The R&D/Marketing Interface: Results from an Empirical Study of Innovation Projects

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Abstract—This paper explores the effect of organizational factors which characterize the interface between marketing and R&D, with respect to the innovation process. The basic premise is that the degree of collaboration/integration between functional units, such as marketing and R&D, has a profound influence on the success/failure outcome of innovation projects in industrial settings. Several important variables which influence the quality of the R&D/marketing interface are defined. These variables are related in an overall model which identifies several actions managers can take to improve the quality of the interface.

I. SOME ISSUES CONCERNING INTERUNIT CONFLICT AND INTEGRATION

THE PROBLEM of collaboration between functionally differentiated groups, such as marketing and R&D, is important because the chances of conflict are generally prevalent in their relationship. A review of the pertinent literature [1]-[7] indicated that the factors which cause conflict among organizational subunits are: mutual task dependency, task-related asymmetry, differences in criteria for reward, functional specialization, dependence on common resources, and ambiguities in role descriptions and expectations for these units. In the case of R&D and marketing groups involved in innovation projects, many of these conditions are present and, consequently, contribute towards the increased likelihood of conflict.

Reciprocal actions of various groups are necessary for achievement of the common organizational goal. Organizational realities also dictate the presence of a better relationship between organizational subunits. Under such circumstances, the integration between the functionally separated groups becomes a necessity. Organizational integration has been defined as: "the symbiotic interrelating of two or more entities which results in the production of net benefits to them which exceed the sum of the net benefits they would produce in a nonsymbiotic relationship" [5]-[7]. A wide variety of mechanisms are in use for achieving integration between these functional units [8]. We focused on the sequences of activities, decisions, events, and behaviors that take place between marketing and R&D in our study. This paper reports some of our results regarding the effect of integration on project outcomes.

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II. PROPOSITIONS FOR EXPLORATION

The 1959-1976 literature related to the topics of R&D and marketing management were surveyed[1] and 74 propositional models and 500 proposition-like statements were extracted. They provided the basis for exploring the support for some key propositions. The following is a list of these key propositions which were found relevant for this study.

Proposition 1A: The degree of R&D/marketing integration is directly related to the degree of success of the project [9]-[16].

Proposition 1B: The effectiveness of information transfer and the clarity of understanding of the problem and the user's needs directly relates to the degree of success of the project [16]-[21].

Proposition 2: Effectiveness of integration is directly related to the degree of legitimization of the integrator role and the presence of joint reward systems [12]-[24]. That is, effectiveness increases (decreases) as the degree of legitimization increases (decreases).

Proposition 3: The degree of conflict between R&D and marketing relates to the presence of technical and marketing uncertainty [25]-[26].

Proposition 4: The degree of integration required is related to the degree of uncertainty which is present [22].

III. METHODOLOGY

A. Selection of Sample Firms

Selection of the sample firms for this field study was guided by the objective of obtaining a diverse group of companies. Six characteristics of each firm were considered:

1) type of market served—e.g., industrial versus consumer;
2) centralization of R&D structure;
3) company size—employees, sales volume;
4) size of R&D budget;
5) product obsolescence rate;
6) presence of new product functions.

B. Selection of Sample Projects

Once we gained access to a particular field site and were assured about its participation in our study by the top management, we prepared a stratified sample of projects from each field site. The dimensions for stratification of the projects are size, initial indication about level of integration problems, and potential or actual degree of project commercial and technical success outcomes.

[1] See Chapter 4 of Souder *et al.* [1] for a detailed description of the sampling process followed in the study.

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TABLE I
NATURE OF INTERACTION/CONFLICT DATA AND CORRESPONDING SOURCES

Nature of Data	Respondent Sources
Department structure, outlook, styles; environmental uncertainty, state-of-art, dependency; interaction patterns, conflict handling mechanisms	Dir. of R&D and Dir. of Mktg.
Behavior of the integrator: his position, role, responsibilities, activities in general and on the selected project (s)	Integrator Person
Conflict and conflict resolution	R&D/Marketing Dyads and Informants
Box scores and confirmations of data	Middle Mgt. and Informants

TABLE II
DISTRIBUTION OF SITES BY TECHNOLOGY AND R&D STRUCTURE

Type of R&D Structure	Level of Technology: Well Developed	Level of Technology: Undeveloped	Total
Centralized	8	4	12
Divisional	5	1	6
Total	13	5	18

TABLE III
DISTRIBUTION OF SITES BY R&D SIZE AND SALES VOLUME

Annual Sales Volume	Size of Annual R&D Budget: Very Large > $50M	Large $26M-$50M	Medium $11M-$25M	Small < $1M	Total
Large (> $3B)	2				2
Medium ($1B-$3B)		4	1	3	8
Small (< $1B)			1	7	8
Total	2	4	2	10	18

TABLE IV
DEGREE OF TECHNICAL SUCCESS SCORING SCALE

Score		Scale Descriptors
4	=	High success technically. It met its technical objectives completely or exceeded its technical objectives. Comments like: a real model of how to do a project; it turned out very well technically; it was a tough problem but we (they) solved it; it was a very difficult problem but the technical goals were met; we have run into no technical surprises since the R&D work was finished. High technical rating on Q-sort and informants ratings.
3	=	Moderate success technically. Moderate (medium) rating on Q-sort or informant's rating. Project completed without undue errors or delays due to technical oversight or failure to resolve technical problems. Comments like: there were some minor problems but they were solved or worked out; no real technical hangups; but some loose ends were left; project succeeded but could have been done better, cheaper, faster, more elegantly.
2	=	Low success technically. Low rating on Q-sort or informant's ratings. Comments like: poor job technically; we couldn't do anything with the results; wasn't worth pursuing; most or some of the important technical problems not solved; our solution much worse than our competitors' or other people's.
1	=	Complete failure technically. Comments like: had to be scrapped because we couldn't solve the problems, make the product, get the quality or yield or cost, meet the specifications, or get the things together; there was nothing to salvage from it for application; it was a complete disaster, a bomb, a turkey.

C. Field Interview Process

Field data were obtained primarily through face-to-face interviews using semistructured interview protocols. The important aspect of our data collection process was the use of a cascading interview approach. Several people from different functional groups—R&D, marketing, and top management—were interviewed to track the congruency of perceptions and validity of the information. The cascading occurred through the organizational hierarchy involving the following types of subjects: 1) primary subjects: upper level personnel who had an overall view of events; 2) key project personnel: people who had responsibility for the projects; and 3) informants: knowledgeable people who could provide background information. Table I provides some details about the nature of the data and the respondents.

IV. DATA ANALYSES

A. Description of Sample

We had eighteen field sites in our study. Table II describes the distribution of these sites by the level of technology and the level of centralization of the R&D function. Table III provides the distribution of these sites according to sales volume and size of R&D budget. Three sites had products with rapid obsolescence rates and eight sites had slow rates of product obsolescence; the remaining seven were experiencing product obsolescence at a moderate level. The sample included firms in the basic consumer products, bulk industrial products, and industrial components fields. From these sites, we selected 117 projects, 49 of which were commercially successful and 68 of which were commercial failures. Of these 117 projects, 41 were large sized and 76 were small sized [1]. The analysis of 114 projects is reported here because sufficient information was not available to complete the statistical analysis for the other three projects.

B. Data Reduction Process and Variables Scoring System

A codebook was developed for content analyzing the interview protocols. This codebook was used to score each project in our sample on every variable in the main propositions. An example of one of the scoring scales from the codebook is shown in Table IV. This scoring scale is for the variable "degree of technical success," which was a dependent variable in several of the propositions.

The project-level as well as the site-level data were content analyzed according to the codebook to obtain the scores on the variables. Both of the authors were involved in the scoring process to achieve intercoder reliability. The site-level data included the following dimensions:

external environment,
internal climate and organizational potency,
organization structure,
project funding processes,
marketing/R&D interface processes,
market entry processes.

The other part of the data reduction focused on the project-level data. Life histories were examined for relevant statements, box scores, integration problems, etc. For each project, data were assembled according to the following dimensions:

impetus for the project,
origin of ideas related to the project,
integration mechanisms used,
project outcomes,
success/failures.

V. RESULTS

For testing Proposition 1A, two dependent variables were used: the degree of commercial success of the project and the degree of technical success of the project. The results for the test of this proposition are shown in Table V.

Four different independent variables were used to operationalize this proposition, as shown in Table V. The variable "effectiveness of integration between R&D and marketing" listed last in Table V was measured on a four-point scale. The descriptors for this scale ran from: 4 = "we really pulled together, etc.," to 1 = "we didn't pull together at all, etc." The results for the four variables listed in Table V show that Proposition 1A is supported. Note that the proposition is supported for *both* a technical and commercial project degree of success. That is, a high degree of R&D/marketing interaction, participation in problem definition, and integration all relate to *both* commercial *and* technical success. (Low degrees of these attributes relate to commercial and technical failure.) We were at first somewhat surprised to find that "good" R&D/marketing relationships aided the *technical success* of the projects. But our results for Proposition 1B below explained that.

The results for Proposition 1B are presented in Table VI. The proposition was tested using three independent variables: the clarity of understanding of the problem and of the user's needs, and the completeness of the information exchanged between R&D and marketing. This latter variable was measured by scale descriptors such as: "we played it close to the vest," "they (we) were very secretive," "they closeted themselves," etc.

Table VI shows that all three independent variables are significantly related to *both* the commercial and technical degree of success of the project. That is, a clear definition of the problem and the users needs, and complete information exchange between R&D and marketing, aids *both* the commercial and technical success of projects. (And vice versa: an absence of clear definitions and understandings and the presence of incomplete information inhibits project success.) These results are about what one might expect. Well-defined commercial and technical targets, to which both R&D and marketing agree, would be expected to facilitate achievements. These results also explain the above findings for Proposition 1A, where it was found that R&D/marketing integration also aids *technical* success. It would be expected that integration would lead to a greater sharing of information and understanding of the technical objectives, and the means for achieving them. This seems to be the case. The independent variables tested in Propositions 1A and 1B were found to be statistically significantly related.

TABLE V
RESULTS FOR PROPOSTION 1A

Independent Variables	Dependent Variables: Degree of Commercial Success		Degree of Technical Success	
	Kendall Tau	Statistical Significance Level	Kendall Tau	Statistical Significance Level
Degree of R&D Marketing Interaction	.381	.001	.288	.001
Degree of Participation in Problem Definition by R&D	.273	.001	.263	.001
Degree of Participation in Problem Definition by Marketing	.204	.006	.145	.034
Effectiveness of Integration Between R&D and Marketing	.427	.001	.325	.001

TABLE VI
RESULTS FOR PROPOSITION 1B

Independent Variables	Dependent Variables: Degree of Commercial Success		Degree of Technical Success	
	Kendall Tau	Statistical Significance Level	Kendall Tau	Statistical Significance Level
Clarity of Problem Definition	.546	.001	.514	.001
Clarity of Understanding of User Needs	.599	.001	.483	.001
Completeness of Information Exchanged	.604	.001	.443	.001

A major question in the minds of most managers is: how can I achieve integration? We found two variables that managers control which significantly influence the effectiveness of integration. These are: 1) the degree of formal legitimization of the integrator person; and 2) the degree of use of joint reward systems. In the most effectively integrated cases we examined, there was a formally appointed "integrator" individual (project manager). This person was appointed and legitimized by top management as the one person who was responsible for linking R&D and marketing, and for the ultimate success of the project. The effectiveness of integration diminished as the formal authority of the integrator declined. For the 114 projects studied here, we found the degree of legitimization of the integrator to be statistically significantly related to the effectiveness of the integration between R&D and marketing as shown in Table VII.

Another action that management can take to reinforce integration is to use joint reward systems in which R&D and marketing share equally in the rewards from a successful effort. In most effective cases of integration we examined,

TABLE VII
RELATIONSHIP BETWEEN LEGITIMIZATION OF INTEGRATOR ROLE AND EFFECTIVENESS OF INTEGRATION BETWEEN R&D AND MARKETING

Legitimization of integrator role		Effectiveness of Integration: Low	Effectiveness of Integration: High*	Total
Low	No Integrator	32	9	41
	Integrator role performed due to feeling to personal responsibility	4	2	6
	Informal authority as information gate keeper	26	19	45
	Formal authority of the integrator	4	9	13
High	Formally appointed as an integrator	1	8	9
	TOTAL	67	47	114

$x^2 = 19.077$ $p \leq .011$

*The data on this variable has been recategorized in dichotomous groups to reduce the degrees of freedom.

both R&D and marketing felt jointly responsible for the project. The parties felt that the company valued cooperation and collaboration between R&D and marketing. They saw many signals coming from top management that testified to this. For the 114 projects examined here, we found that the degree of use of joint reward systems and the effectiveness of integration were statistically significantly related (Kendall Tau = 0.596; $p \leqslant 0.001$). Thus Proposition 2 was strongly supported by our data. Management can promote integration by two actions: 1) carefully legitimizing the integrator's role, and 2) setting up joint reward systems.

For testing Proposition 3, technical uncertainty was measured in terms of the state-of-the-art uncertainty and the storehouse of knowledge available to solve the technical problem at hand. Marketing uncertainty was measured in terms of the degree to which product specifications were fully defined and competitive and customer behaviors were known. The proposition was supported by our data. Technical uncertainty and marketing uncertainty were both statistically related to the degree of interdepartmental conflict (Kendall Tau = 0.276, $p \leqslant 0.001$, for technical uncertainty; Kendall Tau = 0.442, $p \leqslant 0.001$, for marketing uncertainty).

For testing Proposition 4, Kendall Tau's were calculated between the dependent variable "level of required integration" and several independent variables. The dependent variable "level of required integration" was measured as the mean of three dimensions: the degree to which specialized information had to be synthesized, the degree to which decisions were nonprogrammable, and the degree to which joint R&D/marketing efforts were needed on the project. The independent variables were the same ones used in Proposition 1B and Proposition 3 above (technical, marketing, and information uncertainty). The proposition was supported—all the Tau's were statistically significant. Thus the results for this proposition indicate that the greater the uncertainty, the greater is the need for integration.

It is interesting to note that we tried one other independent variable here: the "environmental uncertainty." This variable was measured as the mean of three dimensions. These three were: the regulatory uncertainty (the level of confidence that the company could successfully accommodate regulations that might appear), the competitive uncertainty (the level of confidence that the company could protect itself from any competitive threat), and the historical uncertainty (the level of confidence that the company could accommodate to emergent changes in technologies). The Kendall Tau value for "environmental uncertainty" versus "level of required integration" was 0.256 ($p < 0.01$).

TABLE VIII
"FIT" VARIABLES VERSUS PROJECT OUTCOMES

Independent Variables	Dependent Variables: Degree of Commercial Success: Kendall Tau	Degree of Commercial Success: Statistical Significance Level	Degree of Technical Success: Kendall Tau	Degree of Technical Success: Statistical Significance Level
Level of Fit Between the Technology and the Firm's Business	.314	.001	.286	.001
Specificity of Relationship Between the Technology and Some Existing Problem	.407	.001	.375	.001

A. Some Other Significant Variables

Table VIII presents some results which indicate that it is important for the project to "fit" the company, and for the technology to "fit" the problem, if the project is to succeed [27]. We found several cases where the idea for the project did not "fit" the firm's usual line of business. In all cases, these projects failed commercially [28]. We also found several cases where the technology did not fit any particular problem or market opportunity, e.g., R&D developed a technology for which there was no current need. These projects also failed commercially.

B. Some Nonsignificant Variables

There were several variables which were not directly significantly related to the degree of commercial success of the project. These results thus suggest the following conclusions.

1) R&D capability is not the limiting factor.

2) What competition may do (or does) is not the primary impetus for innovation. Other factors are also important. For instance, we observed that there were two other important impetuses: the desire to enter new markets, and the desire to expand one's own proprietary product lines.

3) Technological opportunities are also not the most important impetus to innovation. These results for variables 2 and 3 are at variance with the findings in some other studies [27], [29].

4) R&D does not need to be represented in the firm's long-range planning in order to achieve success in innovating. This result is at variance with the conventional wisdoms. Perhaps one reason why R&D's representation is unimportant is that many long-range planning activities do not seem to be highly effective.

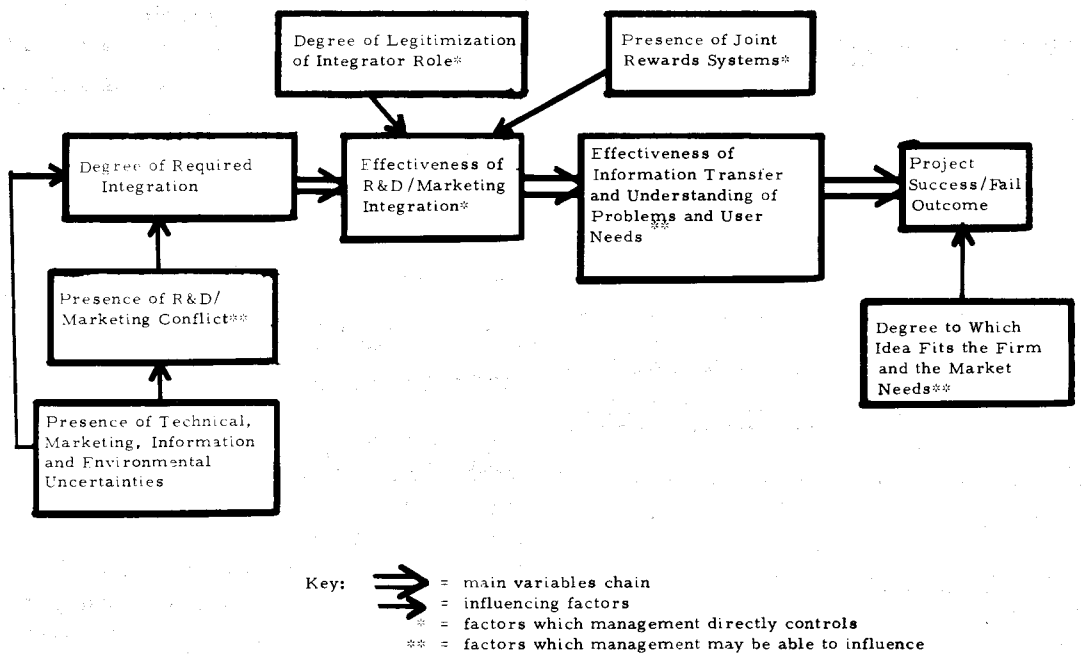

Fig. 1. Summary model of significant relationships found.

5) Projects do not necessarily fail or succeed because of the presence or absence of environmental uncertainty, e.g., regulatory, competitive, and historical uncertainties do not seem to directly "cause" project failures.

VI. SUMMARY AND CONCLUSIONS

This paper has presented data on the influence of the quality of integration between R&D and marketing on the success of innovation projects in industrial settings. The quality of integration was found to relate to the success of the project. It was argued here that the integration between functionally differentiated organizational subgroups can be achieved by deliberate mechanisms. However, it was also recognized that various other organizational, economic, and legal factors are important in explaining project success.

Fig. 1 summarizes the variables chain which has here been found to be statistically significant. This model must be viewed as an exploratory one—to be further tested and validated.

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A Practical Tool for Improved Resource Allocation: the Dynamic Time Now Procedure

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***Abstract*—This paper concerns the resource allocation problem in project management. Besides a review of the literature, a new heuristic method, the Dynamic Time Now Procedure, is presented. Unlike the classical heuristics, it appears to be less affected by the network and resource characteristics of the project. This yields significant project duration reduction, especially on projects with a heterogeneous network structure, as they generally are in practice. The proposed method has been used for a real-life project, the results of which are commented upon.**

I. INTRODUCTION

THIS PAPER presents a new heuristic method for the resource allocation problem in project management. The proposed method has been used for a real-life project which is presented later.

A project consists of a set of activities with a number of precedence or time relationships. Examples are shipbuildings, research and development projects, emergency operations, plant and building construction, energy supply stations, etc. There are generally three classes of problems in project management: 1) the basic-time problem, 2) the budget plan and cost control problem, and 3) the resource allocation problem.

The objective of the basic-time problem is to determine the detailed schedule of activities, on the basis of precedence relations, in order to minimize total project duration. In the budget plan and cost control problem, one tries to find the schedule with the least total cost.

We are concerned with *resource allocation* where the problem is to determine the minimum project duration schedule under limited resources and precedence constraints. Solution methods for resource allocation are classified as either optimal or heuristic. A heuristic procedure provides a "good" feasible schedule, i.e., one which is only an approximation of the optimal solution.

Several comparative studies [3], [10], [11] indicate that network and resource characteristics often interact with the heuristic method in contributing to good or bad performance. This paper presents a new heuristic method, called the *Dynamic Time Now Procedure* (DTN), which appears to be less affected by the problem characteristics. Besides a review of resource allocation literature, computer tests and real-life application in a construction company are commented on.

II. REVIEW OF RESOURCE ALLOCATION METHODS

Solution methods are classified either as optimal or as heuristic. Wiest [15] and Fisher [5]–among others–presented optimal solution techniques, based upon integer linear programming, while Davis and Heidorn [2], Johnson [6], Van Wassenhove and Gelders [14], etc., used branch and bound methods. Usually, the problem is treated as an extension of the job shop scheduling problem, but the precedence relations and the general capacity constraints make the problem harder to solve. Computer time is then the critical factor. Optimal methods also fail in modeling complex real-life situations.

Heuristic methods, on the other hand, provide feasible schedules (with respect to the resource and precedence constraints) but only yield a "good" approximation to the minimum total project duration. The main solution technique in heuristic resource allocation, called the *Time Now Procedure,* is a simulation procedure where time is iteratively increased (Fig. 1). At each time T, available resources are allocated to activities from the active list A, consisting of all activities satis-

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