A CUSTOMER-ACTIVE PARADIGM FOR INDUSTRIAL PRODUCT IDEA GENERATION

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Abstract

New product need assessment and idea generation methodologies, developed and used successfully in the consumer product arena, are seldom used to aid in the design of new industrial products. It is suggested that the "fault" lies in large part with the "manufacturer-active" paradigm underlying these methodologies, which prescribes that the product manufacturer has the role of assessing customer needs and developing a responsive product idea. A new "customer-active" paradigm is proposed in which the customer acts to develop the new product idea and takes the initiative to transfer it to an interested manufacturer.

It is hypothesized that the customer-active paradigm offers a better fit to industrial product idea generation practice than does the manufacturer-active paradigm. This hypothesis is tested against the available empirical data (eight studies are reviewed) and found supported. Speculative reasoning is then offered in support of the notion that the customer-active paradigm provides a good fit to the requirements of industrial product idea generation as well as to current practice. Implications for research and practice are discussed.

A Customer-Active Paradigm for Industrial Product Idea Generation

1.0 INTRODUCTION

It has long been a source of concern to students of marketing research that some of the more sophisticated marketing research techniques, such as multidimensional scaling, routinely used in the generation of ideas for new consumer products, have not been extensively applied to the generation of ideas for new industrial products. Under the well founded assumption that there is at least latent demand for improved need search and idea generation methodologies in the industrial sector,[1] research is being conducted by many to explore differences in the consumer and industrial buying situations, which might be preventing straightforward transfer of consumer marketing research tools to that sector. Among the areas of difference currently being explored are: nature of the multiperson decision process characteristic of industrial buying (Robinson, Farris and Wind, 1967; Brand, 1972; Choffray and Lillien, 1977); differences in buying behavior resulting from the complex "systems-like" nature of many industrial products, e.g. an assembly line, an inventory control system (Mattsson, 1973); differences in buying behavior resulting from the direct buyer-seller interaction

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[1] Empirical research into the industrial good innovation process has shown that the level of manufacturer "understanding of user need" co-varies strongly with the level of commercial success attained by an innovative industrial product. (Cf., Rothwell, Freeman et al., 1974. This study examined forty-three pairs of projects - each pair consisting of a commercially successful and a commercially failing product aimed at the same market niche. Of 122 measures tested for their ability to discriminate accurately between the successful and failing projects, the measure "Were user needs more accurately understood in one member of the pair than the other?" proved to discriminate most effectively. This measure was higher for the successful than in the failing pair member in 33 of 43 pairs and equal for both members in 10 pairs [binomial test $p = 1.2E - 10$]. [Page 261, Table 1])

often present in industrial buying (Håkansson and Ostberg, 1975).

In the present paper, we hope to contribute to the understanding of essential differences between industrial and consumer buying, and the reasons for poor utilization of consumer product idea generation methodologies in the industrial product sector, via an apparently novel proposition - that there is a poor fit between the "manufacturer-active" idea generation paradigm underlying consumer need search and product idea generation methodologies and what we hypothesize to be the actual conditions under which ideas for most new industrial products must be generated. We will then go on to propose and test a new "customer-active" idea generation paradigm which we hypothesize offers a better fit to conditions under which ideas for new industrial products are generated than does the manufacturer-active paradigm, and thus offers a better base upon which to build new methodologies for the generation of ideas for new industrial products.

The paper is organized as follows:

- Section 2: Description of the manufacturer-active and customer-active paradigms and proposal of a test which will allow us to determine the "goodness of fit" of each to actual conditions under which ideas for new industrial products are generated.
- Section 3: Review of empirical data available for performance of proposed test.
- Section 4: Performance of test, analysis of results - which are found to support the hypothesis that the customer-active paradigm offers a better fit to current practice in the industrial sector than does the prevailing manufacturer-active paradigm.

- Section 5: Discussion which links the customer-active paradigm to research findings in industrial buying behavior and the engineering problem solving process and which suggests that the new paradigm offers a better fit to inherent requirements of the industrial idea generation process as well as to current practice.
- Section 6: A useful new paradigm should suggest useful new research questions. In this final section of the paper we provide suggestions for further research derived from the customer-active paradigm.

2.0 THE MANUFACTURER-ACTIVE AND CUSTOMER-ACTIVE PARADIGMS FOR INDUSTRIAL PRODUCT IDEA GENERATION

In Figure 1, the reader will find a schematic representation of both the manufacturer-active product idea generation paradigm (1A) and our hypothesized customer-active product idea generation paradigm (1B). As can be seen, the two paradigms are very different. In the

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INSERT FIGURE 1 HERE

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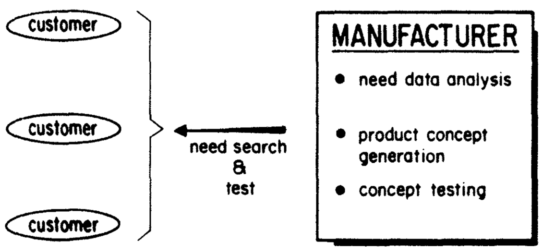
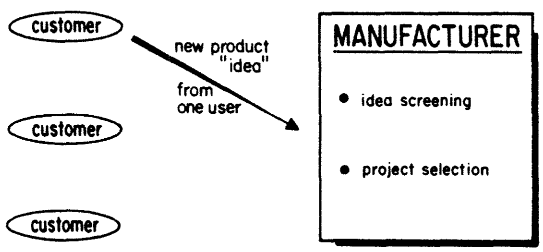
manufacturer-active paradigm, the role of the customer is essentially that of respondent - "speaking only when spoken to". It is the role of the manufacturer in this paradigm to take the initiative and manage the process of:

- selecting and surveying a group of customers to obtain data on needs for new products (and/or sources of dissatisfaction



1A Consumer Product Idea Generation Practice and Manufacturer-Active Paradigm



1B Empirically Observed Industrial Product Idea Generation Practice - and Hypothesized Customer-Active Paradigm with existing products);

- analyzing the data;
- developing a hopefully responsive product idea;
- testing the idea against consumer perceptions and/or purchase decisions.

In the proposed customer-active product idea generation paradigm, on the other hand, it is the role of a would-be customer for a new industrial product to:

- develop the "idea" for a desired new product;
- select a supplier apparently capable of building the product; and
- take the initiative to send a "need message" to the selected supplier.

At the same time, the role of the manufacturer is:

- to wait for a potential customer to make himself known via a need message (as we will discuss, potential customers for new industrial products which fall within the classes appropriate to the new paradigm are usually - and frustratingly - invisible to product manufacturers until they take the initiative to make themselves known);
- to screen ideas (not needs) for new products and select those for development which seem to offer the most promise from the manufacturer's point of view.

Clearly, in the instance of consumer products - especially so-called packaged goods - the manufacturer-active product idea generation paradigm has been a strikingly successful one: Consumer product manufacturers have behaved in accordance with its dictates; researchers have developed a rich inventory of methodologies which fit it, from multidimensional scaling of consumer need data, to focus groups, to ... And, when the methods are applied by manufacturers, the manufacturers develop commercially successful new consumer products a profitable percentage of the time.[2] When we hypothesize, therefore, that this paradigm offers a poor fit to the requirements of industrial product idea generation - and that this poor fit, in turn, is a major reason why consumer product need search and idea generation methodologies are so little used in the industrial product arena - we clearly must provide a strong test of the hypothesis before allowing even provisional acceptance.

Happily, a comparison of the two paradigm schematics presented in Figure 1 suggests a test by which the goodness of fit of each to current practice in industrial product idea generation may be probed. The test: Can a new product "need/idea message" transmitted from a would-be customer at the initiative of the customer, be found as the triggering event behind most new industrial products? If the answer is yes, then clearly the hypothesized customer-active paradigm offers a better fit to current industrial product idea generation practice than does the manufacturer-active paradigm. If, on the other hand, the empirical data does not show such a pattern, then the hypothesized paradigm fails. (Note that the test only addresses the fit of the two paradigms to current practice. In Section 5, we will extend the discussion to a consideration of the potential goodness of fit of each paradigm in that happy world where practice could be adjusted to the optimum.)

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[2] Silk and Urban (1977) review studies performed in the 1960s and 1970s which indicate that 40-60% of packaged goods test-marketed in that time frame were successful (in the sense that their manufacturers decided to launch them nationally). We assume this failure rate has been compatible with profit as manufacturers have continued to develop and test new packaged goods in the face of it for more than a decade. (Silk and Urban suggest, however, that this may be less and less the case as costs of conducting test markets rise, and go on to consider how pre-test market methodologies might be improved and test market failure rates reduced.)

3.0 A REVIEW OF EMPIRICAL STUDIES CONTAINING DATA ON THE DEGREE TO WHICH DEVELOPMENT OF NEW INDUSTRIAL PRODUCTS IS IN RESPONSE TO NEED/IDEA MESSAGES FROM WOULD-BE CUSTOMERS

While reading the reviews, the reader might keep in mind a two-part formulation of the hypothesis which we will attempt to test by means of the data to be presented: (1) Manufacturers do (do not) become aware of user needs for new industrial products via a "need message" directed from customer to supplier at the initiative of the customer; (2) The "need message" provided by the customer does (does not) contain a "sufficient amount" of data regarding what a new product responsive to the need should look like as to be reasonably considered as providing the new product "idea" to the manufacturer. Most of the studies we will review are not explicitly directed at either of these matters. Rather, they glancingly generated some data we find useful for our purposes while in pursuit of some other research objective. Thus, the nature of the samples and the formulation of findings of interest to us vary from study to study. We will address these variations as we integrate the data in further sections of this paper.

3.1 Empirical Studies of New Industrial Products Which Contain Information on Manufacturer Acquisition of the Product "Idea"

1. The first study we would like to review is by Dennis Meadows (1969). The focus of Meadows' work was "Estimate Accuracy and Project Selection Models in Industrial Research", but in the course of it, he collected some data which is relevant to our purposes here. Meadows analyzed the entire portfolio of research projects initiated in "Chem

Lab B" (the laboratory of a chemical company with between 100 million and 300 million dollars annual sales of, primarily, "industrial intermediates") over an approximately two-year period. Among other analyses, Meadows coded the commercial success of all technically successful Chem Lab B projects (n = 29) as a function of the "project idea source" (obtained from reports filed at the inception of all Lab B projects) with the results shown in Table 1.[3]

INSERT TABLE 1 HERE

We see from Table 1 that 45% of all Lab B project ideas - and 53% of all ideas resulting in sales - came from customers. Project ideas from customers and marketing both show a higher probability of commercial success than do ideas from the laboratory (P = .08 that customer ideas are not more likely to achieve sales than laboratory ideas). Note that Meadows' data does not indicate at whose initiative the customer ideas were transmitted to Chem Lab B. In the course of discussion Meadows does observe that "customers tend to request only product modifications" but does not characterize the nature of the new products (e.g., whether first-to-market or "me-too's") or the content of the project - initiating customer ideas further.

2. Meadows' findings are supported by a second study done by M. E. Peplow (1960). Peplow reviewed all "creative" projects carried out during a six-year period by an R&D group "concerned with designing and improving plant processes, process equipment and techniques", and found that:

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[3]In a telephone conversation, Meadows kindly clarified aspects of the methodology used in the portion of the study of interest to us. The outline given here draws both on Meadows' paper and on this direct information.

Sales \ Project Idea Source	Laboratory	Marketing	Customer
None	4	4	4
Low	1	3	4
Medium	0	2	2
High	0	2	3
Total	5	11	13

Table 1: Commercial Outcome of Project by Project Source: Chemical Laboratory B

Source: Meadows, "Data Appendix: Accuracy of Technical Estimates in Industrial Research Planning", M.I.T. Sloan School of Management Working Paper #301-67. (Table 4 in Meadows (1969) is similar but offers percentage data only.)

"The outcome of the 94 creative jobs, in terms of implementation is as follows:

48 successful - accepted by customers
8 successful - equipment for R&D departments' own use
8 negative - i.e., a current theory or design concept disproved
12 partly successful - i.e., partly failed or a slow adoption
18 failed"[4]

Peplow then tried to ascertain differences between the 48 projects which were successfully implemented by customers external to the innovating department and the 30 (bottom two categories in his list) which were not implemented by external customers although apparently available for that purpose. While the value of Peplow's findings for our purposes are reduced because he does not use the same categories in his discussion of reasons for implementation failure as he does in his discussion of reasons for implementation success, he does report that 30 of the 48 successfully implemented jobs were started in response to direct requests from customers, while failures "...lie more with the basic [sic] jobs started by R&D initiative."[5] Like Meadows, Peplow does not spell out the information content of a customer request.

3 and 4. The third and fourth studies which we would like to call to the reader's attention were both conducted by von Hippel. One of these studies examined the source of innovations within four of the most frequently used classes of scientific instrument,[6] while the other

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[4] Peplow (1960), p. 65.

[5] Ibid., p. 66.

[6] See von Hippel (1976). The four classes of instrument examined were Gas Chromatography, Nuclear Magnetic Resonance Spectrometry, Ultraviolet Spectrophotometry and Transmission Electron Microscopy.

explored the sources of innovation in two categories of process machinery.[7] The methodology used in both was similar - to the end that the data from both would be commensurable. In brief, the methodology involved selecting samples of first-to-market innovations which, in the combined judgment of expert users and manufacturers in the field being studied, offered increased functional utility to users when judged relative to previously available products. (Note that these most useful innovations, while all commercially successful in that they were widely adopted by users and manufacturers, were not necessarily the most commercially successful from the standpoint of manufacturers. This is so because there is no necessary correlation between an innovation's functional utility and its cost/price.) Our reason for adopting an exclusive focus on first-to-market innovations which offered a major increment in functional utility to users relative to previous best practice was: Samples so characterized would give us the clearest view of how manufacturers learn of user needs in those instances when the need has not been previously served by a commercial product, so that the mechanisms of "me-too" or "me marginally better" could not be used.

Next, the "innovation histories" of the innovative products selected for study were carefully traced via literature studies and structured interviews with user and manufacturer personnel found to be involved with the innovation work. The result: In 77 percent of the 111 cases of scientific instrument innovation and in 67 percent of the 49 cases of process equipment innovation, it was found that it was a product

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[7] See von Hippel (May 1977). The two categories of process machinery examined were: (i) process machinery used in the manufacture of silicon-based semiconductors and (ii) process machinery used in the manufacture of electronic subassemblies built upon printed circuit boards.

user who:

- perceived the need for the product innovation;
- invented a product responsive to the need;
- built a prototype;
- proved the prototype's value in use by applying it;
- diffused (intentionally or unintentionally) detailed information on the innovative product's design and its utility.

Only after all the above had transpired would the first manufacturer to commercially manufacture and market the product enter the picture, we found. Typically, this manufacturer's contribution to the innovation process was to perform some product engineering work on the user prototype to improve its reliability, ease of operation, etc., and then to manufacture and market the device.

Thus, for the classes of scientific instrument and process equipment examined, we found that, typically, the new product "idea" for a functionally novel new product was generated by a product user and included information on a field-tested product design which met user needs.

Via a further study of our sample of process equipment innovations (von Hippel, October 1977), we attempted to determine at whose initiative - product user or product manufacturer - such user need/solution data was transferred from user to manufacturer. In 21% of the cases, we found, the innovative user had a need for an outside source of supply for the user-developed process equipment - e.g., wished to become a customer for it - and in these instances, the user clearly took the initiative in transferring need and product design data to an equipment manufacturer. In most of the remainder of the cases, users apparently satisfied their own need for the innovative equipment via in-house manufacture, and in these cases transfer from the user-innovator to the equipment manufacturer took longer (mean = 3.7 vs. 1 years), and the source of initiative for the transfer when it finally occurred was not clearly visible in the data (due to multiple user-manufacturer interactions during the intervening years).

5 and 6. A fifth and sixth study examined a sample of engineering polymer innovations and a sample of innovations in chemical additives used in plastics. These studies were done by students of von Hippel and employed the data collection methodology used in the studies of scientific instrument and process machinery innovations described above.

Berger (1975) examined the innovation histories of 5 engineering resins - an exhaustive sample of such resins which met the criteria of: development within the U.S.; commercialization since 1955; and achievement of commercial success (defined as continuous production from time of introduction to the present day and achievement of an annual sales volume of at least 10 million pounds in 1975 - the year of the study). Berger found <u>all</u> of the 5 resins had been developed by resin manufacturers, <u>not</u> resin users. Careful exploration in the scientific literature and with resin manufacturer personnel involved in the innovation work and with key users uncovered no specific user need or solution message responsible for triggering any of these projects. It was observed that the polymer marketing and R&D groups worked closely together, but no attempt was made to ascertain in detail for this sample how the idea for the product was evolved.

Boyden (1976) examined the innovation histories of a sample of eight plasticizers and a sample of eight UV stabilizers - each of these samples being exhaustive in the functional category named if the following selection criteria are applied: post-1945 commercial introduction of the innovations and produced in "commercial quantities"[8] and sold on the open market (as opposed to being used only in-house by its manufacturer). Boyden could get adequate data for 12 cases in his sample, and found that 9 of these conformed to the pattern found by Berger: No specific user need and/or solution message could be found associated with their initiation. Of the remaining 3 cases, it was determined that one innovative plasticizer was developed by Kodak in response to an internal need and then also sold by that firm on the open market. In the other two of this subset of three cases, it was found that suppliers of chemicals used in the innovative products were heavily involved in development of the innovations, taking initiative in proposing to commercial manufacturers of UV stabilizers and plasticizers that they might find it worthwhile to further develop and market the new products.

Thus, the two cases cited immediately above were the only cases in the Boyden sample for which the genesis of the "product idea" could be clearly traced to a particular source or event outside of the commercial manufacturer. In the other cases, Boyden was unable to identify any clear "idea source" for the innovative products, having to be content with general statements regarding the genesis of the product idea such as: We were seeking to expand our range of UV stabilizer and/or additive products (3 cases); the need for a product of those characteristics was "generally known in the industry" (2 cases).

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[8]Actual sales 5 years after the commercial introduction of the innovative product ranged from $300,000 annually to $15 million annually (mean = $4.5 million, SD = $5.1 million).

7. The seventh study which we would like to review is by Utterback (1971). Utterback derived a sample of 32 scientific instrument innovations for study via the following selection strategy:

- selection of all scientific instrument innovations manufactured by Massachusetts firms which had been given awards between 1963 and 1968 by the editors of Industrial Research (the "IR-100 Awards") for their excellence in terms of technical criteria (15 cases);
- selection of the commercially most successful innovation developed by each award-winning firm studied (8 cases);
- selection of a "control group" of innovations comprised of the next product developed by the award-winning firm which cost approximately the same amount to develop as the award-winning project (9 cases).

Utterback gathered his data by interviewing innovation process participants at the instrument manufacturing firms and found that 75% of the innovations in his sample could be characterized as having been stimulated by information about a specific need or problem (a "need input"). While he does not further specify the information content of the need inputs coded, he does make other observations regarding them which are useful for our purposes here, viz: "...the overwhelming majority of need inputs (73.4%) came from discussion, mostly from outside the firm (56.7%)" and "...the source was most often a customer or potential customer..." [9]

3.2 An Empirical Study of the Buying of New and Standard Industrial Goods

8. The research focus of the eighth and final study to be reviewed,

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[9] Utterback (1971), p. 129.

Industrial Buying and Creative Marketing by Robinson, Farris and Wind, (1967), is on industrial buying behavior. The point that makes such a study relevant to our present examination of the sources of ideas for new industrial products is: Industrial buyers of industrial products do not only buy standard, "off-the-shelf" industrial components, materials and capital equipment; they also buy items specially fabricated to serve their purposes. Many such items (often called "specials" in industry jargon) prove to be of interest to many industrial buyers and are eventually offered as standard products by their manufacturers.

The Robinson, Farris and Wind study is probably quite familiar to readers who specialize in industrial marketing. It reports upon insights derived from examination of the purchasing activities of three industrial concerns. The study methodology they used is basically a qualitative one. It involved exploratory interviews "...with individuals involved in procurement activities to varying degrees and from diverse hierarchical levels and functional areas". These interviews led the authors to identify some "types" of buying situations, which in turn allowed them to select some "representative buying situations" for intensive study and analysis.

As a result of their work, the authors felt that a matrix of "buyclasses" and "buyphases" as shown in Table 2 would be a useful framework for the analysis of industrial buying situations.

INSERT TABLE 2 HERE

The authors discuss the findings and insights of their study applicable to each cell of the matrix shown in Table 2. Our interest

Table 2*

The Buygrid Analytic Framework for Industrial Buying Situations

		BUYCLASSES		
		New Task	Modified Rebuy	Straight Rebuy
BUYPHASES	1. Anticipation or Recognition of a problem (Need) and a General Solution			
	2. Determination of Characteristics and Quantity of Needed Item			
	3. Description of Characteristics and Quantity of Needed Item			
	4. Search for and Qualification of Potential Sources			
	5. Acquisition and Analysis of Proposals			
	6. Evaluation of Proposals and Selection of Supplier(s)			
	7. Selection of an Order Routine			
	8. Performance Feedback and Evaluation			

*Redrawn from Robinson, Farris and Wind (1967).

here is restricted to Buyphases 1-3 under the "new task" column. (A "new task" buying situation is defined by the authors as "a requirement or problem that has not arisen before [in the buying firm]." This class includes, but is not limited to the buying of non-standard industrial goods which are built to the needs and specifications of the buying firm. The proportions of non-standard products in the study of Robinson, Farris and Wind is only noted for the subset of industrial purchases by the manufacturing groups of the firms studied. For this group most of the new task purchases were found to be of items "...specifically developed to fit the particular needs of the customer."[10]

For the new task buyclass as a whole, the authors' findings were as follows (emphasis ours):

> Phase 1: Anticipation or Recognition of a Problem (Need)
>
> ...Problem recognition is largely internal to the using firm - indeed to the using department. Salesmen and other information sources are not yet drawn in.[11]
>
> * * *
>
> Phase 2: Determination of the Characteristics and Quantity of the Needed Item
>
> In essence this phase represents a technical refinement of the problem and the direction of its resolution. Specific products or services needed to perform the functional requirements determined in phase 1 begin to be defined. This decision point, too, generally lies within the using department.[12]
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> * * *

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[10] Robinson, Farris and Wind (1967), p. 128.

[11] Ibid., p. 186.

[12] Ibid., pp. 187-188.

Phase 3: Description of the Characteristics and Quantity of the Needed Item

This decision point may be crucial for the marketer, particularly in the new task or modified rebuy situation. It is at this point that the buying influences usually begin to look outside of the company for specific information about supplier capability, availability of goods and services, and product specifications. To expecite the search, information about the required goods or services will be made available to potential suppliers. For most suppliers, this represents the first knowledge that a buying situation is in process.[13]

The eight studies we have reviewed above are, to our present knowledge, the only studies extant which provide data on the presence (absence) of "need messages" provided by customers to manufacturers requesting new industrial products. Numerous other studies explored did come close to meeting our data requirements (Myers and Marquis, 1969; Mansfield and Wagner, 1975), but were found not applicable upon close examination.[14]

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[13] Ibid., p. 188.

[14] As an example, consider the excellent study by Mansfield and Wagner (1975). This study analyzed the commercial success of R&D projects as a function of several variables. One of these looked especially promising for our purposes, viz.: Source of "idea" for project (R&D department versus other parts of firm, suppliers and customers). Telephone discussion with the study's co-author Samuel Wagner (Associate Professor, Temple University), however, showed that the project "idea" data was unfortunately not appropriate for our present purposes. During data gathering, Mansfield and Wagner operationally defined the source of a project idea as the source of the first major, creative step in the solution process which was executed after the input(s) which initiated the project were in hand. The sources and/or content of the initiating inputs would have been relevant to our study, but were not examined by the authors.

4.0 ASSESSING THE DATA FROM THE EMPIRICAL STUDIES

Having completed the review of available empirical data, we will now proceed to our test of the central feature of our hypothesized industrial idea generation paradigm, viz.: Most new industrial products are initiated in response to a "need message" from a would-be customer for the new product, transmitted at customer initiative, and containing sufficient data as to, in effect, provide the "idea" for the new product to the manufacturer. As an aid to clarity, we propose to divide our analysis into two segments:

(1) Presence (absence) of a need message (Section 4.1);

(2) Content of the message when present, and consideration of whether the content observed does (does not) provide the "idea" for the new product to the product manufacturer (Section 4.2).

4.1 Presence (Absence) of a Need Message for a New Industrial Product

Taken in aggregate, the studies reviewed in Section 2 provide, we suggest, very strong support for the hypothesis that manufacturers of new industrial products receive a "need message" regarding that product directed from customer to manufacturer at the initiative of the customer. In Table 3, the findings of the reviewed studies on this matter are displayed in a manner which permits easy comparison.

INSERT TABLE 3 HERE

	Study	Type of Innovation	n	Data Available Regarding Presence of "Need Message"
1.	Meadows (1969)	Chemical products	29	9 of 17 (53%) commercially successful project ideas were from customers.
2.	Peplow (1960)	Plant processes, process equipment and techniques	94	30 of 48 (62%) successfully implemented projects were initiated in response to direct customer request.
3.	von Hippel (1976)	Scientific instrument innovations	111	NA (No data on "need message" portion of hypothesis.)
4.	von Hippel (May 1977)	Innovative process equipment	49	In the 20% of user-innovation cases in which users needed an outside supplier (to manufacture the innovation in quantity), the user (customer) initiated contact and provided a P.O.
5.	Berger (1975)	Engineering plastics	5	No explicit need message observed.
6.	Boyden (1976)	Plastic additives	16	No explicit need message observed.
7.	Utterback (1971)	Scientific instrument innovations	32	75% initiated in response to "need input". When need input originated outside product manufacturer (57%) source was "most often" customer.
8.	Robinson et al. (1967)	Standard and non-standard industrial products	NA	Customers recognize need, define functional requirements and specific goods and services needed before contacting potential suppliers.

Table 3: Source of Initiative in the Transfer of Information Regarding Needs for New Industrial Products.

Our confidence in this finding in the realm of new industrial products is enhanced by data from studies of "research - engineering interactions". In this field too, it appears, successful interactions between engineering groups which need research results and the research teams which provide these are characteristically initiated by a "need message" from the research user. The findings of two important studies in this area should serve to give the flavor:

- In Project Hindsight, Raymond Isenson traces the lineage of 710 "R&D Events", mostly post-1945, which were judged by a group of scientists and engineers as key to the achievement of high performance in 20 military weapons systems (such as the Polaris submarine-launched ballistic missile). Ninety-one percent of the events identified turned out to be "technology events" ("the conception and/or demonstration of the capability of performing a specific elementary function using new or untried concepts, principles, techniques, or materials, or the development of new manufacturing, fabrication, or processing techniques").[15] With respect to these, Isenson finds:

> In more than 85 percent of the technological Events, the individuals responsible for the accomplishment credit a particular applications-engineering group with having originally described the problem. The descriptions of the remaining 15 percent of those Events lack definitive information regarding the problem's source...
>
> * * *
>
> ...there is a very high correlation between utilization of research results and the fact that the user had first stated the problem. Certainly it suggests that the useful authority for defining a requirement is, in most cases, the applications engineer.[16]

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[15] Isenson (1969), p. 157.

[16] Isenson (October 1969), p. 47.

- In a study of the genesis of 10 important new materials (such as Silicones), the Ad Hoc Committee on Principles of Research-Engineering Interaction reported (emphasis theirs):

> In all but one of the cases studied, the recognition of an important need was identified in a majority of the events as an important factor in bringing about the research-engineering interaction
>
> * * *

and

> In almost all of the cases under consideration, it was an individual with a well-defined need who was the initiator of the communications. It was most frequently he who began the dialogue with the basic researchers and determined its continuation until the need was satisfied.[17]

4.2 The "Solution Content" of the Need Message: A New Product Idea?

In this section, we will first discuss the "solution content" of the new industrial product need messages which we have found that customers often provide to manufacturers. Then we will go on to consider whether this solution content is sufficient to be fairly said to constitute the "idea" for the new product needed.

Conceptually, it is important to recognize that any statement of a need or problem contains information about what a responsive solution to that need or problem should look like as well. Consider the following statements of a need. Each succeeding statement addresses the same

[17] Materials Advisory Board (1966), pp. 15, 16.

"need" as the first, but specifies a desired solution more precisely:

> We - the management of Manufacturing Firm A - need higher profits in our semiconductor plant
>
> ... which we can get by raising output
>
> ... which we can best do by getting rid of the bottleneck in process step D
>
> This can best be done by designing and installing new equipment
>
> ... which has the following functional specifications
>
> ... and should be built according to these blueprints.

Clearly, the amount of "solution development work" a manufacturer must do to convert the first need statement - "We need higher profits in our semiconductor plant" - into a responsive new product is high. He must employ skilled analysts able to study the business of the potential customer and conceptualize a new product opportunity which will impact the customer's felt need for higher profits, etc. On the other hand, a manufacturer who receives need information containing the maximum amount of product solution data shown need only instruct his manufacturing people to manufacture the product according to the customer-supplied engineering drawings.

A reader accustomed to thinking of users as supplying product "need" information only, while product manufacturers devise "solutions" - products responsive to the need - might find the concept of product solution data being conveyed <u>along with</u> need data an alien one. If so, an example from our research data might help provide the flavor of the concept. Consider the following case of a product innovation for which a product user did most of the innovation work and provided a great deal of product design data to the manufacturer along with information about his need for a new product:

In the late 1950s, IBM designed and built the first printed circuit card component insertion machine of the X-Y Table type to be used in commercial production. (IBM needed the machine to insert components into printed circuit cards which were in turn incorporated into computers.) After building and testing the design in-house, IBM, in 1959, sent engineering drawings of their design to a local machine builder along with an order for 8 units. The machine builder completed this and subsequent orders satisfactorily and later (1962) applied to IBM for permission to build essentially the same machine for sale on the open market. IBM agreed and the machine builder became the first commercial manufacturer of X-Y Table component insertion machines extant. (The above episode marked that firm's first entry into the component insertion equipment business. They are a major factor in the business today.)

For our purposes here, perhaps the most appropriate scale upon which to measure the "amount" of solution content in a need message is a scale which consists of "stages" in the new product development process. If one were able to measure the solution content of a need message on such a scale, one would be able to say: For "x" product, the customer's need message supplied the data normally generated by product development process stages $1 \rightarrow x$, leaving to the manufacturer the performance of the work of stages $x + 1 \rightarrow N$. Specification of linear "stages" of new product development is somewhat chimerical - researchers in the area have shown that the actual work cannot be said to proceed in clear-cut stages - but for our purposes here, the simple five-stage segmentation shown in Figure 2 will be serviceable.

INSERT FIGURE 2 HERE

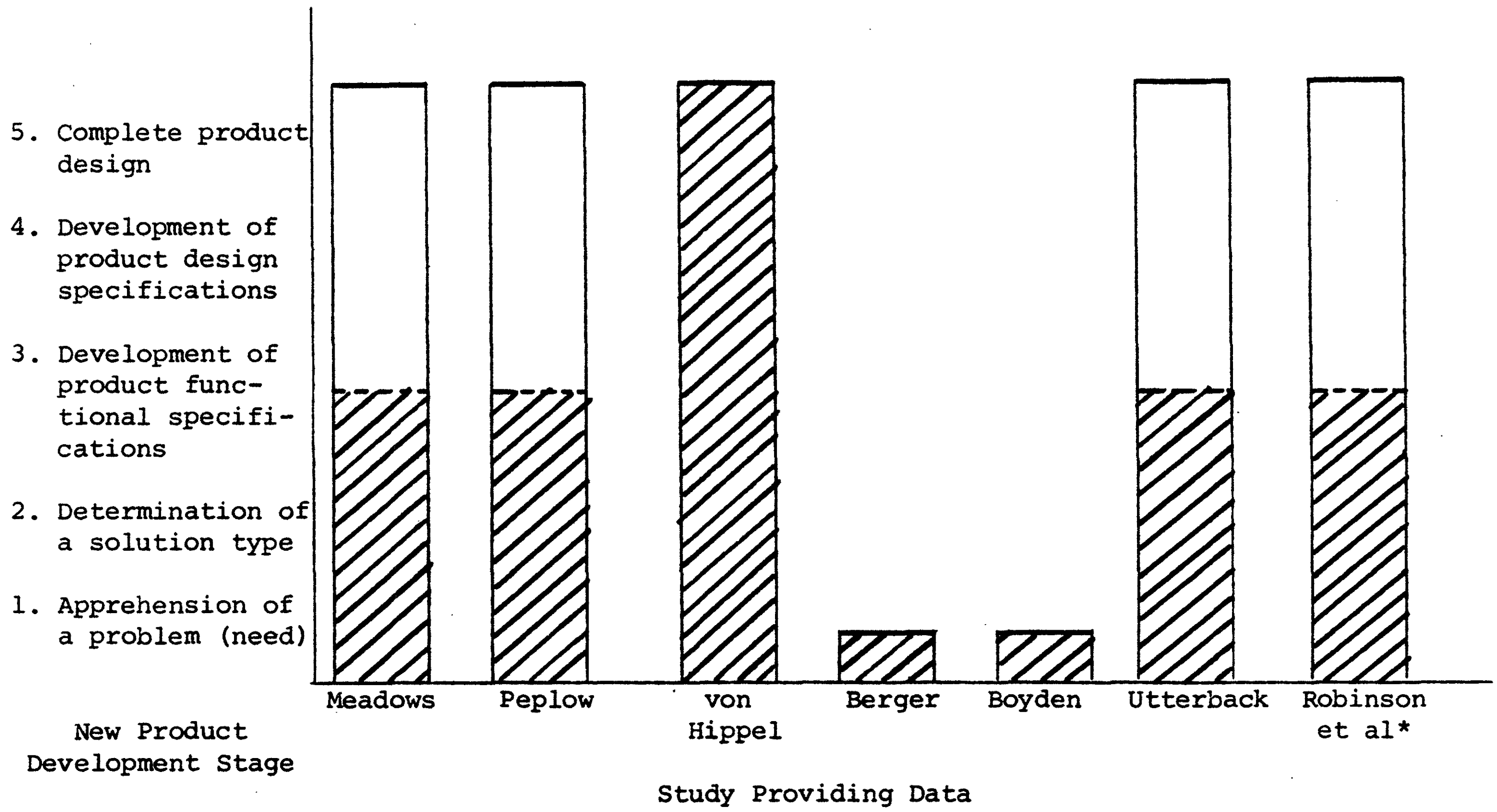

Figure 2: New Product Development Data Supplied by Customer to Manufacturer in "Need Message" (For studies ambiguous on this matter, we have indicated both maximum [total bar height] and minimum [shaded bar height] levels of product design data supplied by customer which is compatible with data and analysis provided by those studies. See text for discussion.)

*Scale valid for new product portion of study sample only.

As was noted in Section 3, the Meadows, Peplow, Utterback and Robinson studies do not spell out the solution content of the customer need messages they observed. And on the face of it, the content of those messages could have been anything from a simple, "Give me a new product - any new product!" to "Make me some of my compound X according to my process Y". (This range of possibility is indicated by the total bar heights shown in Figure 2.) We would argue, however, that the solution content of those need messages must at minimum have included some functional specifications for the new industrial product requested (indicated schematically by the shaded portions of the bars in Figure 2), and at a maximum , have provided complete product design data to the manufacturer.

Our argument that, at a minimum, the need messages must have included some functional specifications for the desired product is as follows: The need messages observed in the reviewed studies were "narrowcast" to specific suppliers - not broadcast to all and sundry. Since different suppliers specialize in different solution technologies, selection of a particular supplier cannot be made until the customer has envisioned the general type of solution he wants to his problem as well as recognized his need. For example, if a customer perceives a need to store corporate data, he will make his need known to Kodak if he envisions microfilm storage as an appropriate "type" of solution to his problem. If, on the other hand, he feels physical storage of hard copy is in order, he may contact a manufacturer of file cabinets, or if he feels storage on magnetic tape might be appropriate, he will contact a computer manufacturer, and so on. Our belief that a user need message must also include some functional specifications for a product responsive to the need is also based on simple logic: It is hard to envision a customer calling up a supplier about a problem and not being able to specify at least some of the functional elements required in a responsive solution. In the instance of the corporate data storage example above, therefore, we find it only logical to assume that, in most instances, such a customer would know roughly how much data he had to store, how often he needed access, and so on.

Our argument that, at a maximum, the need messages from customers noted in the Meadows, Peplow, Utterback and Robinson studies could have included complete product design data for the industrial product requested, is based on the data from our own studies of scientific instrument and process equipment innovations, reviewed in Section 2. That data supports the notion that product users (customers) in at least some fields are the source of the designs for most of the functionally significant, first-to-market, industrial product innovations occuring in those fields.

Finally, we come to the question - is the solution content of the need messages observed in the studies reviewed of such a nature as to constitute the "idea" for the new product being sought? Even though, as discussed above, most of the studies reviewed only allow us to reason what the minimum and maximum solution contents of the messages observed must have been - with quite a range between the admissible minimum and maximum - we feel we can safely conclude that the customer messages <u>have</u> provided the new product idea to the manufacturers. This is so because even the <u>minimum</u> solution content which could have been provided by those messages meets the definition of a new product idea (a very difficult definition to devise) in the usage of many investigators.

(Rubenstein's [1963] working definition of an idea is "an actual or potential proposal for undertaking new technical work which will require the commitment of significant organizational resources such as time, money, manpower, energy." Myers and Marquis [1969] suggest that "the idea for an innovation consists of the fusion of a recognized demand and a recognized technical feasibility into a design concept" ... "The design concept is only the identification and formulation of a problem worth working on. It is followed by problem solving activity.")

5.0 DISCUSSION

The reader might find it convenient if we begin our discussion with a brief recapitulation. We started, it will be recalled, with the often-noted observation that new product need assessment and idea generation tools, used routinely and relatively successfully in the development of new consumer products, are seldom used in the industrial products arena. We proposed that the fault might lie, in large part, with the "manufacturer-active" idea generation paradigm (Figure 1A) underlying these tools, suggesting that this paradigm offered a poor fit with the requirements of industrial product idea generation. We then proposed a "customer-active" idea generation paradigm (Figure 1B) which, we hypothesized, was more appropriate to the industrial product arena. Next, we tested the central feature of the proposed new paradigm - transmittance of ideas for new industrial products from customer to manufacturer at customer initiative - against available empirical data regarding industrial idea generation practice. We found the hypothesis generally well supported by the data - although the Berger and Boyden studies showed that it may only rarely hold in some product categories. That is, we found that the customer-active paradigm appeared to offer a better fit to industrial idea generation practice than does the manufacturer-active paradigm. Further, we found that evidence from the Meadows and Peplow studies suggested that the customer-active paradigm was more likely to offer a good fit to practice in the instance of commercially successful new industrial products than in the instance of commercial failures.

In the body of this section, we would like to consider whether the customer-active paradigm offers a good fit to the requirements of industrial product idea generation as well as to present practice and, if so, for what sections of the universe of new industrial products.

5.1 Conditions Under Which Manufacturer-Active and/or Customer-Active Product Idea Generation Paradigms are Appropriate

There are two possible explanations for our finding that the hypothesized customer-active paradigm fits more closely with industrial product idea generation practice than does the prevailing manufacturer-active paradigm:

(1) The manufacturer-active paradigm is inappropriate to the requirements of industrial product idea generation.

(2) The manufacturer-active paradigm is appropriate to the requirements of industrial product idea generation, but simply has not yet been extensively applied in that field.

We would like to propose that each explanation applies to the situation - but each to different portions of the "universe" of new industrial products, as a function of the following two constraints:

(1) We propose that the customer-active paradigm can only be applied in situations where the would-be customer is overtly

aware of his new product need - while methodologies developed in the context of the manufacturer-active paradigm can be applied to either overt (e.g. conjoint analysis) or latent customer needs.

(2) We propose that the manufacturer-active paradigm can be applied only under circumstances in which the new product opportunity is "accessible to manufacturer-managed action".

If we display these proposed constraints and their impact in a two-dimensional table (Table 4), we see the conditions under which the customer-active and/or manufacturer-active product idea generation paradigm will be appropriate.

INSERT TABLE 4 HERE

The logic behind our proposal that the customer-active product idea generation paradigm can only be applied in instances where the customer is overtly aware of his need is clear: How, after all, can one expect a customer to send a message regarding a need of which he is not overtly aware? The purpose and logic of our second proposal - on the face of it a near-tautology - is doubtless opaque to the reader at this point. Clarifying it and reasoning that it discriminates well between consumer and some industrial new product opportunities is the task to be undertaken in the section which follows.

5.2 Low Accessibility of New Industrial Product Opportunities to Manufacturer-Managed Action

The hallmark of the manufacturer-active idea generation paradigm is manufacturer initiation of the process by which the need for a new product is perceived and manufacturer analysis of those needs and

		Accessibility of New Product Opportunity to Manufacturer-Managed Action: Low	High
Nature of Customer Need	Overt	Customer-Active Only ⟷	Customer and/or Manufacturer-Active
	Latent	Neither ⟷	Manufacturer-Active Only

Table 4: Characteristics of New Industrial Product Opportunity Appropriate to Customer-Active and/or Manufacturer-Active Idea Generation Paradigm

generation of a responsive product idea. In contrast, the customer-active idea generation paradigm is characterized by a message, transmitted at customer initiative to a customer-selected manufacturer, which contains a customer-generated product idea.

Given that a customer need for a new product is overt, we suggest that two characteristics of the new product opportunity are key to determining the relative appropriateness of the manufacturer-active or customer-active paradigms to the product idea generation process:

(1) Easy (low cost) identification of customers with a new product need via manufacturer-initiated methods, such as surveys, will be favorable to use of the manufacturer-active paradigm.

(2) Long-duration "new product selling opportunities" (defined as starting when a customer(s) first develops a need for a new product, and ending when that customer is no longer willing to consider purchase of a responsive product offered by a would-be supplier) will allow application of either paradigm, while very short opportunities (on the order of a few weeks' duration) will only permit application of the customer-active paradigm. (Our reasoning is that a few weeks - at least with current methodologies - is too short a period to allow a manufacturer time to accomplish the steps prescribed by the manufacturer-active paradigm: need analysis and generation of a responsive new product idea. On the other hand, a few weeks would seem sufficient if a manufacturer only had to accomplish the step prescribed by the customer-active paradigm: acceptance or rejection of a new product idea proposed by a customer.)

We next speculate as to how consumer (discussed first) and industrial new product selling opportunities may be seen in terms of these two characteristics.

In many categories of consumer product, on packaged goods notably - and some categories of industrial product - the following conditions prevail:

(i) The proportion of all consumers using an existing product in the functional category being studied (e.g. toothpaste) is sufficiently large and/or known to allow economical identification of a sample of users via a survey or other manufacturer initiative.

(ii) A sample of current users of many consumer goods is effectively equivalent to a sample of future buyers - the real category of interest to market researchers - because the products are frequently repurchased.

(iii) Users/buyers of many consumer goods can be switched relatively easily (economically) to a new brand if they see it as preferable to their present brand because the switch entails little adjustment effort/cost on their part.

To us, these conditions[18] suggest economical execution of the manufacturer-active product idea generation paradigm because:

- identification of users with a new product need/dissatisfaction with existing products via survey or other manufacturer initiative appears economical;
- the duration of the new product selling opportunity appears sufficient to allow execution of the manufacturer-active paradigm. (Since the products are frequently repurchased and since brand switching involves little change-over cost for the buyer, a "selling opportunity" remains open to a manufacturer as long as the need he has identified remains valid and unfilled.)

Consider next the circumstances which studies of industrial buying and engineering problem-solving behavior suggest are characteristic of

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[18] Note that the conditions outlined above also hold for certain types of industrial products. In the instance of electronic components such as resistors, for example: Electronics firms using these components are easily identified, the parts are frequently repurchased, and their physical and functional characteristics are sometimes so standardized that customer firms can make a relatively costless switch from one brand to another if they wish to do so.

the selling opportunity for many new industrial goods: Industrial products (often placed in the categories of materials, components and capital equipment) are "needed" and specified largely by engineers. [Brand, (1972), Robinson, Farris and Wind (1967), Buckner (1967), and Research Department of Scientific American (1969) are unanimous in concluding that R&D personnel, engineers primarily, within the product buying firms are the primary decision makers in the key early stages of the buying process in which the kind of product to be purchased and its specifications are determined.] Such engineers are engaged in "engineering problem solving", we suggest, and derive their need for the product from a particular approach to a particular problem. Thus, if you ask an engineer what he needs in the way of an equipment-cooling fan, his answer may properly be that it depends entirely on the application - the engineer himself has no long-term criteria for what he would like to see in a fan. Since engineers are constantly working on different problems, the result is that an engineer's "need" for an equipment-cooling fan may well change from problem to problem. And, even within the context of a particular problem, the engineer's need will very likely change from moment to moment as the work of problem solving proceeds. As an example, suppose that an engineer is assigned the problem of stabilizing a circuit whose electrical parameters "drift" unacceptably because it gets too hot when operating. The engineer may decide to redesign the cirucit in such a way as to make it stable at the operating temperatures encountered - in which case he has no need for a fan. Or, he may decide he will stabilize the circuit by cooling it - in which case he will have a very specific need for a fan meeting, possibly, very tight cost, size and performance parameters.

Needs change rapidly, we assert, because the engineering problem solving process proceeds rapidly. Studies of the engineering design process by Allen (June 1966) and Marples (1961) show radical changes in preferred solutions - and therefore in needed materials and/or materials and/or process equipment - occuring within the span of a few weeks. Allen displays this rapid change in preferred solutions very graphically via "solution development records" based on data from real-time monitoring of the engineering problem-solving process (cf. Figure 3).

INSERT FIGURE 3 HERE

If the above characterization of needs for new industrial products and the process by which they are generated is correct, one can see that such needs arise quickly within a particular customer, may disappear or change as quickly and, while present, may be very precise (e.g., Yesterday I didn't want a fan, but today I want one which must be less than 5-3/8 inches in diameter, must cost less than $5 in lots of 10,000, etc.).

The conditions described above are, we suggest, appropriate for application of the <u>customer</u>-active idea generation paradigm because:

- Customers who need the product are difficult to identify through manufacturer-initiated action. (This assertion is only logical, given that the buyer is a not-very-accessible engineer in the midst of a corporation who may never before have expressed any interest in the type of product he now needs, etc. It is also a common observation of studies of industrial marketing [Robinson, Farris and Wind, 1967].)
- The selling opportunity - measured as starting when the customer first develops the need for the new product and

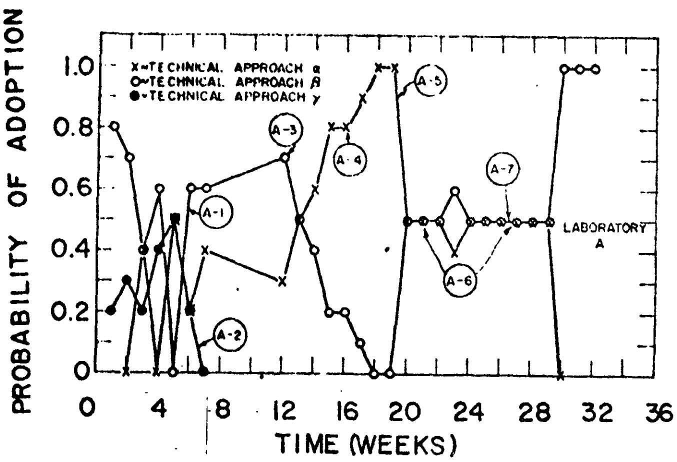

Figure 3: Solution Development Record of Engineering Team Designing an "Antenna Radiation Subsystem" Showing Changes in Probability that Various Solutions Will be Adopted vs. Time

(Redrawn from Allen [1966], p. 75.)

ending when the customer selects an initial supplier - is brief (perhaps only weeks). As we noted above, such a time span is probably too short to accomplish the steps prescribed for the manufacturer by the manufacturer-active paradigm, but it would appear appropriate to the manufacturer's role in the customer-active paradigm. (The selling opportunity noted above is only the initial selling opportunity. Such initial selling opportunities are very important to would-be manufacturers of new industrial products, however, for two reasons: (1) For any given customer, the initial selling opportunity is often the only selling opportunity because, after an initial supplier is settled upon, changeover to a new supplier often involves considerable cost to the buyer. Selection of a new supplier to fill repeat orders under such circumstances is unlikely. (2) A manufacturer who becomes the supplier to the first buyer of a new industrial product often has an advantage in obtaining orders from new customers for the same product because: he is down the experience curve relative to would-be competitors; he is a known supplier of the item and thus increases his chances of obtaining "need messages" from additional customers.)

In sum, the customer-active paradigm appears to fit current industrial product idea generation practice and to offer a good fit to the requirements of such idea generation as well. (Recall here the data from the Meadows and Peplow studies reviewed earlier which suggests that products initiated via direct user request tend to be among the commercially more successful of all new industrial products.) Perhaps, therefore, we should consider the utility of adopting that paradigm (shown schematically in Figure 1B) as a useful base on which to build new methodologies for the generation of ideas for new industrial products.

6.0 SUGGESTIONS FOR FURTHER RESEARCH

A useful new paradigm should suggest useful new questions. If idea transmission at user initiative is to form the basis for a paradigm describing how manufacturers often (usually?) acquire ideas for new industrial products, the questions made relevant ot research and practice are, it seems to us, most useful. Among these are:

(1) The manufacturer switches from a paradigm in which his ability to perceive needs is under his control to one in which the customer must see the manufacturer as relevant and "narrowcast" an idea to him. Until and unless the customer does this, the manufacturer is unable to see the idea. Thus the question arises: How does the manufacturer get the customer - whom he cannot specifically identify - to see him as a potential supplier for a new product idea and contact him?

Manufacturers have already worked out many strategies to this end empirically, we suggest. They advertise the types of technology they are skilled in..."Brazing problem? Call us"... They advertise products they have made to solve other's problems, hoping to strike a spark in a customer engineer who is, even now, solving a problem they could contribute to - but who is, frustratingly, invisible to them until he initiates contact, etc. But how is it best done? Studies of what makes a customer engineer see a manufacturer as relevant are clearly in order. For example, studies of problem-solving behavior by engineers (Allen and Marquis, 1964) and others show that problem solvers tend to return to a technique they have previously used successfully when faced with a new problem. In the present context this finding suggests that customers will tend to transmit their needs to suppliers of old, familiar technologies (e.g., faced with a fastening problem, they would tend to turn to a supplier of a familiar hardware-based fastening technology rather than a new, adhesive-based one). If study shows this hypothesis to be correct, an interesting strategy implication for suppliers of new technology such as adhesives would be that they should acquire a "window on need" by buying into an established company which specializes in an older technology of analogous function.

(2) The manufacturer switches from a paradigm in which he was set up to perceive and analyze needs and generate product ideas to one in which he must efficiently perceive and screen ideas. Obviously, such a change raises major organizational issues for the firm. While in the consumer goods paradigm marketing research was the locus of need perception and analysis activity - and was presumably organized and staffed for the role - in the new paradigm, sales becomes the new need/new product idea reception area. How, in detail, do such messages come to sales? In field contacts with the customer? To the firm's central sales function? Are they transmitted orally or in writing? What incentives do sales people have for sensing these requests and passing them on? (Typically, salesmen's commissions are designed to reward large volume sales in the present - not possible sales of new products in the future.) Are salesmen properly trained to understand new product requests? Is there any incentive/organization which will insure that the salesmen have someone to pass customer ideas along to for evaluation and action? Etc. Clearly, the new paradigm raises many questions for research and practice in the area of firm organization.

(3) Which classes of industrial product fall under the "customer-active" idea generation paradigm we have proposed, and which under the "manufacturer-active" idea generation paradigm? Do these two exhaustively cover the "universe of standard industrial products"? As a research hypothesis, we would suggest that at least three paradigms, shown schematically in Figure 4, will be useful in understanding how ideas for new industrial products are generated by their first-to-market manufacturers.

INSERT FIGURE 4 HERE

The first paradigm is the one we have discussed to this point, the "customer-active" idea generation paradigm. As suggested by the figure, new product ideas are offered by users (customers) to manufacturers for made-to-order industrial products - "specials"

Paradigm	Sequence of Activities						Universe of Standard Industrial Products
1. Customer-Active	product request from customer	→	"custom" industrial product	→	adoption by others	→	% NA
2. Manufacturer-Active	needs research by mfr.	→	idea generation	→	idea testing	→	% NA
3. Unfilled "Known Need"	"generally known" user need	→	advance in technology	→	development of responsive product	→	% NA

Figure 4. Three Proposed Paradigms for Industrial Product Idea Generation

in the jargon of the trade. If a manufacturer receiving such an idea decides that the potential payout is attractive enough to merit his working on it - by no means a certainty - then (a) the resulting product might only serve the needs of the requesting customer and thus only be manufactured for as long as that customer requires it, or (b) the product, once available, might attract the interest of many buyers and become a "catalog item" - a standard industrial product offered by the first-to-market manufacturer and, eventually perhaps, by many manufacturers. (At this point we have evidence, reviewed in Section 2, that many new industrial products fit the customer-active paradigm. We do not, however, know how many of these new industrial products which start out as "specials" go on to become standard products. Thus, as indicated in Figure 4, at this time we have no idea whether most of the "universe" of new industrial products have a customer-active paradigm origin or only a few.)

The second paradigm, the manufacturer-active paradigm, is conventional wisdom in the consumer product field. We have also discussed it above and have suggested that many industrial products may appropriately be addressed by it.

The third and final paradigm which we hypothesize will be found appropriate to some classes of industrial product - and for which we have anecdotal evidence only - is one in which "everyone knows" what the customer wants, but progress in technology is required before the desired product can be realized. In our work in the computer, plastics and semiconductor industries, we have often been told that new product needs were often not a problem: "Everyone knows" that the customer wants more calculations per second and per dollar in the computer business; "Everyone knows" that the customer wants plastics which degrade less quickly in sunlight; and "Everyone knows" that the semiconductor customer wants more memory capacity on a single "chip" of silicon. Under such circumstances, a need message is not required to trigger a new product - only an advance in technology. And since many of the "everyone knows" statements are phrased in dimensional terms, a series of new products can be introduced as technology advances, each responsive to the same dimension of need, with no new need message required. Thus, computer manufacturers do not stop and rest on their laurels after introducing a faster computer - waiting for a user to approach them with the "need message" that still faster is desirable. Rather, they continue to move down the clearly defined "dimension of merit" of greater computing speed as quickly as their advancing technology allows.

We suggest that the absence of explicit need messages directly associated with the samples of engineering plastics and plastics additives examined by Berger and Boyden are the result of such an effect: e.g., that the needs were generally known. Conversations with participants in these industries lends anecdotal support to this hypothesis, and we suggest that research into the matter would be of interest.

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