The importance of customer input in the development of very new products

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This research explores the acquisition of customer input and its importance in the development of very new products. Data were gathered on 55 product development projects from the computer telephony integration industry – a new industry experiencing rapid technological change. The data were used to test hypotheses concerning the relationships between product newness, the importance of customer input in the development process, and the use of customer intensive market research methods. We found that the importance of customer input increases with *market newness* of a product up to a point and then drops off for very new products, whereas the importance of customer input increases with *technological newness* of a product without dropping off. We also found that the importance of customer input significantly increases the use of customer intensive market research methods; whereas, neither market nor technological product newness in themselves had much direct effect on research methods.

1. Introduction

The ability to successfully develop and market innovative new products is critical for modern firms, especially those in technology-related businesses. Most of the research on product development agrees that one of the most critical factors in new product development is understanding user needs and incorporating them into the new product design (Cooper, 1979; Cooper and Kleinschmidt, 1987; Rothwell *et al.*, 1974, Zirger and Maidique, 1990).

All technology driven firms have organizational processes and infrastructures that facilitate the capture of customer requirement information and its integration into the new product's design. Most of these processes and infrastructures, however, are designed for products that are in the latter stages of their lifecycle, or are incremental and continuous innovations (Eliashberg *et al.*, 1997). Wind and Mahajan (1997), in their introduction to the special issue on new product development of the *Journal of Marketing Research*, point to the lack of research on the topic of radical or discontinuous innovation. Although the literature provides little guidance to managers involved in the development of very new products, it appears evident that the development process, including the manner in which users are involved, differs markedly from the incremental new product development process (O'Connor, 1998).

There is some confusion in the literature as to the appropriate role of customer input in the development of very new products. While von Hippel (1986) proposed that users are an important

source of new product ideas, others have argued that being too close to customers or being 'customer-led' may prove detrimental to innovation and firm performance (Macdonald, 1995). These and other studies (Christensen, 1997; Ciccantelli and Magidson 1993; Neale and Corkindale, 1998) form the basis of an ongoing debate in the literature about whether customers and users inhibit or stimulate very new product ideas (Connor, 1999; Slater and Narver, 1998, 1999), and if customer input leads only to incremental new products.

The objective of the paper is to provide empirical evidence on how the importance of customer input in new product development changes with product newness. The paper's principal contribution is to show that the importance of customer input increases with market newness of a product up to a point and then drops off for very new products, whereas the importance of customer input increases with technological newness of a product without dropping off.

The paper is structured as follows. We first review the literature on customer involvement in the development of very new products and formulate a set of hypotheses based on this review. We next outline the research design, including data gathering and the measurement of research variables. After presenting the research results, we summarize our findings and draw general conclusions for managers.

2. The literature on the development of very new products

von Hippel (1986) maintains that there are 'lead users' of products that have useful solution data to offer firms interested in developing very new products. He defines 'lead users of a novel or enhanced product, process, or service as those who display two characteristics with respect to it: they face needs that will be general in the marketplace significantly in advance of the bulk of the marketplace; and they are positioned to benefit significantly by obtaining a solution to those needs'. The implication is that lead users can be an important source of input into the development of very new products.

Lead users must be selected carefully, however. If the sales and marketing organizations in a firm do not understand that lead users are not just well informed current customers, the firm can fail to develop very new products *because* they are attentive to the needs of current customers. Christensen (1997) outlines how incumbent firms that are attentive to the needs of the customers in their 'value network' can fail to recognize that certain 'disruptive' technologies will eventually allow newer entrants to take over their market.

Hamel and Prahalad (1994) suggest that 'customers are notoriously lacking in foresight'. Martin (1995) argues that firms should 'ignore their customers'. These assertions build on work by previous researchers who found that a marketing orientation 'inhibits organizations from developing truly breakthrough innovations' (Kohli and Jaworski, 1990). On the other hand, Slater and Narver (1998) argue that the traditional marketing concept of being 'market-oriented' is still very much desirable and should not be confused with being 'customer-led'. There is evidence that being 'customer-led', or responding to explicit customer needs, impedes innovation. However, avoiding the 'tyranny of current markets' (Leonard, 1995) should not come at the expense of a market-orientation, or 'a long-term commitment to understanding customer needs – both expressed and latent' and to developing innovative solutions that produce superior customer value.

In their in-depth case analyses of four, well-known discontinuous innovations, Lynn *et al.* (1996) found that not only was the information generated from conventional market research techniques not useful to radical innovation projects, it was often misleading. They propose that a 'probe and learn' process is more suited to highly uncertain, radically innovative environments. Companies developed their products 'by probing potential markets with early versions of the products, learning from the probes, and probing again'. Given that this iterative process is inherently exploratory and experimental rather than analytical, the authors point to the need to develop entirely different product development processes for discontinuous products.

Song and Montoya-Weiss (1998) examined the new product development practices of 163 'really new' products and 169 incremental new products. They defined a really new product as 'one that: relies on technology never used in the industry before; has an impact on or causes significant changes in the whole industry; and is the first of its kind and entirely new to the market'. They used six sets of general new product development activities in their analysis: strategic planning, idea development, business and market opportunity analysis, technical development, product testing, and product commercialization. They found that working to improve proficiency in business and

market opportunity analysis to be counterproductive for really new products, but profitable for incremental products. Conversely, they found that proficiency in strategic planning activities had a positive effect on the profitability of really new products, but a negative effect for incremental products.

Veryzer (1998a) examined the customer research efforts and findings of seven firms involved in the development of 'discontinuous' new products. Each of the seven projects was rated as low, medium or high on three dimensions of newness: the customer or user needs that it satisfied; the technological capabilities that it involved; and the thinking and behavior required of the consumer in using the product. Veryzer observed four general phases of product development in the cases studied: concept generation and exploration, technical development and design, prototype construction, and commercialization. He found that relatively little formal research was conducted during the concept generation and design phase, and that the amount of research conducted during the technical development and design phase was also limited. The prototype phase provided the first true opportunity to assess customer reaction to the product, its benefits and capabilities, and how it operated. Customer research during the commercialization phase was aimed at refining design and clarifying marketing issues, and tended to be more formal even if the same methods where used as in earlier phases. Although the sources of innovation were not the focus of his study, Veryzer noted that product ideas originated from within the firms rather than coming from customer input.

In a separate but related study, Veryzer (1998b) used findings from eight cases to develop a descriptive model of the 'discontinuous' product development process. The products were discontinuous in that they all 'involved emerging or new technologies developed by the firms themselves'. He concluded that discontinuous product development processes should be managed differently than those for incremental products. For example, discontinuous products are difficult for customers to understand or appreciate due to the break in logical product evolution that they involve. As a result, early design and prototyping that often precede market analyses are an essential part of the early phase of the discontinuous new product development process.

O'Connor (1998) describes findings from case studies of eight 'discontinuous' innovation projects. She defines a discontinuous innovation as 'a product or process either with unprecedented performance features or fivefold to tenfold improvements in performance or cost'. Her case study data suggested that the market-related questions that are asked during a discontinuous innovation project differ by stage of development, and that they differ from the questions that project teams typically ask during an incremental new product development effort.

O'Connor was also involved in a more recent study using similar case studies (Rice *et al.*, 2001) that addresses the gap between technical insight by technologists and opportunity recognition by managers for radical innovations. The authors develop a framework for bridging this gap that encompasses the radicalness of the technology involved together with the technology capabilities of the company, market related issues and corporate strategy issues. The framework calls for judgments on effects that the innovation can have on the external market and on its congruence with the company's capabilities and strategy.

A variety of terms are used in the literature to describe products that are not incremental developments: radical, discontinuous, really new, and very new. Garcia and Calantone (2002) try to clarify this issue by arguing for a category of product newness they call 'really new' lying between incremental and radical. They also argue for both macro (new to the world, the market or an industry) and micro (new to the firm or customer) perspectives. They state the following:

> Radical innovations are innovations that cause marketing and technological discontinuities on both a macro and micro level. Incremental innovations occur only at a micro level and cause either a marketing or technological discontinuity but not both. Really new innovations cover the combinations in between these two extremes.

We agree with their distinction between micro and macro, and the need for a class of innovation between incremental and radical. We do not find their definition of 'really new' innovations helpful, however, because it remains anchored on the idea of discontinuity making it very hard to operationalize.

We use the term 'very new'. The terms 'radical' and 'discontinuous' have a binary connotation – i.e., whether a new product is either radical or it is not – that can artificially generate controversy. The term 'very new' recognizes this fact and allows a more dispassionate perspective. There

are degrees of newness that we attempt to capture using 7-point Likert scales.

Danneels and Kleinschmidt (2001) show marketing and technological fit to be better predictors of new product performance than technology or market newness (what they call familiarity). However, our focus is on how firms manage their interface with customers when developing new products. As a result we use a 'newness to the firm' perspective in measuring product newness.

Tidd and Bodley (2002) reinforce this point when they state that 'what matters to practicing managers is how close a project is to their existing skills and past experience'. In summary, our approach to product newness is based on a continuum of newness between incremental and radical that focuses on newness to the firm developing the product.

3. Research hypotheses

Our review of the literature highlights the controversy around the importance of customer input in the development of very new products. Understanding user needs and incorporating them is critical for product success (Cooper, 1979; Cooper and Kleinschmidt, 1987; Rothwell *et al*., 1974; Zirger and Maidique, 1990). On the other hand, the importance of customer input in the development of very new products has been questioned (Christensen, 1997; Hamel and Prahalad, 1994; Leonard, 1995; Martin, 1995; Veryzer, 1998b).

To guide our research we formed three testable hypotheses. The first hypothesis deals with the relationship between product newness and the importance of customer input. The logic for this first hypothesis is the following. When the product being developed is one that is familiar to the developing company, customer input should be less important. As the level of product newness increases, the importance of customer input should increase. Beyond a certain point, however, the product being developed can be so new that customers have less relevant and reliable information to provide the firm. Thus our first hypothesis is:

H1: The importance of customer input increases with product newness to a certain level and then decreases for very new products.

This hypothesis has an analogue in the task complexity literature. Schroder *et al*. (1967) hypothesized that the amount of information processing appropriate to carry out a task increases with the complexity of the task up to a certain point and then decreases. This model still has currency in the literature (Campbell, 1998). Product newness is analogous to task complexity; using customer input involves information processing. Developing new products is a more complex task than developing incremental products. Using customer input in the product development process requires extensive information processing – increasingly so for products very new to the company.

It also seemed likely to us that when customer input is very important, the company will be more likely to use methods for gathering customer input that are based on intense interaction with customers. When customer input is not critical, methods such as in-house product demos and customer surveys may suffice. Customer intensive research methods such as co-development of the product with customers would likely be used more when customer input is vital. Thus our second hypothesis is:

H2: The customer intensity of the market research methods used increases with the importance of customer input in new product development.

Our literature review also highlights the fact that market research for very new products is different than that for incremental products (O'Connor, 1998; Veryzer, 1998a). Companies developing incremental products should be able to specify with some certainty what the customer related issues are, and as a result what customer inputs they require. They know what kinds of questions to ask, of whom to ask them, and what kind of responses they are likely to receive. Thus these companies should be able to gather these inputs without the intensive involvement of customers. As product newness increases, what the issues are and what customer inputs are required to resolve them become less clear. Intensive interaction with customers would become more appropriate. Thus our third hypothesis is:

H3: The customer intensity of the market research methods used increases with product newness.

We did not expect that the customer intensity of market research methods used would decrease for very new products. The rationale for this was that if the product is very new, the developing firm would want a close and effective connection with any customer actually involved in the development process.

The relationship among the three hypotheses is shown in Figure 1.

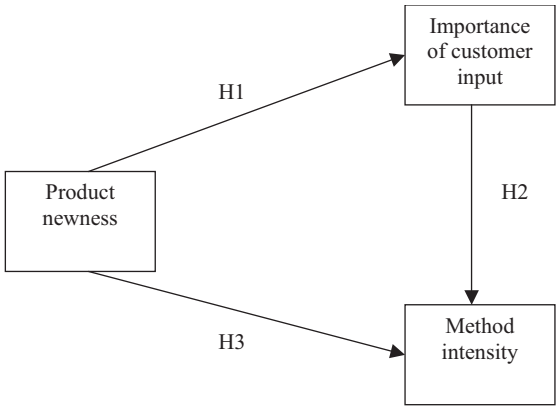

Figure 1. Three hypotheses.

4. Research design

Data collection

Preliminary interviews were conducted with managers responsible for product development at three firms developing computer telephony integration (CTI) products. These firms included one large multibillion-dollar company, a mid-sized vendor, and a smaller, relatively new firm.

The study's sampling frame consisted of 537 computer telephony equipment manufacturers and software developers. The list was compiled from the CTI Magazine directory of firms for 1998–99. A sample of 128 firms was randomly selected from the directory.

The CTI industry was chosen as the sampling frame because innovation was occurring at a very rapid pace in this field. The growth of the Internet had dramatically altered user requirements for telecommunications products as well as the competitive landscape of the telecom industry. As voice and data communications converged on Internet Protocol (IP) networks, traditional telephony vendors commenced supplying data communications capabilities, Internet-enabled products and web integration to their customers. Most CTI products developed just prior to the study period were first generation products incorporating new-to-the-world technology. The relative newness of the Internet, the speed at which it is growing, and the pace of technological evolution made the CTI industry a good source of very new product development projects.

The unit of analysis was a computer telephony new product development project. Senior managers responsible for new product development at the 128 firms were contacted and asked to participate in the study. Thirty firms were disqualified either because they refused to participate in the study or because they were subsidiaries of foreign companies and product development projects were managed in their home countries.

Managers agreeing to participate in the study were sent the questionnaire by fax or e-mail. In all, 98 questionnaires were sent. 23 respondents returned the questionnaires by fax or e-mail. Another 32 questionnaires were completed over the telephone for a total of 55 usable questionnaires – a response rate of 55/96 or 56%.

5. Product newness

McDermott (1998) highlighted the need to use two dimensions of product discontinuity or innovativeness: technology newness and market newness. Given our focus on how firms manage their interface with customers when developing new products, we use a 'newness to the firm' perspective in measuring product newness. Therefore, we measured product newness with five questions relating to technological and market issues. Respondents answered the questions on a seven-point Likert scale. The average of these five questions was used to form an *overall newness* measure for a product. The average responses for the first two questions constituted a *market newness* measure:

- How new (to your company) were the customers targeted by the new product?
- How new (to your company) were the user needs addressed by the new product?

The average responses for the last three questions constituted a *tech newness* measure:

- How new (to your company) was the technology embodied in the new product?
- How new (to your company) was the product architecture?
- How new (to your company) were the core components or software modules in the new product?

Lee and O'Connor (2003) call for measures that encompass both product newness to the firm and impact on consumer consumption behaviors. We do not gather data directly on impact on consumption behaviors but the answers to our

market newness questions do address this issue indirectly.

6. Product development activities

It is common to use development stages in research on product development. Eisenhardt and Tabrizi (1995) divided development projects into five stages: predevelopment, conceptual design, product design, testing, process development, and production start-up. Because of the iterative nature of software development processes (Boehm, 1988), however, it is difficult to determine in what 'stage' a software development project is at any given time. Therefore, we moved away from dividing the development process into stages. Rather, we identified five major activities of software product development the first four of which can be carried out iteratively for any given product development and may overlap:

1. idea generation and screening – the generation of product concepts and their evaluation for technical feasibility and likelihood of market success;
2. requirements definition and design specification–the determination of the commercial (i.e., customer) requirements for the product together with its functional specification;
3. technical development – the definition of the product design at the level of the modules to be used and their interdependencies together with the creation of the source code for the software product in whatever languages that are used;
4. trials and testing – the internal, laboratory based system testing of versions of the entire product and the testing of pre-release versions of the product by end users/customers often at their sites;
5. product launch – the release of the product into the market, marketing and promotion and the commencement of sales to customers.

These five activities are consistent with the stage models reviewed by Tidd and Bodley (2002) and are consistent with our understanding of software intensive product development processes both from this and previous research (Callahan and Moretton, 2001).

7. Customer input

Respondents were asked to rate the *importance* of the input of potential end-users of the product during each of the five major activities of the product development process on a seven-point Likert scale. The questions were of the following form:

- How important was the input provided by potential end-users of the product during idea generation and screening activities?

We averaged these five measures to get *end-user input*.

Respondents were also asked to rate the importance of the input of other customer personnel during each of the five major activities in the development process. These other individuals were described to respondents as IT or technical support personnel, key decision-makers, buyers or influencers of the buying decision at potential customer firms. Most of the products in our CTI sample are sold to companies in which there are many types of customers besides end-users from whom input can be important. We also averaged these five measures to get *other customer input*.

8. Customer intensity of market research methods

Respondents also specified the various market research methods used during each activity of the development process. The extent of the use of customer-intensive market research methods during each of the five major activities in the product development process were measured by assigning scores to the different methods based on the extent of customer involvement that they require. The following method intensity scale was used:

0: in-house demos, and technological forecasting;
1: customer surveys;
2: focus/discussion groups, and user group feedback;
3: alpha/beta site testing, customer site visits, and direct observation of users;
4: co-development.

Total scores for each activity were then summed in order to derive a measure of method intensity during each of the five activities in the product development process. We also averaged these five measures to get *method intensity*.

We found respondents to our questionnaire very confused as to the true meaning of 'lead user analysis'. As a result, our data on the use of lead users was left out of our analysis. Those respondents who indicated that they used lead user

analysis in product development were prompted to explain what they meant by lead users. von Hippel (1986) describes lead user analysis as a method for seeking out users that face needs well in advance of the general marketplace and using these users to generate ideas for new products. Respondents provided very different explanations for what they meant by lead user analysis. The majority of respondents thought of lead user analysis as a method for testing new products with a group of early adopter customers and not lead customers as defined by von Hippel. Therefore, it was decided not to include this item due to the ambiguity of the concept for respondents and the consequent lack of consistency in responses.

9. Results

Sample characteristics

In the sample, product development project durations ranged from 2.5 to 36 months with a mean of 12.8 months; total budgets from $10,000 to $25 million with a mean of $2.3 million. Given that the sample included a very broad cross-section of firms in terms of size and product category as well as a wide range of different products based on cost and length of development, we argue that the results are representative of the computer telephony industry in 1999.

Complete descriptive statistics on project duration and budget, product newness, importance of customer input and market research method intensity are contained in Table A1 in the Statistical Appendix. It can be noted there that the importance of customer input was lowest during technical development. Method intensity is also low during this activity. The importance of customer input was high during trials and testing; method intensity was also highest during this activity.

Testing the hypotheses

H1: the importance of customer input increases with product newness to a certain level and then decreases for very new products.

We first tested for a linear relationship between newness and the importance of customer input. As shown in Table 1, *end-user input* has significant linear relationships with *overall newness* and *technological newness*, but *not* with *market newness*. There are significant linear relationships between *other customer input* and all three measures of newness.

Table 1. Correlations between importance of customer input and product newness.

	Overall newness	Market newness	Tech newness
End-user input	0.42***	0.18	0.48***
Other customer input	0.33**	0.31**	0.26*

*$p<0.10$, **$p<0.05$, ***$p<0.01$.

We then used quadratic regression to test hypothesis 1 further. The quadratic regression specification of the hypothesis is that:

$$\text{importance of customer input} = \alpha + \beta_1(\text{newness}) + \beta_2(\text{newness})^2 + \varepsilon \text{ with } \beta_1 > 0 \text{ and } \beta_2 < 0,$$

and that the importance of customer input reaches a peak when newness is less than the maximum of 7.

Table 2 shows the results of three quadratic regressions. The dependent variable in each regression is *end-user input*. The independent variables are *overall newness*, *market newness* and *technological newness* respectively. The estimates of β_1 and β_2 have the hypothesized sign in each case. The regressions using *overall newness* and *market newness* produce significant estimates for β_1 and β_2. Note that the estimates for β_1 and β_2 are *not* significant when *technological newness* is used as the independent variable in the regression.

These results indicate that there is a quadratic relationship between *end-user input* and *overall newness*, but that the quadratic nature of the relationship comes from *market newness* not from *tech newness*. When *other-customer input* is used as the dependent variable, none of the quadratic regression results are significant.

The best-fit quadratic equation for the first regression – *end-user input* against *overall newness* – is:

$$\textit{end-user input} = \text{constant} + 1.92(\textit{overall newness}) - 0.16(\textit{overall newness})^2$$

The slope of the equation is then 1.92–0.16(2)(*overall newness*). When *overall newness* is at its maximum value of 7, this slope takes the value 1.92–0.16(2)(7) = −0.32. The negative slope of the relationship between *end-user input* and *overall newness*, at high levels of *overall newness*, supports hypothesis 1.

Table 2. Results of quadratic regression analysis: importance of end-user input averaged over all activities against product newness.

Independent variable	R^2 (adjusted)	F	Estimate of β_1	Estimate of β_2
Overall newness	0.22	8.62***	1.92***	−0.16**
Market newness	0.06	2.83*	1.28**	−0.13*
Technological newness	0.20	7.90***	0.79	−0.04

*$p<0.10$, **$p<0.05$, ***$p<0.01$.

These quadratic regression results are supported by correlations on split samples. For the eight products with *overall newness* greater than 6.0, the correlation between *end-user input* and *overall newness* is significantly negative: −0.67*. For the rest of the sample the corresponding correlation is significantly positive: +0.37**.

A fuller set of correlation and quadratic regression results broken out by development process activity is contained in Tables A2, A3, A4 and A5 of the Statistical Appendix. The more detailed results are consistent with those just described.

H2: the customer intensity of the market research methods used increases with the importance of customer input in new product development.

We tested hypothesis 2 using correlation analysis. The correlations between *end-user* and *method intensity* is .46***. The correlation between *other customer* and *method intensity* is .36**.

More complete correlation data for each of the five development activities is contained in Table A6 in the Statistical Appendix. During idea generation and screening, there is no significant linear relationship between importance of customer input (*end-user input* or *other customer input*) and *method intensity*. During requirements definition, trials and testing, and product launch, there are significant correlations between *method intensity* and *end-user input*, but not with *other customer input*. The result is just the opposite for the technical development activity: during technical development, there is a significant correlation between *method intensity* and *other customer* but not with *end-user*.

These correlations provide some support for hypothesis 2.

H3: the customer intensity of the market research methods used increases with product newness.

We also used correlation analysis to test hypothesis 3. As can be seen in Table 3, there are significant positive correlations between *method intensity* and the three measures of product newness. Path analysis based on the relationship between the three hypotheses shown in Figure 1, however, suggests using partial correlations to control for *end-user input*. The partial correlations, also shown in Table 3, show less direct support for hypothesis 3.

In the more detailed results provided in Table A7 and A8 in the Statistical Appendix, there are strong partial correlations between *method intensity* and *overall newness* in idea generation and screening, and between *method intensity* and *market newness* and in technical development.

These results provide weak support for hypothesis 3.

10. Summary and Managerial Implications

Summary of results

There is strong support for hypothesis 1 – that the importance of customer input increases with product newness to a certain level and then decreases for very new products. Correlation analysis and quadratic regression showed that the importance of end-user input does increase with overall newness of a product to a company up to a point, and that it tends to decrease for high levels of overall newness. This drop off in the importance of customer input also occurs with

Table 3. Correlations and partial correlations between newness and method intensity.

Correlations	Overall newness	Market newness	Tech newness
Method intensity	0.34**	0.24*	0.31**
Partial correlations controlling for end-user input			
Method intensity	0.16	0.16	0.10

*$p<0.10$, **$p<0.05$, ***$p<0.01$.

high levels of market newness but not with high levels of technological newness.

There is also support for hypothesis 2 – customer intensity of the market research methods used increases with the importance of customer input in new product development. Correlation analysis demonstrated several positive linear relationships between measures of the importance of customer input and of the customer intensity of the market research methods used.

There was less support in the data for hypothesis 3 – customer intensity of the market research methods used increases with product newness in the data. Partial correlation analysis showed that the relationship between product newness and the customer intensity of the market research methods used demonstrated through correlation analysis, was mostly an indirect effect through the importance of customer input.

There are also results particular to each of the five major activities that are worth noting:

Idea generation and screening. In idea generation and screening, the importance of customer input is relatively high but *not* correlated with product newness. There is a strong positive relationship, however, between overall newness and method intensity during this activity.

Requirements definition. During requirements definition and design specification, the importance of end-user input and product technical newness are strongly correlated. The importance of end-user input is also strongly correlated with market research method intensity.

Technical development. The importance of customer input is low during technical development, as is method intensity. When the sample is split into low and high levels of product newness, the importance of customer input during technical development is positively correlated with product newness for lower levels of product newness. At very high levels of product newness, the importance of customer input during technical development is negatively correlated with product newness. As well, there is a strong positive relationship between market newness and method intensity, and a strong correlation between the importance of other customer input and method intensity for this activity.

Trials and testing. During trials and testing, both the importance of customer input and method intensity are high, and there is a strong positive relationship between market newness and the importance of customer input. There is also a strong correlation between the importance of end-user input and method intensity.

Product launch. During product launch, there is a significant quadratic relationship between the importance of end-user input and overall and market newness. There is again a strong correlation between the importance of end-user input and method intensity.

The sample

Before considering the managerial consequences of the results, we should first review the nature of the sample and how this influenced the results. The sample projects are drawn from the computer telephony industry. 35% of the sample involved pure software products. Over 80% of the sample involved at least 50% software. The results are heavily influenced by software development. It can be argued that software development is different from the development of physical products. For example, software design is 'in the code' – it is not visible. This makes it hard to use software design as a focal point for involving customers in the development process and capturing requirements. These differences may restrict the applicability of the results of this research. On the other hand, software products are of ever increasing importance in the economy. Many physical products, automobiles and home appliances as well as electronic products for example, have significant software components.

Many products included in our research sample would not be considered 'radical' by O'Connor (1998), 'discontinuous' by Veryzer (1998a, b) or 'really new' by Song and Montoy-Weiss (1998). The newest products in the sample are, however, 'very new'. They are drawn from an industry noted for its rapid innovation, and rated as very new by manager respondents.

Consider a conclusion drawn by Veryzer (1998b) in his study of eight discontinuous product development projects. He postulated the existence of a dynamic drifting phase at the front end of discontinuous development – dynamic drifting referring to technical exploration in R&D labs often undertaken separately in independent research programs. There was little 'dynamic drifting' in our sample projects. The average product development duration in the

sample was 12.8 months; the longest was 36 months. The dynamic drifting described by Veryzer is not typical of software based development projects.

Managerial implications

Firstly, in our data the importance of end-user input in product development increases up to a certain point but then decreases for products that are very new to the company developing them. This goes some way to clarifying the managerial controversy outlined in our literature review. Managers do seem to place more importance on end-user input as the level of newness of the product to the developing company increases, but only up to a certain point. When the newness of the product to the company increases beyond a certain point, however, the importance that they place on end-user input drops off. This result is consistent with the 'probe and learn' strategy found by Lynn *et al.* (1996) in their study of four cases of 'discontinuous innovation'. Using a 'probe and learn' strategy, the case study firms brought initial products to market in order to subsequently learn from customer reactions. The initial product was regarded as the first step in a longer process of development. Although the case study firms in each case employed conventional marketing techniques, the 'techniques proved to be of limited utility, were often ignored, and in hindsight were sometimes strikingly inaccurate'.

Figure 2 shows this curvilinear relationship between the importance of customer input and product newness for the whole range of newness: from incremental, through very new to radical. We believe that our sample of very new products has captured how the importance of customer input starts to drop off for products very new to the developing company.

Secondly, market newness of a product (the newness to the company of the customers targeted and customer needs addressed) and technological newness of a product (newness to the company of technology embodied, product architecture and core components) affect the importance of customer input in different ways. The importance of end-user input drops off when market newness is very high. This drop-off does not occur with technical newness. Moreover, use of customer intensive research methods is related to market and technological newness in different ways. For example, it is market newness not technical newness that leads to the use of customer intensive research methods during technical development activities.

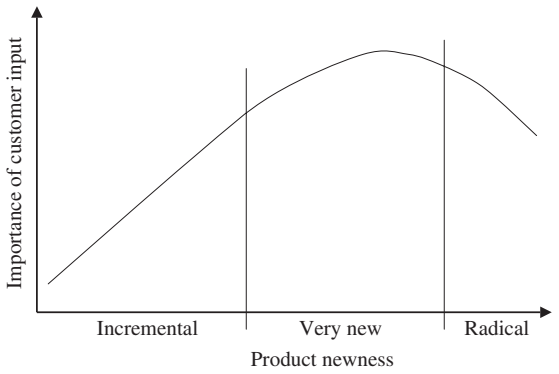

Figure 2. The importance of customer input for incremental, very new and radical products.

Thirdly, both the importance of customer input and the use of customer intensive research methods vary over the major activities of product development. The importance of both end-user and other customer input is lowest during technical development activities and high before and after. Customer intensive research methods are most used during trials and testing and least used during technical development.

Lastly, the importance of the input of end-users and other customers are affected differently by product newness. In particular, the importance of end-user customer input decreases for very new products whereas the importance of other customer input does not.

Acknowledgements

This research was funded by the Social Sciences and Humanities Research Council of Canada (SSHRC) and the Canadian Advanced Technology Association (CATA).

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Statistical Appendix

Table A1. Sample variable descriptive statistics.

Variable	N	Min	Max	Mean	Standard deviation
Duration (in months)	55	2.5	36	12.8	8.3
Budget (in millions $)	48	0.01	25	2.3	5.2
New customers	55	1	7	4.5	1.8
New user needs	55	1	7	5.2	1.7
New technology	55	1	7	5.4	1.6
New architecture	55	1	7	5.2	1.5
New components	55	1	7	4.8	1.6
Overall newness	55	1.2	7	5.0	1.2
Market newness	55	1	7	4.9	1.5
Tech newness	55	1.3	7	5.1	1.4
Importance of end-user input in:					
idea generation and screening	55	1	7	5.1	1.7
req def'n and design spec'n	55	1	7	4.8	1.8
technical development	55	1	7	3.0	1.6
trials and testing	55	1	7	5.1	1.8
product launch	55	1	7	4.8	1.8
Averaged over all activities	55	1	7	4.6	1.3
Importance of other customer input in:					
idea generation and screening	50	1	7	4.3	1.6
req def'n and design spec'n	50	1	7	4.3	1.7
technical development	50	1	7	3.1	1.6
trials and testing	49	1	7	4.3	1.9
product launch	50	1	7	4.3	1.8
Averaged over all activities	49	1	7	4.1	1.3
Method intensity in:					
idea generation and screening	52	0.0	15.0	4.7	4.1
req def'n and design spec'n	52	0.0	15.0	4.5	4.4
technical development	52	0.0	17.0	3.1	3.4
trials and testing	52	0.0	14.0	6.7	3.5
product launch	52	0.0	11.0	4.0	3.3
Averaged over all activities	52	0.6	10.8	4.6	2.6

Table A2. Correlations between importance of customer input and method intensity.

Method intensity	End-user input	Customer input
idea generation and screening	0.09	0.12
req def'n and design spec'n	0.37***	0.22
technical development	0.08	0.30**
trials and testing	0.40***	0.17
product launch	0.37***	0.21
Average over all activities	0.46***	0.36**

*$p<0.10$, **$p<0.05$, ***$p<0.01$.

Table A3. Results of quadratic regression analysis: overall newness.

Importance of end-user input in:	R^2 (adjusted)	F	Estimate of β_1	Estimate of β_2
1. Idea generation and screening	0.05	2.41*	1.98*	−0.19*
2. Req def'n and design spec'n	0.12	4.54**	1.22	−0.07
3. Technical development	0.01	1.37	1.52	−0.15
4. Trials and testing	0.26	10.29***	2.19**	−0.16
5. Product launch	0.14	5.26***	2.71***	−0.25**
6. Average over all activities	0.22	8.62***	1.92***	−0.16**
7. Averaged over the first four activities, excluding product launch	0.19	7.42***	1.73**	−0.14*

*$p<.10$, **$p<.05$, ***$p<.01$.

Table A4. Results of quadratic regression analysis: market newness.

Importance of end-user input in:	R^2 (adjusted)	F	Estimate of β_1	Estimate of β_2
1. Idea generation and screening	0.00	1.09	1.23	−0.13
2. Req def'n and design spec'n	0.04	2.06	1.32	−0.12
3. Technical development	−0.03	0.24	−0.05	−0.01
4. Trials and testing	0.09	3.78**	1.19	−0.09
5. Product launch	0.14	5.31***	2.69***	−0.29***
6. Average over all activities	0.06	2.83*	1.28**	−0.13*
7. Averaged over the first four activities, excluding product launch	0.03	1.76	0.92	−0.08

*$p<.10$, **$p<.05$, ***$p<.01$.

Table A5. Results of quadratic regression analysis: tech newness.

Importance of end-user input in:	R^2 (adjusted)	F	Estimate of β_1	Estimate of β_2
1. Idea generation and screening	0.02	1.45	0.74	−0.05
2. Req def'n and design spec'n	0.13	5.07***	−0.16	0.07
3. Technical development	0.02	1.67	0.70	−0.05
4. Trials and testing	0.22	8.41***	1.35	−0.08
5. Product launch	0.11	4.22**	1.33	−0.09
6. Average over all activities	0.20	7.90***	0.79	−0.04
7. Averaged over the first four activities, excluding product launch	0.18	7.12***	0.66	−0.02

*$p<0.10$, **$p<0.05$, ***$p<0.01$.

Table A6. *Correlations between importance of customer input and method intensity.*

	Method intensity					
	idea generation and screening	requirements definition and design spec	technical development	trials and testing	product launch	Average
Importance of end-user input in:						
idea generation and screening	0.09	0.11	0.05	0.33	0.31**	0.25*
req def'n and design spec'n	0.28**	0.37***	0.31**	0.53***	0.42***	0.54***
technical development	0.06	0.19	0.08	0.30**	0.06	0.20
trials and testing	0.225	0.27*	0.20	0.40***	0.18	0.37***
product launch	0.07	0.17	0.10	0.29**	0.37***	0.27*
Average over all activities	0.20	0.31**	0.21	0.52***	0.38***	0.46***
Importance of other customer input in:						
idea generation and screening	0.12	0.16	0.22	0.16	0.15	0.24
req def'n and design spec'n	0.19	0.22	0.22	0.23	0.29**	0.33**
technical development	0.27*	0.23	0.30**	0.01	0.02	0.25*
trials and testing	0.20	0.29**	0.35**	0.17	−0.09	0.28*
product launch	0.03	0.20	0.21	0.21	0.21	0.24
Average over all activities	0.21	0.29**	0.35**	0.21	0.15	0.36**

*$p<0.10$, **$p<0.05$, ***$p<0.01$.

Table A7. Correlations between newness and method intensity.

Method intensity	Overall newness	Market newness	Tech newness
idea generation and screening	0.28**	0.22	0.24*
req def'n and design spec'n	0.26*	0.25*	0.19
technical development	0.23	0.32**	0.10
trials and testing	0.24*	0.05	0.31**
product launch	0.16	−0.03	0.25*
Average over all activities	0.34**	0.24*	0.31**

*$p<0.10$, **$p<0.05$, ***$p<0.01$.

Table A8. Partial correlations between newness and method intensity controlling for average importance of end-user input.

Method intensity	Overall newness	Market newness	Tech newness
idea generation and screening	0.26**	0.22	0.22
req def'n and design spec'n	0.12	0.17	0.05
technical development	0.22	0.33**	0.08
trials and testing	0.01	−0.12	0.11
product launch	0.04	−0.10	0.13
Average over all activities	0.16	0.16	0.10

*$p<0.10$, **$p<0.05$, ***$p<0.01$.