Marketing-Manufacturing Joint Involvement Across Stages of New Product Development: Effects on the Success of Radical vs. Incremental Innovations

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Abstract

We examine the performance impacts of increases marketing-manufacturing joint involvement (MMJI) across four phases of the new product development (NPD) process. Our study assesses three separate measures of project performance, and contrasts the results across incremental and radical innovation projects. Data drawn from 467 completed high technology NPD projects are analyzed using hierarchical moderated regression.

The results show that for each phase of an average NPD project, increased MMJI is associated with better project performance. However, there are strong differences in these effects across radical and incremental NPD projects, and across different dimensions of project performance. This suggests that managers should tailor the timing and level of MMJI implementation in accordance with project priorities and with the level of innovation involved. The data indicate that practitioners do not currently make these distinctions, and projects could benefit from a greater understanding of the complex relationships of MMJI and performance. In order to explain these relationships, we identify some of the benefits, detriments, and costs of MMJI that should be more deeply explored in future research.
Introduction

Numerous researchers point to the benefits of greater integration of cross-functional concerns in new product development (NPD) processes. In practice, the popularity of cross-functional teams and other integration methods suggests a widely held belief that integration leads to improved new product performance. These approaches have become accepted as best practices in NPD. However, this trend raises important questions. Are high levels of cross-functional integration always effective? Are there stages of NPD in which integration is more important, less important, or even detrimental? What about product innovativeness? Is cross-functional integration equally valuable for incremental and radical innovations? This article addresses these questions for the case of marketing-manufacturing joint involvement (MMJI).

Marketing and manufacturing are arguably two of the most opposed functional perspectives represented in NPD activities. Marketing personnel tend to focus on customer and competitive issues. Manufacturing personnel tend to be inwardly focused, concentrating on core capabilities and capacity issues. The dominance of one or the other perspective throughout NPD phases can lead to deficiencies in new product launch, either in terms of market relevance or in terms of the firm’s ability to successfully deliver what is promised. Thus springs the argument that marketing and manufacturing strategies and design inputs should be closely integrated throughout the new product development effort.

On the other hand, some researchers suggest that cross-functional integration is not always needed or even appropriate, especially not for all levels of product innovation (Crawford, 1992; Craig and Hart, 1992; and Song, Thieme and Xie, 1998). One argument is that early manufacturing inputs can squelch creative ideas for radical new products. Another states that heavy marketing influence can divert attention from technical problems in production ramp-up. In this article, we explicate these and other relevant arguments while exploring the proposition
that new product innovativeness moderates the need for and effectiveness of MMJI across various phases of NPD. We test specific hypotheses borne of this discussion using data from a large number of recently completed NPD projects in manufacturing firms.

This study makes several important contributions in areas where research is sorely lacking. A considerable body of research addresses the contingency of organizational and managerial factors for differing levels of organizational innovation (see Damanpour, 1996 for an interesting meta-analysis). Much less is known regarding contingency factors for product innovation. Furthermore, studies of product innovation and innovativeness have addressed organizational factors mostly at the corporate or business level (Ettlie and Rubenstein, 1987; Kotabe and Swan, 1995). There is a serious need for product level research examining innovation-related contingencies that govern the effectiveness of cross-functional integration in NPD. The scant existing research has focused on marketing-R&D integration and R&D-manufacturing integration, respectively, and it has concentrated primarily on the technical development phase of NPD. Very little attention has been paid specifically to the marketing-manufacturing link or to the effects of integration in earlier and later phases of NPD. Our research examines the relative effects on new product success of MMJI across four major stages of incremental and radically new NPD projects. In doing so, this study amplifies our understanding of functional roles in NPD and furthers the development of contingency theory explaining new product success. This investigation is crucial considering the major emphasis placed on cross-functional integration by practitioners in recent years. In fact, the findings of this study suggest that many practitioners’ efforts in this regard are probably misplaced.

The next section in this article discusses the theoretical underpinnings and the specific hypotheses addressed in this research. The following two sections describe the research
methodology employed and the results of the study. The final two sections of the paper discuss the implications of the findings, identifying conclusions and opportunities for future research.

Theory Development

For the purposes of this research, we define marketing-manufacturing joint involvement as the coordination of the timing and substance of functional strategies and development activities performed by the two disciplines in new product development. Rich communication and cooperation among product development team members are characteristic of high joint involvement in NPD. Arguments for the value of joint involvement and cross-functional integration in NPD find a basis in resource dependency theory (Pfeffer and Salancik, 1978), which argues that the degree of interdependence and the nature of interactions among functional specialists in an organization are influenced by the collective task being accomplished. The roles of marketing and manufacturing personnel in product design and development involve many specialized tasks that are highly interdependent. For example, marketing’s interpretation of customer needs leads to specifications of product features that dictate required manufacturing capabilities. Because of these interdependencies, achieving higher levels of cooperation and information sharing among marketing and manufacturing representatives has been considered an important goal (Pinto, Pinto and Prescott, 1993).

At the same time, joint involvement in NPD is thought to offer certain advantages and disadvantages. The readily apparent advantage is that horizontal linkages are improved (Galbraith, 1971; Moenaert and Souder, 1990). Each functional group gives the other group specific information that is needed to make good decisions due to interdependencies among functional tasks. This information exchange reduces equivocality (ambiguity) in the NPD project (Daft and Lengel, 1986). A more subtle advantage occurs when one functional group
prods the other group toward a more thorough and complete analysis of its own issues. The latter group receives the benefit of an outsider’s perspective offered by the former group. This stimulates creativity and the creation of new knowledge (Ford and Randolph, 1992; Nemeth and Staw, 1989). Increased communication resulting from joint involvement also gives the groups (especially manufacturing) valuable advanced notice of decisions and issues, increasing the time available to secure and prepare needed resources.

Fundamental disadvantages to joint involvement lie in improper or ineffective execution. First, integrated organizational forms tend to complicate inter-functional relationships, increasing organizational conflict (Davis and Lawrence, 1978; Katz and Allen, 1985; Wheelwright and Clark, 1992). Second, personnel from different functions often have different orientations, goals, and values that lead to conflicting expectations and excessive demands on individuals (Lorsch and Lawrence, 1965; Parry and Song, 1993; Song and Parry, 1993). This operating environment tends to produce stress, confusion, and poor decision-making (Ware and Barnes, 1985; (Millson, Raj and Wilemon, 1992). Szulanski (1996) describes situations in which each functional group is mired in its own perspective, lacking a relevant knowledge base (i.e., knowledge of the other group’s issues) that is sufficient to enable constructive knowledge sharing. In NPD, R&D personnel sometimes complain that manufacturing personnel lack marketing expertise and are too detail oriented, that they are too locked-in to conventional solutions and technologies, and that the involvement of too many people makes early decisions more difficult to make (Gerwin, 1993). Swink (2000b) provides empirical evidence suggesting that heavy manufacturing influence may constrain the innovativeness of product features. All this suggests that joint involvement may be rendered ineffective or even detrimental due to a lack of experienced or well-trained personnel. Finally, building needed integration skills (through training) and
enabling interactions for joint involvement between experts (through collocation, meetings, or other means) can be costly and time consuming (Davis and Lawrence, 1978).

Building upon these conceptual underpinnings, we developed the theoretical framework shown in Figure 1 as the model to be tested. The framework indicates direct and indirect effects of MMJI and the level of product innovation on three measures of new product success. The effects of MMJI are partitioned by four basic stages within the total NPD process: Business and Market Analysis (BMA), Technical Development (TD), Product Testing (PT), and Product Commercialization (PC). Urban and Hauser (1993) describe these four stages conceptually. Prior empirical research has validated the stages and measured their use in practice (Song and Parry, 1997).

The objectives of business and market analysis are to understand the new product’s place in the market relative to competition, to make connections between new product features and potential customers’ needs, and to forecast the required investment and risk of the NPD project. Technical development includes product and process engineering studies, establishing product designs and specifications, prototyping the product, and approving final designs. In the product testing phase, key customers and sites are selected, markets are tested, and the results are analyzed. Finally, product commercialization involves all the activities required to launch the product, including developing detailed manufacturing and marketing plans and schedules, starting and ramping-up production, and promoting and distributing the product.

Past researchers have tended to identify BMA as primarily a marketing activity. TD and PT have been placed in the R&D domain, and PC has been viewed as a collection of marketing and manufacturing tasks. In reality, it is clear that all three functions play significant roles in each of the NPD phases. However, because the nature of tasks differs across stages, we expect that the value of joint involvement is not the same at each stage (Song, et al., 1998). In the
following paragraphs we discuss the roles of marketing and manufacturing and the potential pros and cons of their joint involvement in each phase.

Certain activities in the front end of NPD seem by their nature to require the close joint involvement of marketing and manufacturing functional representatives. Khurana and Rosenthal (1997) discuss the need to address technical feasibility and market impacts of product feature options. An effective analysis of these issues requires a conceptualization and evaluation of all aspects of the product’s value chain. Marketing personnel bring to this analysis an understanding of market potential, competitor offerings, strategies for communicating with customers, and the product’s place in the firm’s entire product portfolio. Manufacturing representatives offer information regarding the availability of required resources and capabilities, and suggestions on how the new product might be integrated into the existing production mix. It is easy to envision how joint involvement and intensive discussions between the two functional groups would prompt a more complete and thorough analysis. For example, manufacturing representatives might raise execution issues that would not have been considered if marketing personnel conducted the analysis in isolation.

The technical development stage of NPD transforms new product ideas into a physical product. The impacts of cross-functional integration in this phase have been studied fairly extensively (Griffin and Hauser, 1992; Song and Parry, 1993; Swink, et al., 1996). The primary benefits apply to information transfer, technical learning, and problem solving (Clark and Fujimoto, 1990; Imai, et al., 1985; Nonaka, 1990; Quinn, 1985; Takeuchi and Nonaka, 1986). Prior researchers have focused on the integration of R&D decisions with decisions made by other groups. However, we believe that inter-relationships of marketing and manufacturing activities may be even more interesting. It is in this phase that the differences between the functional perspectives become most pronounced. Marketing is interested in creating change.
Manufacturing is interested in leveraging the status quo. Marketing seeks broad product lines to satisfy the maximum number of customers. Manufacturing seeks economies of scale and minimal product changeovers.

We suggest that the primary benefits of MMJI in this phase are better process capability decisions in manufacturing, and better product feature decisions in marketing. If manufacturing personnel better understand the product volume and variety characteristics of market demand, they are more likely to effectively address the requisite capacity and flexibility characteristics of production process design decisions. Obversely, if marketing personnel more clearly understand the impacts on manufacturing of specific product volume and variety decisions (say the incremental effect of adding one more color to the product line) then they more likely to set reasonable product proliferation and sales targets. These improved decisions should produce higher levels of project performance.

In the product testing stage the major task is to test the physical product with consumers. Marketing typically takes a leading role in designing consumer test questions, establishing test sites, setting schedules, executing the tests, and interpreting the results. Manufacturing’s role in the process is usually minimal, limited to producing demonstration units to support the tests. However, we suggest that manufacturing influence on the design of consumer tests and the interpretation of the results could produce significant benefits. Important questions might not be asked if a manufacturing perspective is absent in the test design. For example, marketing personnel may neglect to ask consumers about features that have little product performance impact but that do have significant manufacturability impact. In addition, some researchers speculate that higher MMJI improves the translation of pretesting results into product and process design modifications (Song, et al., 1998). These improvements should increase the chances of new product success.
The product commercialization phase involves launching and ramping up production to reach full scale, establishing customer orders and sales locations, and filling the distribution pipeline with product. Marketing and sales personnel tend to take an aggressive approach to this phase. Marketing wants rapid production ramp-up and fast, fluid response to growing or changing customer demands. Manufacturing, on the other hand, wants accurate sales forecasts and frozen design specifications so that it can concentrate on achieving consistency and reliability in production. We posit that the greatest benefit from MMJI in this phase is better coordination of production planning and demand management activities. If marketing and sales personnel have better information about production ramp-up progress and associated problems, they may be less prone to over-promise when negotiating sales agreements, and less willing to agree to last minute changes in deliveries. If manufacturing personnel have a better understanding of sales forecasts and market potential, the may be more effective in setting production priorities and attaining schedule goals.

These arguments lead to the following hypotheses.

H1a-d: Marketing-manufacturing joint involvement during each the following phases of NPD is positively associated with product success: (H1a) business and market analysis, (H1b) technical development, (H1c) product testing, and (H1d) product commercialization.

The foregoing discussion describes the potential benefits of MMJI across various phases of NPD. However, important research questions relate to the effectiveness of MMJI in NPD projects of varying innovativeness. Are the advantages of MMJI likely to be greater or lesser on radical versus incremental NPD projects? What about the disadvantages? In the following paragraphs we explore the proposition that NPD innovativeness moderates the effects of MMJI across NPD phases on new product success.
General arguments and findings from the literature are mixed. Some researchers argue that too much manufacturing influence in radical innovation contexts is detrimental. Improved product cost and manufacturability may result from manufacturing influence, but radical innovation projects offer significant product differentiation, making cost and manufacturing advantages less important (Crawford, 1992). Moreover, manufacturing influences may overly constrain decisions regarding innovative product features because manufacturing personnel are ill-equipped to participate in early phases of radical NPD (Gerwin, 1993; Swink, 2000b). Adler (1995) suggests that when product analyzability is low (i.e., product technologies and features are ill-defined and not well-understood), manufacturing involvement should occur later in development in order to optimize the “total cost” of attaining producible product designs. Cordero (1991) suggests that concurrent processing of market and technical problems is most successful on incremental NPD projects. Crawford (1992) also suggests that many formal integration methods are best suited for incremental product development. Moffat’s (1998) recent empirical study supports these suggestions. She concludes that concurrent engineering approaches are less successful when NPD tasks involved high novelty and uncertainty. These arguments and research findings suggest that MMJI is likely to be ineffective when innovation levels are high.

Arguments from other researchers forward the alternative proposition. They suggest that increased novelty in NPD increases the need for cross-functional integration because of greater inter-functional dependence (Gupta, Raj and Wilemon, 1986; Ruekert and Walker, 1987; Takeuchi and Nonaka, 1986; Clark, 1989; and Fitzsimmons, Kouvelis and Mallick, 1991). Because project team members have fewer relevant experiences to draw upon, they perceive their tasks to be more challenging and depend more heavily on other functional specialists for the expertise, information, and other resources needed to arrive at a creative and successful solution.
(Olson, Walker and Ruekert, 1995). Greater uncertainty also produces higher degrees of equivocality on project teams (McCann and Galbraith, 1971; Daft and Lengel, 1986), necessitating access to deep, concentrated sources of functional expertise and technological knowledge (Allen, Tushman and Lee, 1979; Ettlie, Bridges and O’Keefe, 1984; Susman and Dean, 1992; Swink, Sandvig and Mabert, 1996). These arguments and their consistency with dependency theory suggest that high levels of integration make radical NPD more effective. High levels of integration should also be more efficient, because identifying and solving problems early prevents delays and related expenditures in later stages of development.

A discussion of marketing and manufacturing interdependence provides a case in point. More careful, concentrated, and early integration of manufacturing concerns is needed for radical NPD involving significant changes in manufacturing process capabilities (Rubenstein and Ginn, 1985; Ettlie and Reifeis, 1987; Dougherty and Heller, 1994). Increased market and technological uncertainties make choices of product and process design parameters more sensitive to each other. Thus, early linkage of market and process technological possibilities is crucial. Furthermore, marketing proficiency and the voice of the customer are especially important in the development of highly innovative products because of greater risk and consumer uncertainty (Kleinschmidt and Cooper, 1991; Hauser and Clausing, 1988). Coordinated MMJI is likely to be very important in later phases of NPD since customers’ needs may be hard to discern and the mix of product attributes may change as customers learn to use the product (Dougherty and Heller, 1994). The foregoing discussion suggests that firms should see improved new product success in accordance with the following hypothesis:

\[ H2: \text{The presence of MMJI across phases of NPD has greater positive effects on the success of radical NPD projects than on incremental NPD projects.} \]
It is important to note that support for $H2$ from theory and prior research is much stronger regarding MMJI in early phases of NPD than it is for later phases. Almost all of the prior research has concentrated on BMA and TD phases of NPD. Very little has been said regarding integration in the later phases. One could argue that fewer benefits result from MMJI in later phases of radical NPD because many of the product/process uncertainties and interdependencies endemic to high levels of innovation will have been resolved by this time. On the other hand, market demand and production scheduling uncertainties typically remain even throughout the commercialization of radical new products. Our test of $H2$ for the PT and PC phases of NPD provides a more exploratory component of the study.

Furthermore, prior research suggests that the benefits of cross-functional integration do not span all aspects of NPD effectiveness (Griffin, 1997; Souder and Moenaert, 1992; Souder, 1998; and Swink, 2000a). We therefore examine the foregoing hypotheses with respect to three measures of NPD success: product competitive advantage, market share, and ROI. These measures assess dimensions of new product quality, market acceptance, and financial performance respectively. As a set, they provide a more comprehensive picture of NPD effectiveness and they provide the opportunity to assess the potentially inconstant effects of MMJI across different dimensions of performance. The following sections describe the methodology used to collect field data supporting the tests of the hypotheses.

**Methodology**

The data were collected through a large-scale survey of the 643 firms (listed in the High-Technology Marketplace Directory) that met the criteria of developing and commercializing at least four new physical products. In administering the survey, we followed the Total Design Method for survey research (Dillman 1978). The key informant was the project manager of a
most recently developed product. To encourage participation, we signed a confidential agreement with each company and provided them with regular research reports. After four follow-up letters and innumerable personal contacts via telephone and fax, we received 467 usable questionnaires with a response rate of 72%.

The final sample included the following industries: computer related products; electronics; electric equipment and household appliances; pharmaceuticals, drugs and medicines; machinery; telecommunications equipment; instruments and related products; air-conditioning; chemicals and related products; and transportation equipment.

To examine possible nonresponse bias and the representativeness of the participating firms, we performed a MANOVA to compare early respondents with late respondents on all of the variables. The results were not significant at the 95% confidence level, suggesting no significant difference between the early respondents and the late respondents. We also compared the possible differences in total assets, number of employees, and R&D spending between the responding firms and non-responding firms. The results were not significant at 95% confidence level, suggesting that non-response bias is not a concern.

Measures

To develop appropriate measures, we identified relevant measurement scales from the product innovation literature and refined the scales through in-depth case studies and focus group interviews with two new product development teams and follow-up interviews with some individual team members. The interviews consisted of three parts. The first part of the interviews was designed to elicit salient constructs and team-member definitions of those constructs. Team members were first asked their opinions regarding important issues in cross-functional team integration in the NPD process. The second part of the interviews focused on eliciting team member evaluations of the theoretical model to describe their own experiences.
The third part of the interviews addressed team member perceptions of the relevance and completeness of scale items drawn from our literature review and earlier case studies.

After completing the first round of focus group interviews, we followed the recommendations of Churchill (1979) and identified subsets of items that were unique and possessed "different shades of meaning" to informants. We then submitted a list of constructs and corresponding measurement items to a panel of academic “experts” for critical evaluation and suggestions for additional measures. We then constructed a questionnaire based on those items judged to have high consistency and face validity. We pretested the survey using the participants of the case studies and incorporated minor changes into the final version of the questionnaire. The appendix provides a list of the relevant measures.

Scores for these measures were subject to a factor analysis. Table 1 provides the rotated solution using Varimax rotation. Each of the measures loads significantly on only one factor with most loadings well above the generally accepted level of 0.50. The vast majority of off-loadings are below 0.20. These results suggest a high degree of convergent and discriminant validity for the construct measures.

All of the variables depicted in Figure 1 were measured with multiple-item scales and have high construct reliabilities (ranging from .82 to .99). Likewise, the moderator variable, product innovativeness, was also operationalized as a multi-item scale (reliability=0.87). Appendix A provides a complete list of all measurement items for each construct used in this study, as well as the response format employed in the questionnaire. The items for each construct came from existing validated scales from a variety of sources in the literature. Additionally, we asked each respondent to classify the innovation into "radical innovation" or "incremental innovation" based on his or her knowledge or company records. We used the
following definition for "radical innovation" (Dewar and Dutton 1986; Ettlie, Bridges, and O'Keefe 1984): 

Radical innovations are fundamental changes that represent revolutionary changes in technology. These innovations incorporate technology that is clear and risky departure from state of current knowledge prior to the introduction and have high degree of new knowledge embodies in the technology.

**Data Analysis and Results**

The respondents' ratings for the relevant items of each construct were summed and divided by the number of items to obtain the multiple-item scales. Based on the mean score of the composite product innovativeness scale, projects were identified as classify each project into "radical innovation" or "incremental innovation". This classification scheme resulted in 250 "incremental innovations" and 217 "radical innovations" and was highly consistent with the managers’ dichotomous self-classifications.

Table 2 provides descriptive statistics for the variables included in this study. Panel A of the table shows mean and standard deviation statistics for each variable. The statistics are shown for the entire sample as well as subgroups of incremental and radical innovations. These statistics have two interesting results. First, MANOVA tests show significant differences (at p<0.05) across the two groups for MMJI implementation in the all stages of NPD except the product testing stage. These results suggest that managers tend to have higher level of MMJI when developing radical innovations than when developing incremental innovations. Second, the results in Panel A do indicate that the level of MMJI progressively increases as the project progresses. A multiple comparison of differences in MMJI across stages of NPD reveals that MMJI is significantly higher in each successive stage of NPD (p < 0.05). This is true for both incremental and radical innovation subgroups.
Panel B in Table 2 provides intercorrelation statistics for all the variables. Each of the dependent variables is significantly correlated with all of the independent variables, suggesting a high degree of nomological validity.

**Model and Hypothesis Testing**

We used multiple OLS regression models to test the hypotheses. To examine the significance of interaction effects implied by $H2$, a hierarchical regression analysis approach was performed (Cohen and Cohen 1983). Multicollinearity is sometimes present when interaction terms are involved. To reduce multicollinearity, we mean-centered all the independent and dependent variables, as suggested by Jaccard, Turrisi, and Choi (1990). After mean centered the variables, we did not find any multicollinearity problems.

The following model was applied to the data:

$$Z_i - Z = \alpha_0 + \alpha_1 D + \sum_{k=1}^{4} \beta_{ik} (X_{ik} - \bar{X}_k) + \sum_{k=1}^{4} \gamma_{ik} D(X_{ik} - \bar{X}_k) + e_i$$  \hspace{1cm} (1)

where $i=$company;

D=1 for radical innovations; 0 for incremental innovations;

$Z_i$ is the degree of new product success of company and $\bar{Z}$ is the mean value of $Z_i$;

$X_{ik}$, $k=1,2, \ldots 4$ are the four marketing-manufacturing integration variable by company i;

and $\bar{X}_k$, $k=1,2,\ldots 4$ are their mean values; and

$e_i$ is the error term of the regression model.

This model was run using three different measures of new product success: PCA, MS, and ROI respectively.
The hierarchy of regression modeling proceeds as follows. The model was first run with all main effects only. The top portion of Table 3 presents the results of the main effects model. We then added the dummy variable identifying radical versus incremental NPD projects along with the interaction variables added. The lower portion of Table 3 shows the addition of the dummy and interaction variables. The results indicate statistically significant increases in F-values through the addition of the dummy and interaction terms. Furthermore, including the dummy and interaction variables significantly increases the $R^2$ (that is, the variance explained for new product success) in all three performance variables. These results support our basic proposition that there are significant effects on new product success due to interactions between product innovation type and MMJI in the four stages of NPD. The $R^2$ values for the three full regression models are: 0.713 for PCA, 0.656 for MS, and 0.516 for ROI. Thus the theoretical model explains at least 51% of the variance in levels of new product success.

Support for the research hypotheses is strong in most cases, but it is mixed across NPD stages and across measures of new product success. Positive regression coefficients in the main effects models are significant ($p<0.05$), strongly supporting hypotheses $H1a$, $H1b$, and $H1d$ across all three measures of new product success. The regression coefficients for MMJI in product testing are also positive as expected. However, they are only marginally significant ($p<0.10$) in the PCA and MS models, and the coefficient is not significant in the ROI model. These results provide only limited support for $H1c$.

Adding the interaction terms shows that the effects of MMJI on new product success are not as simple as the main effects model would suggest. The coefficient for each main term in the full model indicates the direct association of that variable to new product success for incremental NPD projects (i.e., when the dummy variable equals 0). The interaction term coefficient indicates the additional, moderating effect of radical NPD on the given variable’s association to new product performance. A significant interaction term implies that the effect of the
independent variable on new product performance is significantly greater (or significantly less) for radical NPD projects than it is for incremental NPD projects. The sum of the direct and interaction term coefficients for each variable indicates the association of that variable to new product performance for radical NPD projects.

Hypothesis $H2$ is supported in most of the cases, suggesting that the MMJI produces greater positive impacts on new product success in radical NPD projects. However, there are a few surprising and interesting exceptions. The interaction term coefficients for TD and PT just miss marginal levels of statistical significance in the market share model. The interaction term for TD in the ROI model is only marginally significant. More important, in two specific cases an effect opposing $H2$ is observed. The results indicate that MMJI in product commercialization has less of an effect on ROI in radical projects than it does in incremental projects. Similarly, MMJI in business and market analysis produces less of an effect on product competitive advantage in radical projects than it does in incremental projects.

In addition to these findings, the relative magnitudes of the coefficients across stages and across innovation types suggest several interesting phenomena. Regarding ROI and market share, it appears that increasing MMJI in the product commercialization stage is a strategy that produces the greatest benefit on incremental NPD projects. The coefficients are much more significant and positive for commercialization than they are for the other phases. However, a different effect is indicated for radical NPD projects, where large positive impacts of MMJI are experienced in the business and market analysis and technical development stages, and non-significant effects are indicated in the commercialization stage. Regarding product competitive advantage, MMJI is effective in business and market analysis on incremental NPD projects. However, it is most effective in the latter three stages of NPD in radical NPD projects. The implications of these findings are summarized in Table 4.
Discussion

Dougherty and Heller (1994) maintain that making marketing-manufacturing linkages in NPD requires a very complex creative process. Some of this complexity may derive from the variable impacts of MMJI on NPD performance. Our findings suggest that the benefits, detriments, and costs of MMJI vary considerably across NPD stages and levels of innovation attempted.

In order to move toward a theory that explains these differential effects, we need to consider how these benefits and costs might influence the different the NPD performance measures we used. Our product competitive advantage construct addresses only the quality and technical performance aspects of the product, whereas the ROI and market share measures are more comprehensive measures of total NPD project performance. Inherent in ROI, and to some extent in market share, is an assessment of the costs of MMJI and how they may offset some of the benefits of MMJI. We take these fundamental differences into account as we discuss the implications of the findings for incremental and radical NPD projects respectively.

Marketing-Manufacturing Joint Involvement in Incremental NPD

The results of this study suggest that higher MMJI in incremental NPD projects is associated with increased product competitive advantage, but this is true only for MMJI in the business and market analysis stage. Perhaps it is only in this early stage of incremental NPD that product designs are malleable enough so that the benefits of manufacturing inputs can be realized. We expect that experiences that marketing and manufacturing personnel have had with the previous product generations provide a strong basis for fruitful interactions between the two groups. In incremental NPD, both parties typically business and market analysis with a strong
understanding of the issues and features that need to be addressed in the product extension strategy.

Interestingly, while product competitive advantage tends to improve, early MMJI efforts do not consistently produce better ROI or market share. In fact, negative coefficients suggest a detrimental effect, though these coefficients are not statistically significant. Perhaps the costs of increased joint marketing-manufacturing involvement early-on in incremental NPD are sufficient to obviate the benefits to and returns from increased product competitive advantage. Another possibility is that the marginal additions to product competitive advantage, while significant, are not fully appreciated by the pre-existing market (i.e., established through prior product generations).

Our initial expectation was that the contributions of manufacturing personnel are likely to be valuable in incremental NPD because they have much relevant experience and information to bring to the design table. For example, quality control data from the production of the earlier generation product can be applied to the new design. Assuming this kind of information is likely to applied in the technical development phase, the results of our study indicate only a marginal effect on ROI and market share.

The results suggest that the biggest impacts of MMJI on ROI and market share come in product commercialization. In an incremental NPD environment, forecasts of product demand and needed production capabilities are likely to be quite accurate. The availability of good information makes for effective joint planning efforts, which in turn, produce high levels of customer service and production efficiency.

*Marketing-Manufacturing Joint Involvement in Radical NPD*

In radical NPD, very early MMJI efforts produce little effect on product competitive
advantage, yet they are quite effective in improving market share and ROI (see Table 4). Perhaps this is because product design parameters are ill-defined and manufacturing relevant experience is limited. Prior research suggests that early manufacturing involvement may place limits on the product competitive advantage of radical innovations because manufacturing personnel are too locked-in to conventional technologies and the status-quo (Garvin, 1993). Our results are consistent with this criticism. However, the results for ROI and market share suggest that the constraints manufacturing personnel may place on innovation are actually good for the overall project performance. This finding strongly supports those who have argued the need for closer cross-functional integration in radical NPD contexts (Olson, et al., 1995; Allen, et al., 1979; Ettlie, et al., 1984; Susman and Dean, 1992; Swink, et al., 1996; Gupta, et al., 1986; Ruekert and Walker, 1987; Takeuchi and Nonaka, 1986; Clark, 1989; and Fitzsimmons, et al., 1991) and it contradicts those who suggest that integration efforts are better-suited to incremental NPD (Adler, 1995; Crawford, 1992; Moffat, 1998). We posit that manufacturing personnel serve as useful technical experts on radical NPD projects, pointing out limitations of current production capabilities, and assessing the feasibility of options. The results suggest that this role is less needed on incremental innovations where production performance is well understood and process technologies are more familiar.

The results also suggest that MMJI in technical development and subsequent phases of radical NPD leads to significant improvements in product competitive advantage and market share. These findings support the proposition that greater interactions between marketing and manufacturing personnel help to improve product quality and the timeliness of product launch and customer deliveries. Radical NPD involves many uncertainties regarding the feasibility of product and process technologies, the optimality of design specifications, the volume and variety of customer demand, and proper timing of production scheduling. Our study points to the
importance of MMJI in resolving these issues as they impact PCA and market share. However, the findings also suggest that downstream MMJI may be costly. One interpretation of the insignificant effect of late MMJI on ROI is that interactions involve high costs in product testing and commercialization, costs that negate the returns created by improvements in the other dimensions of performance. These high costs could be due to the lack of good information needed support forecasting and planning. Another source of costs could be that MMJI distracts functional groups from a much-needed focus on the tasks at hand. For example, the production ramp-up of radical new products can be rife with problems. High levels of interaction between marketing and manufacturing (e.g., marketing continually changing their demand forecasts) might disrupt manufacturing’s focus on the process of solving production problems in order to achieve smooth and rapid production ramp-up.

Managerial Implications

The results in Table 2 indicate that on average NPD projects the level of MMJI grows significantly with each subsequent stage of the project. While this appears to be an appropriate strategy for incremental NPD efforts, it leads to the loss of significant opportunities in early phases of radical NPD efforts. Why are managers not taking advantage of these opportunities? Perhaps the opportunities are not fully recognized. Moreover, some have suggested that early cross-functional integration suffers because of shortage of qualified manufacturing personnel (Garvin, 1993). If this is the case, our study points to the potential benefits of equipping manufacturing personnel with the skills necessary to contribute to early decisions in radical NPD.

Another implication from this study for managers is that trade-offs appear to exist among dimensions of NPD performance. Conventional wisdom states that it is difficult to create new
products faster at the same time as making them better and cheaper. Our study supports this view. An integration strategy properly designed to improve product competitive advantage is likely to be different than the strategy needed to maximize market share or financial returns. This suggests that investments in MMJI should be made with an eye toward NPD project priorities.

**Conclusions**

The primary limitations of this study are those inherent in survey-based research. The study is cross-sectional. This approach, while very useful for hypothesis testing, provides little insight into why the results are what they are. This study has produced several counter-intuitive and provocative findings. Future, more in-depth, research is needed to explore the underlying reasons for the relationships depicted in the data.

Two general research hypotheses were supported by the analysis. First, the analysis indicates that increased levels of MMJI tend to produce beneficial impacts on project performance in terms of product competitive advantage, market share, and ROI. For average projects we studied, increased MMJI in all phases of NPD produced improvements in all three dimensions of performance, respectively, with few exceptions. However, further analysis showed that these “main effects” do not fully explain the relationship between MMJI and project outcomes. A hierarchical moderated regression analysis revealed a complex set of associations between MMJI. In most cases, MMJI is shown to produce greater impacts on the performance of radical NPD projects than for incremental NPD projects. This was consistent with our second hypothesis. But even this moderated model does not hold consistently across all NPD project stages and for all performance dimensions.

These findings point to the importance of designing tailored, time-phased, strategies for
cross-functional integration in NPD. These strategies should be based on project priorities and on the level of innovation attempted. We suggest that future explorations of these phenomena should focus on the benefits, detriments, and costs of cross-functional integration in these different contexts. This research approach is needed in order to illuminate the varying net impacts of integration on NPD. Our study also suggests that it is important to study multiple dimensions of performance, as trade-offs among performance outcomes are likely to be present.
References


Figure 1

A Theoretical Framework for Studying the Impact of Marketing-Manufacturing Integration on New Product Success

- Marketing-Manufacturing Joint Involvement in Business/Market Analysis
- Marketing-Manufacturing Joint Involvement in Technical Development
- Marketing-Manufacturing Joint Involvement in Product Testing
- Marketing-Manufacturing Joint Involvement in Product Commercialization

Product Performance
- Return on Investment
- Product Competitive Advantages
- Market Share

Product Innovativeness
### Table 1
#### Factor Analysis: Factor Loadings

<table>
<thead>
<tr>
<th></th>
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**Notes:**
Please see the Appendix for the detailed description of each variable.
Table 2
Descriptive Statistics

A: Means and standard deviations

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<th>Construct (scale)</th>
<th>All Products N=467</th>
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<th>Radical innovations N=217</th>
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<td>Mean</td>
<td>Standard Deviation</td>
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B: Correlation Matrix

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Hierarchical Moderated Regression Analysis

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D=Dummy Variable for Radical innovation
### Table 4
Summary Interpretation of Findings

Effectiveness of MMJI as a Means to Improve NPD Performance

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<th>PCA</th>
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<tr>
<td>Business and Market Analysis</td>
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<tr>
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<td>Marginally effective</td>
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<tr>
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<td>Not effective</td>
</tr>
<tr>
<td>Product Commercialization</td>
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<td><strong>For Radical NPD projects:</strong></td>
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<td>Product Commercialization</td>
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<td>Not effective (-)</td>
</tr>
</tbody>
</table>

Notes:

“Effective” – slope coefficient is positive and significant (p < 0.05)
“Marginally effective” – slope coefficient is marginally positive and significant (p < 0.10)
“Not effective” – slope coefficient is not significantly different than zero
(-) – Slope coefficient is significantly less positive than the coefficient for incremental NPD projects.
(+) – Slope coefficient is significantly more positive than the coefficient for incremental NPD projects.
Appendix
Measurement Items and Response Format

Dependent Variables:

ROI: Return on investment during the first twelve months of its life in the marketplace (in percentage)

Market share: The market share in principal served market segments at the end of first year of its life in the marketplace (in percentage)

Product Competitive Advantage (PCA):
(11-point scales, anchors: 0=strongly disagree; 10=strongly agree)

Compared to competitive products, this product offered some unique features to the customer (PCA1)
This product was clearly superior to competing products in terms of meeting customers’ needs (PCA2)
This product was higher quality than competing products (PCA3)
This product had superior technical performance than competing products (PCA4)

Independent Variables:

The level of marketing-manufacturing integration in conducting business and market opportunity analysis activities (MKTG):

Please indicate the extent to which the two departments (marketing and manufacturing) integrate their efforts in conducting the following new product development activities. (1=never; 5=always)

Analyzing the potential competition (MKTG1)
Conducting the detail market research (MKTG2)
Determining the desired product features (MKTG3)
Analyzing the potential customer needs (MKTG4)
Assessing the required investment, time, and risk of the project (MKTG5)

The level of marketing-manufacturing integration in conducting technical development activities (PD):

Please indicate the extent to which the two departments (marketing and manufacturing) integrate their efforts in conducting the following new product development activities. (1=never; 5=always)

Preliminary engineering, technical, and manufacturing assessments or studies (PD1)
Building the product to designated specifications (PD2)
Establishing criteria for judging the product performance and market acceptance (PD3)

Approving the final product designs. (PD4)

The level of marketing-manufacturing integration in conducting product testing activities (TEST):

*Please indicate the extent to which the two departments (marketing and manufacturing) integrate their efforts in conducting the following new product development activities. (1=never; 5=always)*

Planning testing sites, methods, schedules, responsibilities, and costs (TEST1)

Executing prototype testing with customers (TEST2)

Selecting customers for test marketing (TEST3)

Test marketing/trial selling prior to launch (TEST4)

Analyzing the findings from the pretests. (TEST5)

The level of marketing-manufacturing integration in conducting product commercialization activities (COMM):

*Please indicate the extent to which the two departments (marketing and manufacturing) integrate their efforts in conducting the following new product development activities. (1=never; 5=always)*

Completing the detail plans for manufacturing (COMM1)

Completing the detail plans for marketing (COMM2)

Start-up of full-scale production (COMM3)

Establishing over-all direction of the commercialization of the product (COMM4)

Launching the product in the market—selling, promoting, and distributing (COMM5)

*Moderating Variable*

**Product Innovativeness:**

(11-point scales, anchors: 0=strongly disagree; 10=strongly agree)

This product relied on technology which has never been used in the industry before.

This product caused significant changes in the whole industry.

This product was one of the first of its kind introduced into the market.

This product was highly innovative—totally new to the market.