

The empirical studies and the clinical evidence coalesce around the relationship between matrix organization designs and new product innovation. Is there a causal connection whereby matrix stimulates new product innovation? Is it as a result of the difficulties associated with implementing new ideas that an organization adopts a matrix design? Causality aside, are there specific explanations apart from the previously cited benefits of matrix organization that explain the relationship?

Product Champions and Innovation in Matrix Organization

One of the key benefits of matrix organization design is that it creates many "mini-general managers".²⁶ In this capacity, the product or project or business area managers are not unlike the chief executive officer because total responsibility for the particular task is theirs and theirs alone. They have a generalist orientation that no functional manager has,

irrespective of how important that functional area may be to the organization. Each mini-general manager is responsible for something "whole": a business area or a technology or a project or a product or a task or an idea. Each is a kind of entrepreneur operating within the confines of the larger organization.

As mini-general managers they are measured on their degree of achievement in making their particular activity succeed along whatever might be its relevant dimensions of success. They take on a "product champion" role²⁷ and manoeuvre and manipulate the particular activity through all the possible obstacles it is likely to encounter in the organization: low priority, inadequate resources, resistance along a variety of dimensions, early failures, redesigns, changes in specifications, low acceptance, competitive pressures from other activities, poor communications, unsatisfactory collaboration and coordination, etc. The combination of an evaluation system that incites them to be aggressive product champions coupled with an open reporting system that, intentionally or otherwise, puts their performance on display in competition with the performance of every other product champion or mini-general manager in front of the entire organization is a powerful set of factors for assuring that they will confront and reduce the organizational obstacles in the way of the technical success of their (new product) activity. While pure project organization forms also emphasize the product champion role, matrix organizations exaggerate the competitive aspect and throw the project managers into the heavy political role of negotiating with functional managers for the resources to accomplish their tasks.

Jervis²⁸ has studied the characteristics of the "product champions" in the SAPPHO studies²⁹ and broken the role down into technical innovators, innovation managers, chief executives and product champions where the latter are people who contribute to the innovation activity but don't necessarily have managerial responsibility. His term "innovation manager" which he defines as "The individual who was actually responsible within the management structure for the overall progress of the innovation project"³⁰ comes closest to the concept of project or product manager used here. Jervis found innovation managers associated with most of the successful innovations in the SAPPHO studies. His concluding comments are important explanations for matrix organization's apparent high correlation with new product innovation:

When technology transfer from an external source is involved, effective contact between the external Technical Innovator and the innovating firm appears crucial, and transfer of people seems an important method of overcoming barriers to success.³¹

This, in fact, is what matrix design accomplishes. Functional organization serves as the external source for the project/product team and technology transfer takes place effectively via the two-boss person. The coupling between project/product and the functions is tight but the project manager is still left with freedom to interact with the outside, the users and the markets; interactions considered crucial to innovation success.³²

I conducted open ended interviews with 14 managers in a matrix organization with a record of high success in new product innovation over

the last five years.³³ The sample was a mixture of product and project managers, their bosses, some functional bosses, the CEO and two internal consultants charged with new product innovation activities. A content analysis of the interviews identified individual characteristics as the most important category of issues related to successful innovation. This category included risk-taking propensities, technical knowledge,³⁴ and creative, committed and dedicated people. Two other categories that dominated the interviews were climate issues (atmosphere supportive of innovation, good internal communications and organized efforts to foster creativity) and external relationships (with customers, with the marketplace and with others such as government and professionals). Additional items such as autonomy for the project and a tendency for project personnel to have a short-term orientation³⁵ which worked against successful innovation were also frequently cited.

This leads to several hypothesis related to the role of product champion or project managers in the relationship between matrix organization and new product innovation:

H1A: The high rate of new product innovation in matrix organizations is directly related to the existence of product champions (project managers) whose projects are tightly coupled to the functional departments.

H1B: Matrix organizations invite higher political (risk-taking) and competitive behaviors from product champions than do either project or functional forms.

H1C: The perspective of product champions in matrix organizations will be more generalist (or broader based or diverse) than will that of their counterparts in functional forms of organization (e.g., technical innovators).

Hypothesis H1A refers to the fact that projects in a matrix are more closely coupled to the functional groups than they would tend to be under project/product organization. This is what leads to the negotiation behavior suggested in H1B. Hypothesis H1C refers to the "mini-general manager" role of project managers; but they are not necessarily more generalist than project managers in project/product organization forms and, in fact, might be less so.

Rationalization and Innovation: The Benefits of Matrix Organization

Functional organization offers efficiency, scale economies and high technical performance. Project organization offers high marketplace responsiveness and excellent coordinating characteristics. Matrix organization designs allow project or product or business area units to gain the economies of scale or rationalization of the functional side of the organization while still maintaining the autonomy, organic characteristics and coordinating capacity to manage innovative activities successfully within the boundaries of the larger organizations.

The ability to draw upon the functional skills of the rest of the organization increases the probability of success for the product because:

- (1) the unit has access to but is not forced to utilize all of a set of

well-honed skills; (2) the diverse skills, if properly coordinated, can bring creative problem-solving perspectives to product problems;³⁶ (3) the link back to the functional organizations via product unit members increases the probability of successful cooperation from the different functional units, linkages considered important to successful innovation.³⁷

Many studies have pointed to the importance of organic organization to successful innovation.³⁸ The structure of the small, semi-autonomous project or product or business area tends to be organic both in structure and in behavior. This is in part because it is small and in part because good communication depends upon the unique input of each member such that authority is knowledge-based rather than position-based. It also comes about because most unit members are two-boss persons over whom authority is shared and whose cooperation must be solicited rather than decreed.

Apart from organic organization of the product or project, autonomy for the unit is also considered a characteristic of successful innovation.³⁹ Project or product groups are usually given total task responsibility and budgeting authority that allows them to buy resources inside the organization or outside of it.⁴⁰ This control over resources is one of the most powerful levers an organizational unit can have to ensure itself freedom and autonomy within the larger organizational framework.

The literature from venture management research also supports the importance of autonomy to new product/business innovation,⁴¹ and autonomy is a concept (1) built into the "product team" structure that has been so successful in generating new products and businesses for 3M⁴² and

(2) incorporated in the "product-customer centers" that have been equally successful at Texas Instruments.⁴³ It was also one of the factors cited in the above mentioned interview survey in a matrix organization.

This suggests a line of thinking akin to the suggestion Peterson made a while back with respect to new venture organization which "enjoys the best advantage of two business worlds: the incentive and independence of the small entrepreneur and the resources of dollars, experienced people and facilities found in the large corporation."⁴⁵ In contrast to new venture forms, matrix designs are called for when the degree of coupling must be tight between the project/product focus and the functional skills in the organization. This has always been the case for high technology sectors but has increasingly become so for many other sectors.⁴⁶ The increasing rate of change and complexity in organizational environments has made matrix designs attractive to many industries where new venture forms might previously have sufficed.

This discussion leads to a second set of hypothesis to account for the new product innovation - matrix organization correlation:

H2A: The high rate of successful new product innovation in matrix organizations is directly related to the autonomy of the project team and inversely related to its size and structure (i.e., directly related to its "organic" organization).

H2B: The high rate of successful new product innovation in matrix organizations is a function of the ease of access the project team has to a variety of functional skills.

Hypothesis H2A suggests that project teams will be small, autonomous and organically structured in a matrix organization. Under project organization autonomy will exist, but size will tend to be larger to self-contain necessary resources, and structure, while flat, will not be as low as in matrix because the essence of project organization is control.⁴⁷

Matrix is differentiated from project organization in hypothesis H2B by the way the matrix project teams maintain access to the functional departments through tightly coupled two-boss managers. Project and product organization would tend to have more control over functional representatives.

Summary

There are different stages to the new product innovation process and at the different stages different organizational forms serve the process best. Functional forms are best for developing creative but generalized excellence in specialist or technical areas and for advancing and maintaining the state-of-the-art in particular specialist activities. Project or product forms are best at providing a specific focus and direction. They are also effective in securing close cross-functional coordination and a good fit with the external customer environment. There is increasing evidence that at the stages involved with the successful development of new products within the organization itself, matrix organization serves best.

Two sets of concepts are advanced to explain why this relationship between matrix and new product innovation exists. One refers to the characteristics of the product champion as an individual operating in a

complex, tightly coupled network. The other set of concepts is structural and deals with the project/product team's ability to maintain autonomy and small size while still retaining access to the efficient functional resources of the organization.

Table 1

Major Organizational Factors in New Product Innovation

Communications, Collaboration and Information Flows⁵

Good Communication Linkages

- between team members (interpersonal processes)
- across functional units, particularly R&D and marketing
- between innovative phases
- between innovators and users and other outside sources
- across group boundaries
- between inventors and project groups
- between strategy and R&D/technology profile

Information Flows

- about market characteristics
- coordinated by technological gatekeepers

Management Style and Organizational Climate⁶

- organic management to encourage adoption
- innovation depends on risk attitudes
- mutual trust
- innovation catalyst
- top management receptive to new ideas
- encourage technical experimentation
- senior individuals responsible for innovation.

Organizational Structure⁷

- project vs. functional vs. matrix tradeoffs
- degree of project leader authority
- excessive project team structuring related to failure
- organizational 'fit' necessary.

Other Organizational Factors⁸

- product champions
- project group autonomy
- participative decision-making
- conflict management through confrontation modes

Table 2

Strength & Weaknesses of Different Functional Forms

<u>Functional</u>	<u>Project of Product</u>	<u>Matrix</u>
	<p>STRENGTH OF THE FORM</p> <p>Clear project or task visibility through clearly designated responsibility for task and via focus on specific outcome parameters.</p> <p>Full time orientation towards task with need for high responsiveness to task problems provides a superordinate goal for team members.</p> <p>Inputs from different specialist functions can be consolidated easily.</p> <p>Different inputs from different perspectives can lead to creative solutions.</p>	<p>Project champion with strongly articulated organizational authority to cut through bureaucratic roadblocks.</p> <p>Good links with specialist group via two-boss people. Keeps functions continuously "on board" and provides source of specialist back-up.</p> <p>Administrative support for project team.</p> <p>Different inputs from different perspectives can lead to creative solutions.</p> <p>Project task provides superordinate goal for team members.</p> <p>Relatively autonomous team but able to change membership and be freed from long-term commitments.</p>
<p>Tendency to drift from task goals or specifications in favour of more interesting specialist solutions.</p> <p>Time responsiveness to needed changes is slow. Specialist values favored at expense of task.</p> <p>Conflicts over task priorities in multi-task environments.</p>	<p>WEAKNESS OF THE FORM</p> <p>Solutions restricted to specific task needs, often at the expense of more generalized responses that would benefit organization long-term.</p> <p>Conflicts over resources shared with other task/project/product units.</p> <p>Specialists "go native" and lose competence.</p>	<p>Specialist loyalties are sometimes difficult to maintain.</p> <p>Conflict can be created by different orientations of bosses.</p> <p>Considerable time spent in coordination, meetings, etc.</p>

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34. For example, the proximity of new product activity managers to both the market for their product and the relevant technology increases the probability that they will accomplish a good "fit" between the two. This fit or linkage is considered a key characteristic of successful innovation.
35. Jermakowicz (1978), for example, suggests that new venture groups be superimposed over matrix product or project groups because the latter are not too innovative. Given a specific task to perform (business area, technology, product or project) the managers of the activity will tend to subordinate any other activities to the one assigned and won't be creative in areas other than the specifically assigned ones.
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