

Context and Antecedents of Information Utility at the R&D/Marketing Interface

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The objective of the present study was to develop a comprehensive empirically-based model of the communication interface between R&D and marketing. Following Moenaert and Souder (1990), a causal model of the antecedents of information utility at the R&D/marketing-interface was postulated. A non-experimental critical incident method was used to test the model. The field survey involved 386 team members of 80 new product innovation teams in 40 companies. Path analysis was used to test the causal model. Support for several aspects of the model were found. First, the relevance and the credibility of the message had strong effects on the perception of information utility. The comprehensibility of the message had a moderate effect on the perception of information utility, whereas novelty had a small effect. Second, the quality of the relationship, the seniority and the prior experience of the message source, and the type of communication channel used had significant effects on the perception of the message. The implications of the research results for managers and researchers are detailed.
(*Project Management; Cross-functional Communication; Information Use*)

1. Introduction

Following the classic studies by Pelz and Andrews (1966), Allen (1985) and Roosenbloom and Wolek (1970), numerous empirical inquiries into the nature of communication processes within innovation contexts have been undertaken. Several studies have investigated the occurrence and effects of boundary spanning roles on innovation team performance, the impact of organizational context and structure on communication networks, and the use of communication channels and sources in innovation projects (e.g., see Tushman 1977, Allen et al. 1980, Gerstenfeld and Berger 1980, Katz 1982, Nilakanta and Scamell 1990). In addition, empirical inquiries on the antecedents of new product development performance have shown that the quality of cross-functional communication correlates positively with innovation success (e.g., see Rothwell et al. 1974, Cooper 1979, Zirger and Maidique 1990). Integration at the R&D/marketing interface appears to be especially important to innovation success (Gupta et al. 1986, Souder 1987).

Thus, insights into the factors that determine cross-functional or "extra-functional" information transfer and consumption may be very important in understanding innovation success. However, it is only very recently that theoretical analyses (Moenaert and Souder 1990) and empirical inquiries (Gupta and Wilemon 1988a, 1988b; Griffin and Hauser 1992) have explored the issue of information use at the individual level. The research question of this paper is: *assuming that cross-functional communication between R&D and marketing contributes to the commercial success of a technological product innovation project, what are the elements that influence the perception of utility of received extrafunctional information at the individual level?* The objective of the present study was to develop a more comprehensive empirically-based model of the communication interface between R&D and marketing. A better insight into the information styles of R&D and marketing personnel, i.e., in their tendency to behave in certain patterns in relation to information use (Rubenstein et al. 1970), is a research

question that is pertinent to R&D/marketing integration as a factor in the success of industrial innovation (Gupta and Wilemon 1988a, 1988b; Griffin and Hauser 1992; Moenaert and Souder 1990).

The paper is structured as follows. First, following Moenaert and Souder (1990), a causal model of the antecedents of information utility at the R&D/marketing-interface is postulated. In the second section, we review the nonexperimental critical incident method and the measurement instruments that were designed to test the model. The third section comments on the empirical findings of the study. Using path analysis, we have investigated the antecedents of information utility at the R&D/marketing interface. Support for several aspects of the model were found. The implications of these results for managers and researchers are detailed in the fourth section.

2. The Antecedents of Information Utility: Theoretical Model

Organizations may be defined as information processing systems (Tushman and Nadler 1978, Daft and Weick 1984). Information is verbally encoded knowledge. Such knowledge may refer to facts, truths, principles, experience based insights, exemplary practices and empirical results (Glaser et al. 1983). Communication, i.e., the interpersonal transfer of information, has been proposed as the "lifeblood of an organization" that links the different members in the organization (Rogers and Agarwala-Rogers 1976, p. 7).

Innovation teams have been viewed as information processing subsystems (Allen 1985, Clark and Fujimoto 1991). Technological innovation requires the organization to invest human resources in the development of new products. Each person involved in a new product project fulfills a functional role (Souder 1987). A role is the "expected behavior patterns attributed to a particular position in an organization" (Gibson et al. 1988, p. 292). From an information processing point of view, the role accomplished by innovation team members may be defined as information processing behaviors.

However, it is not because information is transferred among team members, that it will be used by the receiver. While this issue has not often been addressed in the innovation field, it has received considerable atten-

tion in the MIS literature (Zmud 1978, Larcker and Lessig 1980, Bailey and Pearson 1983, Ives et al. 1983, Baroudi and Orlikowsky 1988). The MIS-studies on the antecedents of information utilization indicate that the utility of received information is determined by many elements that are related to one of the four components of the source-channel-message-receiver model of interpersonal communication (hereafter referred to as the SCMR-model). The SCMR-model portrays communication as the transfer of a message through a channel from a source to one or more receivers (Berlo 1960, Rogers and Agarwala-Rogers 1976).

The extant empirical studies on the subject of information use suggest that individuals assess information on the basis of the following three dimensions (Schuler and Blank 1976, Larcker and Lessig 1980, Bailey and Pearson 1983, Ives et al. 1983, O'Reilly 1982, Wilton and Myers 1986, Baroudi and Orlikowsky 1988, Gupta and Wilemon 1988b). The *relevance* of information refers to the extent to which the information is perceived to be appropriate to the user's task or application. The *novelty* of information refers to the number of new insights perceived by the receiver in an information stimulus (Wilton and Myers 1986). The information's *credibility* relates to the degree to which the receiver of the information believes the information to be undistorted (Thayer 1968).

With the exception of the abovementioned study by Gupta and Wilemon (1988b), these studies focused on the use of *intra-functional* knowledge use. However, functional systems show a natural tendency to create a technical language of their own (March and Simon 1958, Weick 1969). While the development of a function-specific language facilitates *intra-functional* communication, it may hinder *interfunctional* communication (Lawrence and Lorsch 1967). Based on the results from an exploratory study (Moenaert and Souder 1990), we expect the perceived utility of information to be positively related to the comprehensibility of the received information. The *comprehensibility* of information concerns the ease with which the receiver of the information can decode and understand the information (Thayer 1968).

These four information dimensions constitute a parsimonious description of the message-component of Berlo's linear communication model (Moenaert and

Souder 1990). Within innovation teams, novelty, relevance, credibility and comprehensibility of information may be necessary prerequisites for information to be judged useful. Hence:

PROPOSITION 1. *The perceived utility of information received from another function relates positively to the receiver's perception of the relevance, novelty, credibility and comprehensibility of that information.*

These four information dimensions are expected to mediate the effects of the type of communication channel used and the characteristics of the source/receiver interaction (Moenaert and Souder 1990). For example, written extra-functional information may be perceived as less comprehensible than oral information. While the majority of the communication studies suggest that "comprehension is greater when information is transmitted in written form" (Porter and Roberts 1983, p. 1563), recent exploratory research on the R&D/marketing communication interface suggests the contrary (Moenaert and Souder 1990). The receiver of extra-functional information must be able to decode function-specific language. Thus, effective communication between source and receiver may require an interactive communication process in order to clear jargon-related equivocalities. Furthermore, a large part of the information exchanged in innovation processes concerns tacit information (Dougherty 1992). The effective transfer of such information relies to a large extent on the use of "rich" information channels, such as face-to-face conversations and group meetings (Fidler and Johnson 1984, Daft and Lengel 1986). As oral communication allows for immediate feedback, oral channels may be important in clarifying the meaning of extrafunctional vocabularies and tacit information.

At the same time, we expect written information to be more credible than oral information. Written information obliges the source of the message to analyze the issues to be communicated more thoroughly. Oral communication may be perceived to be less rigorously substantiated by hard facts, and thus less credible than written information (Moenaert and Souder 1990). Thus, the following proposition is formulated:

PROPOSITION 2. *Interpersonal media (e.g., face-to-face contacts, meetings, telephone conversations) are perceived by*

the receiver as having higher comprehensibility and lower credibility than written media (e.g., reports and electronic mail).

Empirical studies have shown repeatedly that the quality of the relationship between information source and receiver will influence the effectiveness of interpersonal communication (Roberts and O'Reilly 1974; Deshpande and Zaltman 1984; Moorman, Zaltman and Deshpande 1992). For instance, Roberts and O'Reilly (1974) found a strong positive relation between interpersonal trust and the perceived accuracy of received information.

The quality of the relationship between information source and receiver, i.e., the degree of interest, enthusiasm, support and participation between these persons, may be expected to influence the effectiveness of the communication at the R&D/marketing interface. Innovation involves change which may disrupt the established personal task routines (Souder 1987). In the absence of a good working relationship among team members, we may expect them to be reluctant to use extra-functional information. One interviewee in the study by Moenaert and Souder (1990) observed the following: "From certain persons, I read every little detail. There are also persons whose reports are immediately vertically classified [meaning condemned to the wastebasket] . . . Some people just dance around, are constantly preoccupied with the same matters and pet ideas. They give you very polarized information" (p. 221). The better the quality of this relationship, the more credible and the more comprehensible received information will be perceived to be (Moenaert and Souder 1990).

PROPOSITION 3. *The perceived credibility and comprehensibility of extrafunctional information relate positively to the quality of the relationship between the source and the receiver.*

Studies on marketing information use suggest that communication intensity influences the perception of received information. A study by John and Martin (1984) showed that the centralization of the marketing planning structure had "deleterious effects" (p. 177) on the credibility of the plan. The study by Deshpande and Zaltman (1982) found that the degree of interaction between market research agencies and marketing man-

agers positively influenced the latter's perception of the content and the form quality of the received information, the ability to implement the recommendations and their political acceptability.

Communication intensity between the source and the receiver may be expected to be positively related to the receiver's perception of the credibility and comprehensibility of extra-functional information. First, frequent interactions may help to overcome some of the technical communication barriers that may exist because of differences in function-specific languages. Second, since people prefer enduring support over temporary support (Weick 1969), intensive interactions between two or more persons may help to improve the credibility of received information (Gupta and Wilemon 1988b). Thus, we postulate the following:

PROPOSITION 4. *The perceived credibility and comprehensibility of extrafunctional information relate positively to the frequency of past interactions between the source and the receiver.*

Allen (1985, p. 43) observed that "the best way to transfer technical information is to move a human carrier." It has been suggested that manpower flows between the R&D and marketing function may help to improve the communication interface between these two functions (Moenaert and Souder 1990). This may be explained on the basis of source-receiver homophily. Homophily may be defined as "the degree to which pairs of individuals who interact are similar in certain attributes, such as beliefs, education, social status, and the like" (Rogers 1983, p. 274). The greater the similarities between source and receiver, the easier the transfer of information between these two persons (Rogers 1983), and the greater the influence of the information source over the information receiver (Berscheid 1966). The message receiver may be expected to be positively predisposed toward information that arises from somebody that belongs to the so-called "old-boy network," i.e., has worked in his/her own function before. During that previous period, these persons had the opportunity to communicate more frequently, hence sharing technical vocabularies and task routines, as well as building interpersonal trust. Hence, the following proposition is deduced:

PROPOSITION 5. *The perceived credibility and comprehensibility of extrafunctional information relate positively to the experience similarity of source and receiver, i.e., to the prior functional experience of the source in the function of the receiver.*

Empirical research has emphasized the role of senior project personnel. For instance, it has been found that successful project managers have accumulated a diversity of skills and experiences through several innovation projects (Souder 1987, Clark and Fujimoto 1991). Especially during the 'fuzzy front-end,' critical experiential information is often perceived to reside with the more senior project members. All too often, however, senior management is not involved with new product development efforts (Roussel et al. 1991; Dougherty 1992).

According to the theoretical review by Gupta et al. (1986), senior management may influence R&D/marketing integration through the encouragement of risk taking, the stipulation of joint reward systems, and the signaling of R&D/marketing integration needs. In addition, we expect senior project personnel to be an important source of novel information in innovation projects. Senior project personnel, through their experience gained during previous projects, may be better at spotting opportunities and making trade-offs in terms of markets opportunities, technologies, competitors' strategies and resource constraints (Souder and Moenaert 1992). Hence, the following proposition is suggested:

PROPOSITION 6. *The perceived novelty of received extrafunctional information relates positively to the relative seniority of the source of the information.*

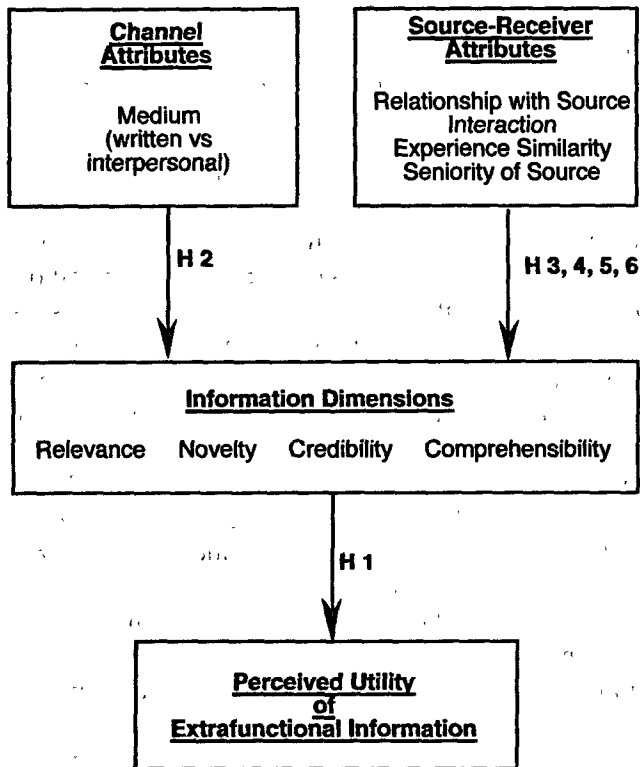
The above hypotheses are summarized in Figure 1.

3. Research Method

3.1. The Critical Incident Technique and Questionnaire

A nonexperimental critical incident technique (Flanagan 1954) was used to collect data in this study, in a method analogous to the one used by Roosenbloom and Wolek (1970). However, instead of asking the critical incident "when was the last time you received information from the other party [marketing or R&D]" (Roosenbloom and Wolek 1970), the reference group was constrained

Figure 1 Theoretical Model



by asking "when was the last time you received information on this project from one of the following persons" (the names of the persons were customized per company). This approach improved the respondents' recall of their communication activities (Killworth and Bernard 1976, Bernard and Killworth 1977), and it enabled us to collect objective data on both receiver and source characteristics. Marketing and R&D members of the team were sent a similar questionnaire: R&D personnel for information they had received from marketing, and marketing personnel for information they had received from R&D. Thus, characteristics of the source of the message such as age and cross-functional experience were obtained directly from the questionnaire of the message source and added to the respondent's record (the message receiver).

3.2. The Unit of Analysis

The level of analysis in the present study concerns the individual and the unit of analysis is the communication incident between two or more persons. It must be

emphasized that the present study has not investigated innovation projects. The projects were employed to collect in situ real-life data on communication incidents within those on-going projects. We expected the internal validity of the study to be better served by asking about specific communication incidents in well-defined projects, rather than asking for a general assessment of the information flows from the other department. Thus, respondents did not respond to a project, but to the evaluation of a specific recent piece of information. In order to maximize the independence of communication incidents reported (i.e., preventing several respondents from referring to the same communication incident), the administration of the questionnaires within each company was randomized over a three week period.

3.3. Organization and Respondent Sample

Forty Belgian companies agreed to participate in this study. Earlier studies have hypothesized that information styles are contingent upon the stage of the project life-cycle (Moenaert and Souder 1990, Moenaert et al. 1992). Therefore, within each company, two ongoing innovation projects were studied: one project in its planning phase ($n = 40$), and one project in its development phase ($n = 40$). During the planning phase, the innovation team formulates and decides on a new product concept. Following the acceptance of a new product concept, the concept is then designed and engineered during the development phase (Souder and Moenaert 1992). In a deliberate sampling for heterogeneity (Cook and Campbell 1979), the firms in this sample were selected to represent a broad spectrum of industrial activities: telecommunication, industrial machinery, software engineering, electrical equipment, pharmaceuticals, plastics, metal products, professional equipment, financial institutions, paper, chemicals, and food. The companies differed also in terms of their size: from less than 20 employees to more than 10,000 (median: 1,238).

Four hundred and ten questionnaires were administered, and 386 questionnaires were returned (response rate of 94.1%). An overview of the respondent profile is given in Table 1. Eliminating incomplete questionnaires and inadequate responses reduced this sample by 84 units: 35 respondents referred to a communication incident with someone from their own department, 26 admitted they did not communicate directly with team

Table 1 Respondent Profile by Job Descriptions

Research and Development	Number	Marketing and Sales	Number
Research manager	4	General director	4
Development manager	13	Marketing director	3
R&D section supervisor	32	Commercial director	3
Project manager	35	Sales director	3
Project co-ordinator	7	Marketing manager	13
Development engineer	26	Product (group) manager	24
Software engineer	27	Supervisor section comm. dept.	14
Design engineer	16	New business manager	8
System engineer	8	Marketing service & support	6
Designer	6	Sales representative	8
Other	44	Other	52
Total	218	Total	138

Key: The total number of respondents mentioned (356) is smaller than the number of questionnaires received (386), because 30 respondents answered a questionnaire for both a planning and a development project in their firm. Some respondent job descriptions were difficult to classify, and they were placed in the 'other' category.

members from the other function, and 23 answered the questionnaire inadequately. Using listwise deletion of missing values on the message attributes ($n = 33$), and excluding multivariate outliers ($n = 6$) (Nunnally 1967; Joliffe 1986, p. 195; Tabachnik and Fidell 1983) the final sample size amounted to 263 units. This sample consisted of 144 persons working in the R&D function and 119 persons working in the marketing function. One hundred and twenty-seven respondents were working on projects in the planning phase, and 136 respondents worked on projects in the development phase.

3.4. Instrument Development

3.4.1. Measurement of Information Utility. A key variable in this research concerns the perceived utility of the received extra-functional information, i.e., the perceived overall value of information (Zmud 1978). There is little consensus on the concept of information utility. A number of measures have been offered in the literature (e.g., Zmud 1978, Deshpande and Zaltman 1982, Bailey and Pearson 1983, Ives et al. 1983, John and Martin 1984, Allen 1985). Dunn (1983) observes that any measure must include conceptual variety, e.g., composition, expected effect, and scope. Dunn further argues that attempts to measure use should be based on equally general behavioral criteria.

We formed an item pool on the "theory of the trait" (Loevinger 1957). More specifically, the review of the above-mentioned studies, and the transcripts of the interviews of an earlier study (Moenaert and Souder 1990) suggested a pool of items to construct the information utility measure. We formed the initial item pool as follows: (i) likelihood of use, (ii) satisfaction with the content of the information, (iii) satisfaction with the form and the presentation of the information. It seemed to us that this tapped the utilitarian construct "perceived utility of received information" adequately. However, on the basis of the results obtained from two small group pilot studies with 14 graduate students at an American industrial engineering school and 37 graduate students at a leading European business school, a fourth item was included in the final measure: (iv) perceived usefulness of the information. These four items reflect the requisite variety called for by Dunn (1983). The internal consistency of this measure in the final study (Cronbach $\alpha = 0.65$) is comparable to the results reported by Deshpande and Zaltman ($\alpha = 0.63$) (1982), John and Martin ($\alpha = 0.71$) (1984) and Moorman et al. ($\alpha = 0.53$) (1992).

3.4.2. Measurement of the Information Dimensions. The four information dimensions (relevance,

Adopting the 0.30 cut-off rule for interpreting factor loadings (Nunnally 1967), principal component 1 refers to the comprehensibility of the information (validity, project relatedness, understandability, completeness, synthesis, contextuality, clarity, accuracy) (see row 14, Table 2). Principal component 2 has been labelled credibility (validity, timeliness, completeness, clarity, surprise, recency, accuracy) (see row 15, Table 2). Principal component 3 refers to the novelty of the information (familiarity, surprise, recency) (see row 16, Table 2) and principal component 4 refers to the relevance of the information (project relatedness, actionability, completeness, contextuality) (see row 17, Table 2).

3.4.3. Measurement of Channel Attributes. In this study, the communication channel is measured by one questionnaire item. The respondents were asked to check one of the following communication channel options for the critical incident they selected: face-to-face conversation ($n = 75$), telephone call ($n = 26$), meeting ($n = 110$), written ($n = 41$) or electronic information system ($n = 2$). It may be noted that six of the respondents mentioned that the information had been transferred to them through multiple channels. Three respondents did not answer this question adequately.

3.4.4. Measurement of Source-Receiver Attributes
The quality of the relationship between the source and the receiver was measured by 2 semantic differential scales, that ranged from 1 (bad, dissonant) to 7 (good, harmonious). Results from the two scales were averaged to obtain a single score per respondent. The prior experience of the individual initiating the message (source) with the receiver's work or job was obtained by a direct question. The response was coded 0 if the message source had not worked in the receiver's job or function ($n = 128$), and 1 if the source had previously worked in the receiver's function ($n = 80$). In 55 cases, there was no information on the source's experience.

The two items we have used to measure a person's seniority involved i) age and ii) company experience. The correlation between these two measures was 0.75 (two-tailed $p < 0.01$). Therefore, source seniority was measured by summing the age and the company experience of the source (in years), and subtracting the age and the company experience of the receiver (also in years).

Communication frequency between source and receiver was measured by a rating scale, where 1 = almost never communicate; 2 = communicate once every three months; 3 = communicate monthly; 4 = communicate more than once a month; 5 = communicate weekly; 6 = communicate more than once a week; 7 = communicate daily.

4. Results

4.1. Path Analysis

The focus of the statistical analyses concerns the test of the *individual* propositions. Since the objective of the analysis is not to support or disprove the *full* theoretical framework, path analysis rather than LISREL is used to test the theoretical framework. Path coefficients can be estimated by ordinary least squares regression (Billings and Wroten 1978, Pedhazur 1982). This procedure holds the advantage that the parameters are estimated for each equation separately (Dillon and Goldstein 1984). Thus, in order to test the theoretical model outlined in Propositions 1-6, the following four regression equations were formulated:

Information Utility

$$\begin{aligned}
 &= \beta_{10,6} \text{ Information Relevance} \\
 &+ \beta_{10,7} \text{ Information Comprehensibility} \\
 &+ \beta_{10,8} \text{ Information Novelty} \\
 &+ \beta_{10,9} \text{ Information Credibility} \\
 &+ \epsilon_{10}.
 \end{aligned}$$

Information Comprehensibility

$$\begin{aligned}
 &= \beta_{7,1} \text{ Quality of Relation} \\
 &+ \beta_{7,2} \text{ Prior Experience of Source} \\
 &\hspace{15em} \text{in Function of Receiver} \\
 &+ \beta_{7,4} \text{ Communication Frequency} \\
 &+ \beta_{7,5} \text{ Communication Channel} \\
 &+ \epsilon_7.
 \end{aligned}$$

$$\text{Information Novelty} = \beta_{8,3} \text{ Source Seniority} + \epsilon_8.$$

Information Credibility

$$\begin{aligned}
 &= \beta_{9,1} \text{ Quality of Relation} \\
 &+ \beta_{9,2} \text{ Prior Experience of Source} \\
 &\quad \text{in Function of Receiver} \\
 &+ \beta_{9,4} \text{ Communication Frequency} \\
 &+ \beta_{9,5} \text{ Communication Channel} \\
 &+ \epsilon_9.
 \end{aligned}$$

The theoretical and statistical assumptions underlying path analysis are met. First, the theory itself is formulated as a set of linear, additive and causal relationships among the variables (Pedhazur 1982). We have routinely checked for non-linearity in the relationships and interaction effects. The scatterplots and the data analyses showed no evidence of nonlinear relationships. In addition, while an extensive analysis in search of interaction effects was conducted, very few interaction effects were actually observed. Second, two-stage least squares regression (Tait and Vessey 1989) showed no evidence of reciprocal causation among the variables. Third, the residuals of the endogenous variables do not correlate significantly with any of the preceding variables in the model (Pedhazur 1982). Fourth, while two variables are not measured on an interval scale ("prior experience of the source in the function of the receiver" and "type of communication channel used"), it has been argued that the violation of this assumption is not severe, and the use of dummy coding may be considered to be a sufficient remedy (Billings and Wroten 1978). Fifth, Table 2 shows no evidence of multicollinearity among the variables in the model (Billings and Wroten 1978).

The results of the path analysis are found in Figure 2 and Table 3. We have chosen to report the standardized β coefficients in the path analysis, since we have relied on principal component scores. In the causal modeling literature, paths with a magnitude of at least 0.05 are considered to be causally meaningful. The present analysis does not pose a problem of deciding upon meaningfulness: if the path was statistically not significant (i.e., one-tailed $p > 0.05$), its magnitude was also not substantive (i.e., $\beta < 0.05$).

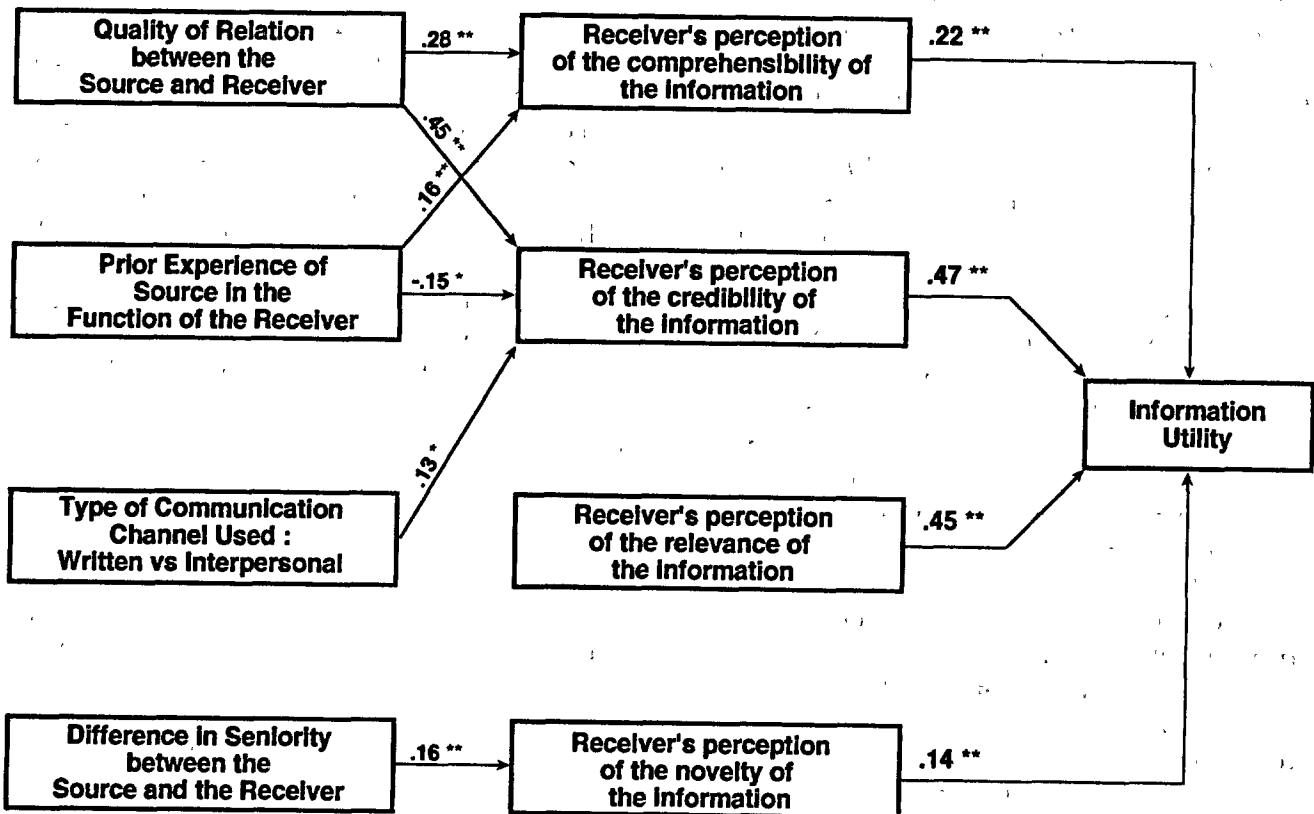
While the significant and nonsignificant findings resulting from the path analysis will be discussed in

greater detail below, a preliminary inspection of Figure 2 shows a number of particularly strong effects. Relevance ($\beta = 0.45$) and credibility ($\beta = 0.47$) have substantive effects on the perceived utility of information. The quality of the relationship between source and receiver has strong effects on the perceived comprehensibility ($\beta = 0.28$) and the perceived credibility ($\beta = 0.45$) of received information. The other paths show weaker influences. The model explains a significant amount of the variation in four variables: the perception of comprehensibility ($R^2 = 0.13$, $p < 0.01$), the perception of credibility ($R^2 = 0.23$, $p < 0.01$), the perception of novelty ($R^2 = 0.03$, $p < 0.05$), and the perceived utility of extrafunctional information ($R^2 = 0.49$, $p < 0.01$).

In the existing literature on causal modeling, one of the most often cited measures of causal soundness of the model is the degree to which the effect coefficients (direct + indirect effects) replicate the correlation coefficient (Table 3). An effect coefficient is assumed to replicate the correlation coefficient if it is within 0.05 of the magnitude of the correlation coefficient (Billings and Wroten 1978). Deletion of some residual outliers in the calculation of the path analysis, accounts for the small differences in the correlations reported in Tables 2 and 3. Also, it does not make much sense to compare the four information dimensions' total effect on information utility with their correlation with that variable. Indeed, since varimax factor scores are orthogonal, the β regression weights will equal the Pearson correlation statistic r . The comparison of the total effects and the correlation coefficient for the remaining five exogenous variables suggests that the total effects reproduce fairly well the observed correlations. The best result we have achieved concerns the reproduction of the correlation coefficient concerning the quality of relation. The data suggest that the effects of the quality of relation on information utility are mediated completely by the comprehensibility and credibility of the extra-functional information. There is only one residual between total effect and correlation that is substantial, i.e., the frequency of communication. However, this variable correlates with the quality of relation and the perceived novelty of information (see Table 2). Accounting for these unanalyzed and indirect effects, the total effect approximates the correlation coefficient.

Figure 2 Path Analysis of the Theoretical Model

Note: Figure only shows significant paths: * $p < 0.05$, ** $p < 0.01$ (one-tailed significance)



4.2. The Effects of the Information Dimensions on Perceived Utility

The path analysis supports Proposition 1. The utility of extrafunctional information relates positively to the rele-

vance, the novelty, the credibility and the comprehensibility of that information. However, the results suggest that extrafunctional information is met with considerable suspicion. The two most prominent

Table 3 Path Analysis: Direct, Indirect and Total Effects of Antecedents on Information Utility

Construct	1 Direct effect	2 Indirect effect	3 Total effect	4 Corr. coeffic.
1. Source seniority	—	0.02	0.02	-0.04
2. Source experience	—	-0.04	-0.04	-0.03
3. Quality of relation	—	0.27	0.27	0.25
4. Frequency of communic.	—	0.01	0.01	0.13
5. Communication channel	—	0.02	0.02	-0.01
6. Comprehensibility	0.22	—	0.22	0.22
7. Credibility	0.47	—	0.47	0.47
8. Novelty	0.14	—	0.14	0.14
9. Relevance	0.45	—	0.45	0.45

dimensions are the effects of information credibility ($\beta = 0.47$, one-tailed $p < 0.01$) and information relevance ($\beta = 0.45$, one-tailed $p < 0.01$). Less important, but statistically significant, are information comprehensibility ($\beta = 0.22$, one-tailed $p < 0.01$) and information novelty ($\beta = 0.14$, one-tailed $p < 0.01$). The overall model R^2 is 0.49 ($p < 0.01$).

The difference between $\beta_{\text{credibility}}$ and $\beta_{\text{relevance}}$ is not significant, nor is the difference between $\beta_{\text{comprehensibility}}$ and β_{novelty} . But the beta weights for the two most important dimensions (credibility, relevance) differ significantly (two-tailed $p < 0.01$) from the two less important dimensions (comprehensibility and novelty). Thus, the major concerns that emerge when a team member receives information from the other function are: "Can I believe the information?" (credibility) and "Is this information related to my work?" (relevance). The information's comprehensibility contributes much less in determining the perceived utility of received information. This may be an indication that project personnel are willing to invest time and efforts in understanding information, but only when the received information is perceived as being relevant and credible.

The novelty of information contributes the least to the receiver's perception of the utility of that information. This suggests a "Not-Invented-Here" syndrome (Katz and Allen 1982, 1988). Novel information carries with it a certain degree of surprise (loading = 0.44, cf. Table 2, row 16). Such information challenges existing beliefs and commitments, which has a negative impact ($r_{\text{surprise, information utility}} = -0.25$, one-tailed $p < 0.01$) on information utility (Deshpande and Zaltman 1982, Menon and Varadarajan 1992). The NIH-hypothesis is further underscored by the presence of a group polarization effect (Petty and Cacioppo 1981). For 18 communication incidents (6.8%), respondents marked on their questionnaires that they had received the information from multiple persons simultaneously (e.g., during a meeting). The results suggest that information received from multiple persons at once is considered to be significantly less credible than information received from a single person (-0.71 vs. 0.05 , Mann-Whitney U test, two-tailed $p < 0.01$).

On the basis of the above arguments, we may expect an interaction effect between the impact of the information on the course of somebody's job and the per-

ceived novelty of information (Chaiken 1980; Petty and Cacioppo 1981, 1984). More specifically, we would expect the novelty of information to contribute less to the utility of the received information the bigger the impact. The more novel high-impact information, the greater the likelihood it will adversely affect the existing task routines, and the less the receiver of the information will appreciate the information. The correlation between perceived novelty and perceived utility was significantly higher (two-tailed $p < 0.05$) for information that had a low to moderate impact than for information that had a high impact on the respondent's job ($r = 0.22$ vs. $r = -0.05$). Thus, the work situation seems to be an important moderating variable for the contribution of novelty to information utility. The larger the impact of the information on one's own work situation, the less the novelty of information will contribute to the positive assessment of received extra-functional information. Further statistical analyses showed that the impact of the information on the receiver's work had no moderating effect on any of the other three information dimensions (credibility, relevance, comprehensibility) with respect to the utility of information.

4.3. Robustness of the Findings Across Industries and Respondents

A company-contingent analysis on the importance of the four factors suggested that the dimension effects are robust across different types of organizations. Nevertheless, some differences emerged from the data. The comprehensibility of the information contributed more to perceived information utility in industrial product companies than in consumer products ($r = 0.28$ vs. $r = 0.04$; two-tailed p of observed difference < 0.10). During the feedback sessions, the participants felt this could be explained by the greater complexity of industrial products. The more complex the product, the more the comprehensibility will contribute to the perceived utility of information. Also, the size of the company seems to have an effect on information styles. The effects of comprehensibility and novelty of information on perceived utility are the largest in small companies, i.e., companies employing less than 250 employees. The participants in the feedback workshops suggested an explanation on the basis of the entrepreneurial orientation of such companies and their scarcity of resources. The

more entrepreneurial the orientation of a firm, the more opportunistic its posture will be. This may explain for the large novelty effect ($r = 0.27$, one-tailed $p < 0.05$). Also, considering their resource scarce position, information will have to be more easily digestible. This may explain for the large comprehensibility effect ($r = 0.48$, one-tailed $p < 0.01$).

It must be noted that the analyses showed no statistical evidence of an interaction between the antecedents of information and the age, the company experience (in years) or the project workload (in hours per week) of the respondents.

The theoretical model by Moenaert and Souder (1990) posited that someone's information style will depend on (i) the function to which that person belongs (R&D or marketing), and the stage in the innovation process (planning or development). The correlation analyses showed that the perceived credibility of information contributed significantly more (two-tailed $p < 0.05$) to information utility for marketing respondents reporting about R&D information received ($r = 0.55$) than for R&D respondents reporting about marketing information received ($r = 0.35$). Overall, the analyses at the subsample level showed the magnitude of the effects of the information dimensions on the perceived utility of extra-functional information at the R&D marketing interface to be consistent across these four subsamples.

4.4. Evaluation of the Information

The data suggest that innovation personnel assess the utility of extra-functional information first and foremost on the basis of its relevance and its credibility. This, however, should not lead us to believe that the respondents in our sample had a negative appreciation of the extra-functional information they received. Table 2 suggests the contrary! Since the regression factors scores of the four information dimensions are distributed $N(0, 1)$, we must rely on the original message attributes to gauge the evaluation of received information. On the 1 (low on the attribute) to 7 (high on the attribute) semantic differential scale used here, the extrafunctional information was perceived to be: valid ($\bar{x} = 5.84$), moderately familiar ($\bar{x} = 4.03$), project related ($\bar{x} = 6.53$), timely ($\bar{x} = 5.24$), actionable ($\bar{x} = 4.78$), understandable ($\bar{x} = 6.25$), complete ($\bar{x} = 4.78$), well synthesized ($\bar{x} = 5.61$), clear ($\bar{x} = 5.70$), carrying a low degree of

surprise ($\bar{x} = 2.71$), recent ($\bar{x} = 5.30$), and accurate ($\bar{x} = 4.95$). Logically then, the respondents had a positive esteem of the perceived utility of received information ($\bar{x} = 3.89$ on a 1 [low] to 5 [high] scale).

No studies were found in the literature that measured marketing and R&D perceptions of the information they receive from each other. Only one study was found that addressed the individual perceptions of R&D personnel concerning marketing information (Gupta and Wilemon 1988a). That study drew a rather gloomy picture. "The biggest problem R&D managers perceive with marketing information is that it reflects a lack of understanding of product design tradeoffs such as between price and the product features. Thus, information often appears to be contradictory (75 percent of the R&D managers agreed with this assessment) and incomplete (56 percent)" (p. 36). There are, however, some parallels between the present study and the Gupta and Wilemon study. In the present study, information coming from marketing is being perceived as significantly less timely (5.00 vs. 5.53, two-tailed $p < 0.05$), less complete (4.59 vs. 5.02, two-tailed $p < 0.05$), more surprising (2.86 vs. 2.53, two-tailed $p < 0.05$), but also more understandable (6.38 vs. 6.08, two-tailed $p < 0.05$). This may explain why the utility of extrafunctional information was perceived as being significantly lower by R&D personnel than by marketing personnel (3.80 vs. 4.00, two-tailed $p < 0.05$). Finally, only one of the differences between planning and development personnel was significant. The extra-functional information received by planning personnel was perceived as significantly less actionable than similar information received by development personnel (4.98 vs. 5.32, two-tailed $p < 0.05$).

4.5. Communication Channel Effects

Proposition 2 is not supported by the data. Written channels are seen as significantly more comprehensible than interpersonal channels ($\beta = 0.13$, one-tailed $p < 0.05$). However, interpersonal channels are not considered to be significantly less credible ($\beta = -0.01$). While this finding on comprehensibility contradicts earlier exploratory research (Moenaert and Souder 1990), it is consistent with other studies that found written information to be more comprehensible than oral communication (Porter and Roberts 1983, p. 1563).

The most important means for information transfers between R&D and marketing were interpersonal

conversations (face-to-face and telephone conversations) and meetings (Table 4). Written communication or electronic mail was less frequently used. Table 4 also indicates that R&D and marketing personnel report similar communication strategies ($\chi^2 = 2.79$; ns). Channel usage was also independent of the phase of the project ($\chi^2 = 4.7$, ns). Observe also the important role that meetings occupy in the interfunctional communication flows between the R&D and marketing functions.

4.6. Source-Receiver Interaction

Proposition 3 is supported by the data. The effect of the quality of the relationship on the receiver's perception of information credibility and comprehensibility is supported by the data. In fact, the magnitude of the effect is large ($\beta_{\text{credibility}} = 0.45$ and $\beta_{\text{comprehensibility}} = 0.28$, one-tailed $p < 0.01$). Also, the quality of the relationships between the marketing and the R&D personnel was good ($\bar{x} = 5.90$, on a scale that runs from 1 = "very bad" to 7 = "very good"). These findings are not in accordance with earlier U.S. findings. For instance, research by Souder (1987) on 289 projects in 53 companies suggested that many projects suffered from "mild disharmony" (20.5%) or "severe disharmony" (38.7%) between R&D and marketing. "Harmony" between R&D and marketing prevailed in 40.8% of the observed projects. There are a number of plausible explanations for this divergence of findings. First, we have used different scales and question framing techniques to measure the quality of the interpersonal relationship. Second, there may be cross-cultural differences with respect to the R&D marketing interface in Europe and in the U.S. Third, data from a recent study by Gupta and Wilemon (1990, pp. 278-280) suggest that the quality of the R&D/marketing relationship has improved. These authors suggest that the stimulation of teamwork, the increased empathy between these two functions, the implementation of organizational development programs and new human resource management practices, and the recent institutionalization of integration (through the implementation of e.g. quality function deployment and concurrent engineering) may have contributed to this trend. Fourth, the average team size may have been smaller in the present study than in the Souder study, where it was noted that the smaller the team, the better

Table 4 Communication Channels Used by R&D and Marketing Personnel

Communication Channel Used	From R&D to Marketing ($n = 119$)	From Marketing to R&D ($n = 144$)
1. Face-to-face	32.2%	26.1%
2. Telephone	11.9%	8.5%
3. Meeting	39.8%	44.4%
4. Written	12.7%	18.3%
5. Electronic Mail	0.0%	1.4%
6. Combination of Channels	3.4%	1.4%

the relationships between team members (Souder 1987). Fifth, there may also be group polarization effects (Petty and Cacioppo 1981) at the R&D/marketing interface, i.e., perceptions about groups are less positive than perceptions about individuals.

Proposition 4 is not supported by the data. There were no significant effects of source-receiver communication frequency on the perceived comprehensibility ($\beta = 0.04$) and the perceived credibility ($\beta = -0.01$) of extrafunctional information. However, subsample analyses revealed some important findings. First, the more intense the communication link between the R&D source and the marketing receiver, the greater the comprehensibility of information originating from R&D ($r = 0.19$, one-tailed $p < 0.05$). This may be indicative of the greater complexity of R&D jargon. Frequent communications between both parties can render the R&D language more comprehensible for the marketing project member. Second, information credibility was found to correlate significantly with communication frequency during the development stage of the project ($r = 0.21$, one-tailed $p < 0.01$). In view of the NIH-syndrome, this finding suggests that information received from colleagues with whom one has infrequent contact will be considered with greater suspicion.

The data analysis also shows a weak positive correlation between communication frequency and the perceived novelty of information ($r = 0.14$, two-tailed $p < 0.05$). This runs counter to the "strength of weak ties" theory postulated by Granovetter (1973). The more frequent the contact, the more novel the information one gets. One may argue that the present finding could be

explained on the basis of the workload of the source. Persons who work more intensively on a project can be expected to contribute new information more frequently, and may be contacted more often by the other project team members. However, while the measure of communication frequency correlates positively with the workload of the source ($r = 0.19$, two-tailed $p < 0.01$), the measure for the workload of the source does not correlate significantly with the perceived novelty of the information ($r = 0.12$). Thus, it does not seem that he or she will be a better source of novel information if he or she works more intensively on a project.

Proposition 5 is partly supported. While the source's experience contributes to the perceived comprehensibility ($\beta = 0.16$), it decreases the assessment of the credibility ($\beta = -0.15$). That is, information originating with persons who have moved to another function will be regarded with more precaution. Again, this can be considered to be an example of the NIH syndrome (Katz and Allen 1982). Personnel at one of the sites suggested that this NIH-factor would manifest itself more strongly for information sources who had only recently moved to the other function. Further statistical analysis supported this assertion. Information originating with project personnel who had moved to the other function less than five years ago (the median in our sample) was perceived to be significantly less credible than information originating with project personnel who had moved more than five years ago (-0.467 vs. 0.153 , two-tailed $p < 0.01$).

Proposition 6 is supported. The data supported the proposition that the more senior the source is in relation to the receiver of the information, the more novel the information will be perceived to be ($\beta = 0.16$, one-tailed $p < 0.01$). The seniority effect was only significant for the planning stage of innovation projects ($r = 0.25$, one-tailed $p < 0.01$). Source seniority did not contribute significantly to information novelty during the development stage of the project ($r = 0.07$). This is in line with theoretical assertions that the planning stage is characterized by a low degree of analyzability. Experience, it seems, is most critical for uncertainty reduction during the front-end of the innovation project (Roussel et al. 1991, Souder and Moenaert 1992).

5. Conclusions

The present empirical study has tested a causal model on the factors that influence the perception of utility of extrafunctional information at the interface between R&D and marketing. A critical incident technique was designed to sample communication incidents in eighty project teams in forty Belgian companies. It was found that the relevance and the credibility of extrafunctional information had very strong effects on the perception of information utility, whereas novelty had a marginal effect. The comprehensibility of information had a moderate effect.

The analysis of the antecedents of these four information dimensions revealed that the quality of the relationship between message source and message receiver (e.g., marketing and R&D departments) had a strong positive influence on the perceived comprehensibility and the perceived credibility of extra-functional information. Also, the more senior the message source vis-à-vis the message receiver, the more novel the information was perceived to be. Prior experience of the source in the function of the receiver (e.g., the marketing person had prior experience as a member of the R&D department) had a positive impact on the perceived comprehensibility. But, it had a negative impact on the perceived credibility. The frequency of interactions between source and receiver did not relate significantly to perceived credibility and comprehensibility. Finally, written communication was perceived to be more comprehensible than oral communication, and to be equally credible. These results have several implications for managers and for future research.

5.1. Management Implications and Directions for Future Research

Information sharing between R&D and marketing parties is essential for successful new product development and product innovation (Souder 1987, Leonard-Barton 1992). The creation of a sustainable competitive advantage depends on a firm's ability to continually learn new systems and unlearn older routines (Levitt and March 1988, Cohen and Levinthal 1990, Van de Ven and Polley 1992). However, information sharing does not necessarily lead to information utilization (Goldhar et al. 1976). In this regard, earlier studies have demonstrated that the Not-Invented-Here (NIH) syndrome may

inhibit collaborative information seeking and exchange behaviors (Katz 1982, Katz and Allen 1988, Griffin and Hauser 1992). The study reported here indicates that the NIH syndrome may be even more pernicious than previously indicated: it can block information utilization and lock in the subsequent course of the project during the planning phase of the project. This is an important finding, since successful innovation may depend on maximum information exchange and utilization during the planning phase of the project (Hauser and Clausing 1988, Souder and Moenaert 1992).

These results suggest that the tendency of some social theorizing to cast human beings as mere cognitive organisms without drives, motives and tensions is misdirected (Frey 1986). As Van de Ven (1986) notes, a more holistic perspective may be needed that dwells on the sociological, psychological and emotional limitations of humans in accepting and processing information. Thus, Van de Ven argues for more direct personal confrontation as the means to resolve information exchange and utilization issues such as those identified here. For instance, job rotation is one traditional remedy (e.g., see Taylor 1990) suggested for encouraging improved cross-functional communication. However, the present study shows that information received from persons who have recently moved into another function is perceived as less credible. Thus, managers must be aware that job rotation may achieve the desired effects of increasing interactions and concomitant information flows between functions (Moenaert et al. 1994). But it may also create the undesired side effect of reducing the utilization of that information due to credibility gaps perceived by the recipients. To avoid this side effect, it makes sense to make the job rotation periods longer, e.g., instead of rotating individuals between R&D and marketing every two to three years, keep them in their respective marketing and R&D jobs for five years or even more. This would be long enough for them to become more fully enculturated in the respective R&D and marketing cultures, experience more than one project life cycle and gain the complete respect and confidence of their R&D and marketing colleagues.

Recent research has suggested that appropriate organizational designs may foster cross-functional integration. Project team formalization promotes cross-functional cooperation (Souder and Moenaert 1992;

Pinto et al. 1993, Moenaert et al. 1994), which enhances the creation of a common vocabulary (Griffin 1992). Thus, managers are encouraged to use more cross-functional teams. Empirical studies in the marketing function have found formalization to relate positively to information utilization (John and Martin 1984, Deshpande and Zaltman 1987). However, in an earlier study in consumer product companies, Deshpande and Zaltman (1982) have found information utilization to be related negatively to organization formalization. Empirical evidence seems to suggest that the formalization of communication patterns between R&D and marketing through quality function deployment may be a catalyst for the not-invented-here syndrome (Griffin and Hauser 1992). Given the equivocal evidence concerning the relationship between organizational context and information use, further research on this topic is warranted. The organizational context was not included in the present study. Also, we have not linked individual information styles to project success. It may well be that the continued use of novel information leads to dysfunctional group processes. As one of the participants in the present study observed during the group feedback sessions: "One cannot aim at a moving target."

Our finding that the perceived novelty of information related positively to the relative seniority of the source also deserves further research. Since the involvement of experienced innovation personnel is critical to the success of product innovation processes (Souder and Moenaert 1992, Roussel et al. 1991), further research could clarify the role of such individuals. Indeed, the present study has not analyzed the information consumption style of special persons in the innovation process (e.g., boundary spanners, gatekeepers, team leaders). Given their position in the communication network within the organization (Allen 1985), these persons act as nodes of uncertainty absorption (March and Simon 1980). The information consumption style of such key individuals may help us to better understand the dynamics of information acquisition and dissemination within the organization. For instance, innovation processes thrive on the exchange of both explicit as well as tacit knowledge (Badaracco 1991). Experience facilitates the communication of tacit information (Polanyi 1948, Nonaka 1991). Unfortunately, senior personnel tend to become involved with innovation projects pri-

marily at the end, when their potential impact on project orientation is low (Roussel et al. 1991). Early involvement of senior R&D and marketing personnel during the project definition, concept formulation and evaluation may provide an important lever in the innovation process.

Our finding that the quality of the relationship between the message source and the message receiver is pivotal to communication effectiveness is in line with earlier project level evidence on the impact of cross-functional climate on innovation performance (Souder 1987). The assessment of individual cross-functional relationships seemed to be less negative than the assessment of cross-functional relationships at the group level.

It is important to observe that the present analysis shows an important absence of cause-effect relationship: information relevance did not correlate significantly with any of the antecedents that were investigated in the present study (column 17, Table 2). Thus, the degree to which the receiver deems the information to pertain to his or her task is not significantly related to any of these measures. Considering the important impact the perceived relevance has on the perception of information utility, further research is needed on the causal antecedents of the perceived relevance of received extrafunctional information.

At scientific conferences where the research results have been presented, American researchers showed more discomfort with the apparent apathy of project personnel towards novel information than their European colleagues. Indeed, some of the European colleagues we have shared the results with, appreciated the attitude of the surveyed Belgian innovation team members quite positively. This may point in the direction of national culture as a variable moderating cause-effect relationships in the propositional model. While cross-cultural innovation studies concern a very recent area of research in the field of innovation management, some of them have shown that national culture may influence innovation performance (Clark and Fujimoto 1991, Kedia et al. 1992, Shane 1993). The Belgian national culture can be described as a Latin culture. It is characterized by a high degree of uncertainty avoidance (Hofstede 1980, Hoppe 1991), a strong emphasis on duty, and a low risk tolerance (Ronen 1986). The present study

needs replication in countries that are characterized by another ethnic culture. For instance, such cross-cultural studies may investigate whether countries that score low on uncertainty avoidance (e.g., U.S.A., Australia) have an advantage because of the potentially greater propensity of innovation personnel to use novel information. However, a high degree of uncertainty avoidance may not necessarily lead to uncompetitive behaviors. The Japanese ethnic culture, that is characterized by a high degree of uncertainty avoidance, traditionally relies on tools such as quality function deployment and Taguchi methods to minimize innovation risk effectively and efficiently. Also, research has shown that a low degree of uncertainty avoidance may become a disadvantage when it leads to the continued pursuit of scientific and technological invention over market driven innovation (Florida and Kenney 1990).¹

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