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Predicting the Source of Innovation: Lead Users

The experiment I report on in this chapter involves predicting the source of innovation, user innovation in this instance. The specific context of the work addresses an important problem facing industrial and consumer marketing research: How can one accurately determine user needs for new products (processes and services) in fields that are rapidly changing such as those touched by high technology?

I begin by exploring the difficulty faced by marketing research in more depth. Then, I spell out the lead user methodology I have proposed as a solution.[1] Finally, I describe a first application of the method.[2]

Root of the Problem: Marketing Research Constrained by User Experience

Users selected to provide input data to consumer and industrial market analysis have an important limitation: Their insights into new product (and process and service) needs and potential solutions are constrained by their real-world experience. Users steeped in the present are, thus, unlikely to generate novel product concepts that conflict with the familiar.

The notion that familiarity with existing product attributes and uses interferes with an individual's ability to conceive of novel attributes and uses is strongly supported by research into problem solving (Table 8–1). We see that experimental subjects familiar with a complicated problem-solving strategy are unlikely to devise a simpler one when this is appropriate.[3] Also, and germane to our present discussion, we see that subjects who use an object or see it used in a familiar way are strongly blocked from using that object in a novel way.[4] Furthermore, the more recently objects or problem-solving strategies have been used in a familiar way, the more difficult subjects find it to employ them in a novel way.[5] Finally, we see that the same effect is displayed in the real world, where the success of a research group in solving a new problem is shown to depend on whether solutions it has used in the past will fit that new problem.[6] These studies thus suggest that typical users of existing products—the type of user-evaluators customarily chosen in market research—are poorly situated with regard to the difficult problem-solving tasks associated with assessing unfamiliar product and process needs.

As illustration consider the difficult problem-solving steps potential users must go through when asked to evaluate their need for a proposed new product. Since individual industrial and consumer products are only components in larger usage patterns that may involve many products and since a change in one component can change perceptions of, and needs for, some or all other products in that pattern, users must first identify their existing multiproduct usage patterns in which the new product might play a role. Then, they must evaluate the new product's potential contribution to these. (E.g., a change in the operating characteristics of a computer may allow users to solve new problem types if they also make changes in software and perhaps in other, related products and practices.) Next, users must invent or select the new (to them) usage patterns that the proposed new product makes possible for the first time and then evaluate the utility of the product in these patterns. Finally, since substitutes exist for many multiproduct usage patterns (e.g., many forms of problem analysis are available in addition to the novel ones made possible by a new computer), the user must estimate how the new possibilities presented by the proposed new product will compete (or fail to compete) with existing options. This problem-solving task is clearly a very difficult one, particularly for typical users of existing products whose familiarity with existing products and uses interferes with their ability to conceive of novel products and uses when invited to do so.

The constraint of users to the familiar pertains even in the instance of sophisticated marketing research techniques such as multiattribute mapping of product perceptions and preferences.[7] Multiattribute (multidimensional) marketing research methods, for example, describe users' (buyers') perception of new and existing products in terms of a number of attributes (dimensions). If and as a complete list of attributes is available for a given product category, the users' perception of any particular product in the category can be expressed in terms of the amount of each attribute they perceive it to contain, and the difference between any two products in the category can be expressed as the difference in their attribute profiles. Similarly, users' preferences for existing and proposed products in a category can in principle be built up from their perceptions of the importance and desirability of each of the component product attributes.

Although these methods frame user perceptions and preferences in terms of attributes, they do not offer a means of going beyond the experience of those interviewed. First, for reasons discussed earlier, users are not well positioned to accurately evaluate novel product attributes or accurately quantify familiar product attributes that lie outside the range of their real-world experience. Second, and more specific to these techniques, there is no mechanism to induce users to identify all product attributes potentially relevant to a product

TABLE 8–1. The Effect of Prior Experience on Users' Ability to Generate or Evaluate Novel Product Possibilities

Study	*Nature of Research*	*Impact of Prior Experience on Ability to Solve Problems*
1. Luchins (1942)	Two groups of subjects ($n =$) were given a series of problems involving water jars, for example, "If you have jars of capacity A, B, and C, how can you pour water from one to the other so as to arrive at amount D?" Subject group 1 was given five problems solvable by formula, $B - A - 2C = D$. Next, both groups were given problems solvable by that formula *or* by a simpler one (e.g., $B - C = D$).	81% of experimental subjects who had previously learned a complex solution to a problem type applied it to cases where a simple solution would do. No control group subjects did so ($p =$ NA).[a]
2. Duncker (1945)	The ability to use familiar objects in an unfamiliar way was tested by creating five problems that could only be solved by that means. (E.g., one problem could be solved only if subjects bent a paper clip provided them and used it as a hook.) Subjects were divided into two groups. One group of problem solvers saw the crucial object being used in a familiar way (e.g., the paper clip holding papers), the other did not (e.g., the paper clip was simply lying on a table unused).	Subjects were much more likely to solve problems requiring the use of familiar objects in unfamiliar ways if they had not been shown the familiar use just prior to their problem-solving attempt. Duncker called this effect "functional fixedness" ($n = 14$; $p =$ NA).[a]
3. Birch and Rabinowitz (1951)	Replication of Duncker, above.	Duncker's findings confirmed ($n = 25$; $p < .05$).
4. Adamson (1952)	Replication of Duncker, above.	Duncker's findings confirmed ($n = 57$; $p < .01$).
5. Adamson and Taylor (1954)	The variation of functional fixedness with time was observed by the following procedure. First, subjects were allowed to use a familiar object in a familiar way. Next, varying amounts of time were allowed to elapse before subjects were invited to solve a problem by using the object in an *un*familiar way.	If a subject uses an object in a familiar way, he or she is partially blocked from using it in a novel way ($n = 32$; $p < .02$). This blocking effect decreases over time.
6. Allen and Marquis (1964)	Government agencies often buy R & D services through a request for proposal (RFP) that states the problem to be solved. Interested	Bidders were significantly more likely to propose a successful task approach if they had prior experience with that approach only

bidders respond with proposals that outline their planned solutions to the problem and its component tasks. In this research the relative success of eight bidders' approaches to the component tasks contained in two RFPs was judged by the agency buying the research ($n = 26$). Success was then compared to prior research experience of bidding laboratories.	rather than prior experience with inappropriate approaches only.

Source: Eric von Hippel, "Lead Users: A Source of Novel Product Concepts," *Management Science* 32, no. 7 (July 1986), 794—95. Copyright 1986, The Institute of Management Sciences, 290 Westminster Street, Providence, Rhode Island 02903.

[a]This relatively early study showed a strong effect but did not provide a significance calculation or present data in a form that would allow one to be determined without ambiguity.

category, especially attributes that are currently not present in any extant category member. To illustrate this point, consider two types of such methods, similarity-dissimilarity ranking and focus groups.

In similarity-dissimilarity ranking, data regarding the perceptual dimensions by which users characterize a product category are generated by asking a sample of users to compare products in that category and assess them in terms of their similarity and dissimilarity. In some variants of the method, the user interviewee specifies the ways in which the products are similar or different. In others, the user simply provides similarity and difference rankings, and the market researcher determines—through his personal knowledge of the product type in question, its function, the marketplace, and so on—the important perceptual dimensions that must be motivating the user rankings obtained.

The similarity-dissimilarity method clearly depends heavily on an analyst's qualitative ability to interpret the data and correctly identify all the critical dimensions. Moreover, by its nature, this method can only explore perceptions derived from attributes that exist in, or are associated with, the products being compared. Thus, if a group of evaluators is invited to compare a set of cameras and none has a particular feature—say, instant developing—then the possible utility of this feature would not be incorporated in the perceptual dimensions generated. That is, the method would have been blind to the possible value of instant developing prior to Edwin Land's invention of the Polaroid camera.

In focus group methods, market researchers assemble a group of users familiar with a product category for a qualitative discussion of perhaps two hours' duration. The topic for the focus group, which is set by the market researcher, may be relatively narrow (e.g., users' perceptions of *x* brand) or somewhat broader (e.g., camera users' perceptions of the photographic experience). The ensuing discussion is recorded, transcribed, and later reviewed by the researcher, whose task it is to identify the important product attributes that have implicitly or explicitly surfaced during the conversation. Clearly, as with similarity-dissimilarity ranking, the utility of information derived from focus group methods depends heavily on the individual analyst's ability to accurately and completely abstract from the interview data the attributes users feel important in products.

In principle, however, the focus group technique need not be limited to only identifying attributes already present in existing products, even if the discussion is nominally focused on these. For example, a topic that extends the boundaries of discussion beyond a given product to a larger framework could identify attributes not present in any extant product in a category under study. If discussion of the broad topic mentioned earlier, camera users' perceptions of the photographic experience, brought out dissatisfaction with the time lag between picture taking and receipt of the finished photograph, the analyst would be in possession of information that could induce him to identify an attribute not present in any camera prior to Land's invention, instant film development, as a novel and potentially important attribute.

But how likely is it that an analyst will take this creative step? And, more generally, how likely is it that either method discussed above, similarity-dissimilarity ranking or focus groups, will be used to identify attributes not present in extant products of the type being studied, much less a complete list of all relevant attributes? Neither method contains an effective mechanism to encourage this outcome, and discussions with practitioners indicate that in present-day practice, identification of any novel attribute is unlikely.

Finally, both of these methods conventionally focus on familiar product categories. This restriction, necessary to limit the number of attributes that completely describe a product type to a manageable number, also tends to limit market research interviewees to attributes that fit products within the frame of existing product categories. Modes of transportation, for example, logically shade off into communication products as partial substitutes ("I can drive over to talk to him, or I can phone"), into housing and entertainment products ("We can buy a summer house, or go camping in my recreational vehicle"), indeed, into many other of life's activities. But since a complete description of life cannot be compressed into 25 attribute scales, the analysis is constrained to a narrower—usually conventional and familiar—product category or topic. This has the effect of rendering any promising and novel cross-category new product attributes less visible to the methods I have discussed.

In sum, then, we see that marketing researchers face serious difficulties if they attempt to determine new product needs falling outside of the real-world experience of the users they analyze.

Lead Users as a Solution

In many product categories, the constraint of users to the familiar does not lessen the ability of marketing research to evaluate needs for new products by analyzing typical users. In the relatively slow-moving world of steels and autos, for example, new models often do not differ radically from their immediate predecessors. Therefore, even the "new" is reasonably familiar and the typical user can thus play a valuable role in the development of new products.

In contrast, in high technology industries, the world moves so rapidly that the related real-world experience of ordinary users is often rendered obsolete by the time a product is developed or during the time of its projected commercial lifetime. For such industries I propose that lead users who *do* have real-life experience with novel product or process needs are essential to accurate marketing research. Although the insights of lead users are as constrained to the familiar as those of other users, lead users are familiar with conditions that lie in the future for most—and, so, are in a position to provide accurate data on needs related to such future conditions.

I define lead users of a novel or enhanced product, process, or service as those who display two characteristics with respect to it:

1. Lead users face needs that will be general in a marketplace, but they face them months or years before the bulk of that marketplace encounters them, *and*
2. Lead users are positioned to benefit significantly by obtaining a solution to those needs.

Thus, a manufacturing firm with a current strong need for a process innovation that many manufacturers will need in two years' time would fit the definition of lead user with respect to that process.

Each of the two lead user characteristics provides an independent contribution to the type of new product need and solution data such users are hypothesized to possess. The first specifies that a lead user will possess the particular real-world experience manufacturers must analyze if they are to accurately understand the needs the bulk of the market will have tomorrow. Users "at the front of the trend" typically exist simply because important new technologies, products, tastes, and other factors related to new product opportunities typically diffuse through a society, often over many years, rather than impact all members simultaneously.[8]

The second lead user characteristic is a direct application of the hypothesis we have focused on in this book, and assumes it correct: Users who expect high rents from a solution to a need under study should (I reason) have been driven by these expectations to attempt to solve their need. This work in turn will have produced insight into the need and perhaps useful solutions that will be of value to inquiring market researchers.

In sum, then, lead users are users whose present strong needs will become general in a marketplace months or years in the future. Since lead users are familiar with conditions that lie in the future for most others, I hypothesize that they can serve as a need-forecasting laboratory for marketing research. Moreover, since lead users often attempt to fill the need they experience, I hypothesize that they can provide valuable new product concept and design data to inquiring manufacturers in addition to need data.

Testing the Method

Glen Urban and I, with the able assistance of our student, David Israel-Rosen, have conducted a prototype lead user market research study in the rapidly changing field of computer-aided-design (CAD) products. (Over 40 firms compete in the $1 billion market for CAD hardware and software. This market grew at over 35% per year over the period 1982 to 1986 and the forecast is for continued growth at this rate for the next several years.) Within the CAD field, we decided to specifically focus on CAD systems used to design the printed circuit (PC) boards used in electronic products, PC–CAD.

Printed circuit boards hold integrated circuit chips and other electronic components and interconnect these into functioning circuits. PC–CAD systems help engineers convert circuit specifications into detailed printed circuit board designs. The design steps that are, or can be, aided by PC–CAD include component placement, signal routing (interconnections), editing and checking, documentation, and interfacing to manufacturing. The software required to perform these tasks is quite complex and includes placement and routing algorithms and sophisticated graphics. Some PC–CAD manufacturers sell only such software, whereas others sell systems that include both specialized computers and software. (Important suppliers of PC–CAD in 1985 included IBM, Computervision, Redac, Calma, Scicards, and Telesis.)

The method Urban and I used to identify lead users and test the value of the data they possess in the PC–CAD field involved four major steps: (1) identify an important market or technical trend, (2) identify lead users with respect to that trend, (3) analyze lead user data, and (4) test lead user data on ordinary users. I will discuss each in turn.

Identifying an Important Trend

Lead users are defined as being in advance of the market with respect to a given important dimension that is changing over time. Therefore, before one can identify lead users in a given product category of interest, one must specify the underlying trend on which these users have a leading position.

To identify an "important" trend in PC–CAD, we sought out a number of expert users. We identified these by telephoning managers of the PC–CAD groups of a number of firms in the Boston area and asking each: "Whom do you regard as the engineer most expert in PC–CAD in your firm?" "Whom in your company do group members turn to when they face difficult PC–CAD problems?"[9] After our discussions with expert users, it was qualitatively clear to us that an increase in the density with which chips and circuits are placed on a board was, and would continue to be, a very important trend in the PC–CAD field. Historical data showed that board density had in fact been steadily increasing over a number of years. And the value of continuing increases in density was clear. An increase in density means that it is possible to mount more electronic components on a given size printed circuit board. This in turn translates directly into an ability to lower costs (less material is used), to decreased product size, and to increased speed of circuit operation (signals between components travel shorter distances when board density is higher).

Very possibly, other equally important trends exist in the field that would reward analysis, but we decided to focus on this single trend in our study.

Identifying Lead Users

To identify lead users of PC–CAD systems capable of designing high-density printed circuit boards, we had to identify that subset of users: (1) who were designing very high-density boards now and (2) who were positioned to gain especially high benefit from increases in board density. We decided to use a formal telephone-screening questionnaire to accomplish this task, and we strove to design one that contained objective indicators of these two hypothesized lead user characteristics.

Printed circuit board density can be increased in a number of ways and each offers an objective means of determining a respondent's position on the trend toward higher density. First, the number of layers of printed wiring in a printed circuit board can be increased. (Early boards contained only 1 or 2 layers but now some manufacturers are designing boards with 20 or more layers.) Second, the size of electronic components can be decreased. (A recent important technique for achieving this is surface-mounted devices that are soldered directly to the surface of a printed circuit board.) Finally, the printed wires, vias, that interconnect the electronic components on a board can be made narrower and packed more closely. Questions regarding each of these density-related attributes were included in our questionnaire.

Next, we assessed the level of benefit a respondent might expect to gain by improvements in PC–CAD by means of several questions. First, we asked about users' level of satisfaction with existing PC–CAD equipment, assuming that high dissatisfaction would indicate expected high benefit from improvements. Second, we asked whether respondents had developed and built their own PC–CAD systems rather than buy the commercially available systems such as those offered by IBM or Computervision. (We assumed, as we noted previously, that users who make such innovation investments do so because they expect high benefit from resulting PC–CAD system improvements.) Finally, we asked respondents whether they thought their firms were innovators in the field of PC–CAD.

The PC–CAD users interviewed were restricted to U.S. firms and selected from two sources: A list of members of the relevant professional engineering association (IPCA) and a list of current and potential customers provided by a cooperating supplier. Interviewees were selected from both lists at random. We contacted approximately 178 qualified respondents and had them answer the questions on the phone or by mail if they preferred. The cooperation rate was good: 136 screening questionnaires were completed. One third of these

TABLE 8–2. Cluster Analyses Show User Group with Hypothesized Lead User Characteristics

	Two-Cluster Solution		*Three-Cluster Solution*		
	Lead User	*Nonlead User*	*Lead User*	*Non-lead (A)*	*Non-lead (B)*
Indicators of user position on PC–CAD density trend					
Use surface mount?	87%	56%	85%	7%	100%
Average line width (mils)	11	15	11	17	13
Average layers (number)	7.1	4.0	6.8	4.2	4.4
Indicators of user-expected benefit from PC–CAD improvement					
Satisfaction[a]	4.1	5.3	4.1	5.2	5.2
Indicators of related user innovation					
Build own PC–CAD?	87 %	1 %	100 %	0 %	0 %
Innovativeness[b]	3.3	2.4	3.2	2.1	2.8
First use of CAD (year)	1973	1980	1973	1980	1979
Number in cluster	38	98	33	46	57

[a]7-point scale—high value more satisfied.
[b]4-point scale—high value more innovative.

were completed by engineers or designers, one third by CAD or printed circuit board managers, 26% by general engineering managers, and 8% by corporate officers.

Simple inspection of the screening questionnaire responses showed that fully 23% of all responding user firms had developed their own in-house PC–CAD hardware and software systems. This high proportion of user-innovators that we found in our sample is probably characteristic of the general population of PC–CAD users. Our sample was well dispersed across the self-stated scale with respect to innovativeness: 24% indicated they were on the leading edge of technology, 38% up-to-date, 25% in the mainstream, and 13% adopting only after the technology is clearly established. This self-perception is supported by objective behavior with respect to the alacrity with which our respondents adopted PC–CAD.

We next conducted a cluster analysis of screening questionnaire data relating to the hypothesized lead user characteristics in an attempt to identify a lead user group. The two- and three-cluster solutions are shown in Table 8–2.

Note that these analyses do, indeed, clearly indicate a group of respondents who combine the two hypothesized attributes of lead users and that, effectively, all of the PC–CAD product innovation is reported by the lead user group.

In the two-cluster solution, what we term the lead user cluster is, first, ahead of nonlead users in the trend toward higher density. That is, lead users report more use of surface-mounted components, use of narrower lines, and use of more layers than do members of the nonlead cluster. Second, lead users appear to expect higher benefit from PC–CAD innovations that would allow them even further progress. That is, they report less satisfaction with their existing PC–CAD systems (4.1 vs. 5.3, with higher values indicating satisfaction). Strikingly, 87% of respondents in the lead user group report building their own PC–CAD system (vs. only 1% of nonlead users) in order to obtain improved PC–CAD system performance.[10] Lead users also judged themselves to be more innovative (3.3 vs. 2.4 on the four-statement scale with higher values more innovative), and they were in fact earlier adopters of PC–CAD than were nonlead users.

Note that 28% of our respondents are classified in this lead user cluster. The two clusters explained 24% of the variation in the data.

In the three-cluster solution the lead user group was nearly unchanged, but the nonlead group was separated into two subgroups. Nonlead group *A* had the lowest use of surface-mounted components, the widest line widths, the fewest layers, and the latest year of adoption, and it rated itself as lowest on adoption of innovations. Nonlead group *B* also differed from the lead user group in the expected ways, except for one anomalous result: Nonlead group *B* showed a higher usage of surface-mounted components than did the lead user group. In the three-cluster solution 37% of the variation is explained by cluster membership.

A discriminant analysis indicated that building one's own system was the most important indicator of membership in the lead user cluster. (The discriminant analysis had 95.6% correct classification of cluster membership. The standardized discriminant function of coefficients were: build own .94, self-stated innovativeness .27, average layers .25, satisfaction −.23, year of adoption −.16, surface mounting .152.)

Analyzing Lead User Insights

The next step in our analysis was to select a small sample of the lead users identified in our cluster analysis to participate in a group discussion to develop one or more concepts for improved PC–CAD systems. Experts from five lead user firms that had facilities located near MIT were recruited for this group. The firms represented were Raytheon, DEC, Bell Laboratories, Honeywell, and Teradyne. Four of these five firms had built their own PC–CAD systems. All were working in high-density (many layers and narrow lines) applications and had adopted the CAD technology early.

The task set for this group was to specify the best PC–CAD system for laying out high-density digital boards that could be built with current technology. (To guard against the inclusion of "dream" features impossible to implement, we conservatively allowed the concept the group developed to include only features that one or more of them had already implemented in their own organizations. No one firm had implemented all aspects of the concept, however.)

The PC–CAD system concept developed by our lead user creative group integrated the output of PC–CAD with numerically controlled printed circuit board manufacturing machines; had easy input interfaces (e.g., block diagrams, interactive graphics, icon menus); and stored data centrally with access by all systems. It also provided full functional and environmental simulation (e.g., electrical, mechanical, and thermal) of the board being designed and could design boards of up to 20 layers, route thin lines, and properly locate surface-mounted devices on the board.

Testing Product Concept Perceptions and Preferences

From the point of view of marketing research, new product need data and new product solutions from lead users are only interesting if they are preferred by the general marketplace.

To test this matter, we decided to determine PC–CAD user preferences for four system concepts: the system concept developed by the lead user group, each user's own in-house PC–CAD system, the best commercial PC–CAD system available at the time of the study (as determined by a PC–CAD system manufacturer's competitive analysis), and a system for laying out curved printed circuit boards. (This last was a description of a special-purpose system that one lead user had designed in-house to lay out boards curved into three-dimensional shapes. This is a useful attribute if one is trying to fit boards into the oddly shaped spaces inside some very compact products, but most users would have no practical use for it. In our analysis of preference, we think user response to this concept can serve to flag any respondent tendency to prefer systems based on system exotica rather than practical value in use.)

To obtain user preference data regarding our four PC–CAD system concepts, we designed a new questionnaire that contained measures of both perception and preference. First, respondents were asked to rate their current PC–CAD system on 17 attribute scales. (These were generated by a separate sample of users through triad comparisons of alternate systems, open-ended interviews, and technical analysis. Each scale was presented to respondents in the form of a five-point agree-disagree judgment based on a statement such as "my system is easy to customize."[11] Next, each respondent was invited to read a one-page description of each of the three concepts we had generated (labeled simply, *J, K,* and *L*) and rate them on the same scales. All concepts were described as having an identical price of $150,000 for a complete hardware and software workstation system able to support four users. Next, rank-order preference and constant-sum paired comparison judgments were requested for the three concepts and the existing system. Finally, probability-of-purchase measures on an 11-point Juster scale were collected for each concept at the base price of $150,000, with alternate prices of $100,000 and $200,000.

Our second questionnaire was sent to 173 users (the 178 respondents who

TABLE 8–3 Test of All Respondents' Preferences Among Four Alternative PC–CAD System Concepts

PC–CAD Concept	*% First Choice*	*Constant Sum*[a]	*Average Probability of Purchase*
Lead user group concept	78.6	2.60	51.7
Respondents' current PC–CAD	9.8	1.87	[b]
Best system commercially available	4.9	0.95	20.0
User system for special application	6.5	0.77	26.0

[a]Warren S. Torgerson, *Theory and Methods of Scaling* (New York: Wiley, 1958).
[b]Probability of purchase only collected across concepts.

qualified in the screening survey less the 5 user firms in the creative group). Respondents were called by phone to inform them that a questionnaire had been sent. After telephone follow-up and a second mailing of the questionnaire, 71 complete or near-complete responses were obtained (41%) and the following analyses are based on these.[12]

Lead User Concept Preferred

As can be seen from Table 8–3, our analysis of the concept questionnaire showed that respondents strongly preferred the lead user group PC–CAD system concept over the three others presented to them: 78.6% of the sample selected the lead user creative group concept as their first choice. The constant sum scaled-preference value was 2.60 for the concept developed by the lead user group. This was 35% greater than users' preference for their own current system and more than twice as great as the preference for the most advanced existing commercially available product offering.

The concept created by the lead user group was also generally preferred by users over their existing systems (significant at the 10% level based on the preference measures: t = 12 for proportion first choice and t = 2.1 for constant sum). And, the lead user group concept was significantly preferred over the special application user system developed to lay out curved boards. (The lead user concept was significantly better than the user-developed special application system on all measures at the 10% level (t = 12.3 for first choice, t = 7.9 for preference, and t = 8.5 for probability).[13]

Respondents maintained their preferences for the lead user concept even when it was priced higher than competing concepts. The effects of price were investigated through the probability of purchase measures collected at three prices for each concept. For the lead user concept, probability of purchase

TABLE 8–4. Concept Preferences of Lead Versus Nonlead Users

	% First Choice		*Constant Sum*		*Average Probability of Purchase*	
PC–CAD Concept	*Lead*	*Nonlead*	*Lead*	*Nonlead*	*Lead*	*Nonlead*
Lead user group concept	92.3%	80.5%	3.20	2.37	53.1	51.2
Respondents' current PC–CAD	7.7	11.1	2.64	1.56	0	0
Best system commercially available	0	2.8	0.67	1.06	10.2	23.9
User system for special application	0	5.6	0.52	0.87	16.3	29.9

increases from 52.3% to 63.0% when the price is decreased from $150,000 to $100,000 ($t = 2.3$) and drops to 37.7% when the price is increased to $200,000. Probability of purchase of the lead user concept was significantly higher at all price levels (t greater than 4.4 in all paired comparisons), and it was preferred to the best available concept even when the specified price was twice as high as that of competing concepts. All three concepts displayed the same proportionate change in purchase probability as the price was changed from its base level of $150,000. The probability measures indicate substantial price sensitivity and provide a convergent measure on the attractiveness of the concept based on lead user solution content.

Similarity of Lead and Nonlead User Preferences

The needs of today's lead users are typically not precisely the same as the needs of the users who will make up a major share of tomorrow's predicted market. Indeed, the literature on diffusion suggests that in general the early adopters of a novel product or practice differ in significant ways from the bulk of the users who follow them.[14] However, in this instance, as Table 8–4 shows, the product concept preferences of lead users and nonlead users were very similar.

A comparison of the way in which lead and nonlead users evaluated PC–CAD systems showed that this similarity of preference was deep-seated. An examination of the PC–CAD attribute ratings and factor analyses derived from each group showed five factors in each that explained the same amount of variation (67.8 for lead users and 67.7 for nonlead users). The factor loadings were also similar for the two groups, and their interpretation suggested the same dimension labels. Also, analysis showed that each group placed a similar degree of importance on each dimension.[15]

Discussion

From the point of view of marketing research, I think that the results of this first test of a lead user method must be seen as encouraging. Lead users with the hypothesized characteristics were clearly identified; a novel product concept was created based on lead user insights and problem-solving activities; and the lead user concept was judged to be superior to currently available alternatives by a separate sample of lead and nonlead users. I should point out, however, that the high level of actual product innovation found among lead users of PC–CAD can only be expected in product areas where the rents expected by such users are sufficient to induce user innovation. Where expected user benefit is less, need data available from lead users should still be more accurate and richer in "solution content" than data from nonlead users, but it may not include prototype products such as those we have observed in the study of PC–CAD.

From the point of view of my underlying hypothesis regarding the ability to predict the sources of innovation on the basis of innovators' related expectations of rent, I think the lead user application has also shown very encouraging results. Users who identified themselves as dissatisfied with existing products were shown more likely to be involved in developing new ones responsive to their need.

Notes

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bute Approaches for Product Concept Evaluation and Generation: A Critical Review," *Journal of Marketing Research* 16, no. 2 (May 1979): 159–80.

8. For example, when Edwin Mansfield (*The Economics of Technological Change* [New York: Norton, 1968], 134–35) explored the rate of diffusion of 12 very important industrial goods innovations into major firms in the bituminous coal, iron and steel, brewing, and railroad industries, he found that in 75% of the cases it took over 20 years for complete diffusion of these innovations to major firms. Accordingly, some users of these innovations could be found far in advance of the general market.

9. PC–CAD system purchase decisions are made primarily by the final users in the engineering department responsible for CAD design of boards. In this study we interviewed only these dominant influencers to find concepts and test them. If the purchase decision process had been more diffuse, it would have been appropriate to include other important decision participants in our data collection.

10. The innovating users reported that their goal was to achieve better performance than commercially available products could provide in several areas: high routing density, faster turnaround time to meet market demands, better compatibility to manufacturing, interfaces to other graphics and mechanical CAD systems, and improved ease of use for less experienced users.

11. The 17 attributes were: ease of customization, integration with other CAD systems, completeness of features, integration with manufacturing, maintenance, upgrading, learning, ease of use, power, design time, enough layers, high-density boards, manufacturable designs, reliability, placing and routing capabilities, high value, and updating capability.

12. There were 94 individuals (55%) who actually returned the questionnaire, but only 71 returns were judged complete enough to use. This subset consists of 61 respondents who completed all items on both the screening and concept questionnaires, and an additional 10 who completed all items except the constant-sum paired comparison allocations.

13. As part of our analysis we tested for potential nonresponse bias by comparing early and later returns and found none. Returns from the first 41% of respondents showed 77% first choice for the creative group concepts and the last 59% showed 71% first choice. The differences between the early and later returns were not significant at the 10% level ($t = .15$). Thus, there was no evidence of a nonresponse bias. A possible demand-effect bias toward the lead user group concept could have been present, but the low preferences for the best available product and the curved board concepts argues against it. All concepts were presented in a similar format with labels of concept *J*, *K*, and *L* (the lead user group concept was labeled *K*). We did not expect any differential bias toward concept *K*.

14. Everett M. Rogers with F. Floyd Shoemaker, *Communication of Innovations: A Cross-Cultural Approach*, 2nd ed. (New York: Free Press, 1971).

15. Urban and von Hippel, "Lead User Analyses for the Development of New Industrial Products."