DEVELOPING A BASIS FOR ASSESSING THE MARKETABILITY OF PASSIVE SOLAR TECHNOLOGY IN THE U.K.

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codification; congruency; diffusion; descriptive languages; eccentricity; expert systems; K-strategist; N-strategist; customer segmentation; source effects; usage situations

Acknowledgement

This paper reflects ideas and issues raised in debate with many friends equally concerned as I, but in particular I would like to thank Robin Wensley for the support, help and constructive criticism he gave me in writing this paper.

Introduction

The overall Project P3/2 was set up by the Energy Technology Support Unit of the Department of Energy (DEn/ETSU) to develop a model of the marketability of passive solar technology within the private domestic housing sector in the UK. Such a model was to provide a means of understanding how market potential and market penetration depended on immediately quantifiable parameters such as costs and performance, and on qualitative attitudinal factors. It would consider both general issues of the impact of energy cost-in-use for domestic buildings as well as detailed responses to specific passive solar measures. This paper explores the issues raised in seeking to develop such a model and sets out in more detail the methods appropriate for describing such dependence.

The origins of this study lay in the earlier study of The Market Potential for Solar Water Heating (Beesley et al 1981). The conclusions of that study were that while there was a viable long term market for domestic Solar Water Heating (SWH) in the UK which could be worth around £25 million per year over the next ten years, in national energy terms the impact was likely to be small. A substantial improvement in the cost effectiveness of SWH systems via Research, Development and Demonstration would however have a significant impact on market potential. DEn/ETSU (1978) concluded that:

> "the rate at which energy savings would accrue depends upon the market penetration rate, which is likely to be relatively slow until solar water heaters are cost-effective. At current prices they are cost-effective only in a limited number of situations."

For the given level of cost effectiveness therefore, the SWH project reinforced this conclusion that the factors affecting the speed of diffusion of the technology and its associated degree of penetration of the market were critical to whether or not there was a payoff in national energy terms.

Clearly an assessment of long run market potential was an important input in predicting the ultimate market for passive solar technology even if it only reflected the present understanding of the state of the technology. If the speed of diffusion however was to be such that the degree of penetration was likely to be minimal within a short to medium-term time horizon, then to understand the factors affecting penetration was to understand the market potential in the short to medium term. No wonder therefore that Dr Wensley (Wensley 1983) expressed some concern over the perspective from which the Department of Energy addressed Energy Conservation Policy in general:

> "to reinforce the view that because the world is complex one can do little else but get the price signals right."

Wensley's concern however reflects on what the Department was able to <u>say</u> about Energy Conservation Policy: its actions spoke of a far more complex theory-in-use embracing intervention in information and technology transfer as well as standards regulation.

Predicting Penetration

Penetration of a market by a new technology depends upon the diffusion of that technology through the market. This diffusion will be measurable in terms of customers' behaviour, and those behaviours will flow from two distinct kinds of choice: firstly, the producers offering the technology will have had to have chosen to make the technology available to the customer in the first place; and secondly, the customer will have had to have chosen to buy the technology. We cannot assume that producers and customers exercise these choices from a single frame of reference, so that if we are to predict penetration we are faced with the problem of articulating multiple frames of reference and the ways in which they influence behaviour. We have two questions therefore:

(a) What choices will the producer's view of the market lead him to offer his customers?

(b) What choices will the customer's view of his needs lead him to make in relation to the choices on offer to him?

An example of concern over the way in which the first kind of producer's choice is made is to be found in an EDC project proposal (PIF No 3A/14) on Building design and construction design information for the construction industry:

> "The EDC committee reviewing BRS's industry sponsorship programme in 1981 considered that the biggest single benefit to research application was likely to lie in improving rather than increasing information. They suggested that high priority should be given to research on information, to better understand industry's motivation to use information…. information is of no value if it is not read, understood, and used. The project is therefore reader-centred. It seeks ways of ordering and presenting information to suit the activities of particular readers."

Such an approach concentrates on the way in which information is codified, so that by adopting different systems of codification, the information can be made more readily accessible to different groups of users. This is not merely a matter of, for instance, producing attractive brochures. An effective approach inevitably involves inventing new systems of codification reflecting the different ways of thinking of different groups of users. As soon as a new system of codification emerges however, a barrier to diffusion emerges (Boisot & Brumat 1982), since by virtue of its being a new system it requires translation from other systems. Achieving diffusion in this way therefore requires the diffuser to develop his knowledge of the uses to which the technology can be put so that he can adopt multiple ways of thinking about his technology.

The Energy Conservation Demonstration Projects Scheme

The problems inherent in getting diffusion through doing this translation can be seen in the progress report of the Energy Conservation Demonstration Projects Scheme (Currie 1981). The purpose of the Scheme was to stimulate investment in new ways of using energy more efficiently. It was to work in two ways: firstly, companies got grants to mount demonstrations. This was to accelerate the rate at which novel projects occurred. Secondly, information from the demonstrations was to be

disseminated to other companies. This was to stimulate the 'replication' of successful projects, thus accelerating the overall rate of investment. The original budget for the Scheme allocated £20M over the four years 1978/82. The bulk of this money was to be disbursed through grants of up to 25%. This meant that industry had to find about £60M to invest in the demonstration projects. The next stage was to achieve replication so that an overall energy saving of £100M per annum was achieved. Assuming a three year payback, this meant capital investment of £300M. What happened is as follows:

> "It did not prove possible to build up the programme at the planned rate. There were simply not enough proposals satisfying the criteria that the Scheme demanded. In consequence, not as much as £20M will have been committed to projects let alone spent by March 1982…. (the original budget) made no allowance for the cost of managing and promoting the Scheme.... we obtain a rough estimate of £5M as the cost of managing and promoting the existing scheme…. the total anticipated government expenditure for existing projects is £11M, the capital contribution of industry towards those same projects is £20M. The target annual energy savings/cost to Government needs to be 27/1, compared with the 5/1 budgeted for…. the results to date show that a ratio of 7/1 has already been achieved and that there is a good possibility that 20/1 will be achieved as a result of further promotion by the equipment suppliers and the DEn/ETSU."

In the initial stages of the Scheme, projects arose in a fairly random way. However, it became inefficient in terms of management and marketing to go on expanding the programme in this fashion. In addition, it began to become clear that a random collection of projects would be unlikely to have as stimulating an effect as a coherent programme in which the results of individual users' projects could reinforce one another. Therefore, it was considered that a better way of proceeding was to start from the market by identifying areas where substantial savings could be realised and then sponsoring several closely related projects which would all be relevant to the same area of the market and would provide would-be investors with comprehensive techno-economic information and choices. In this way strong user applications were to be created which could pull the new technology into that area of the market. In effect therefore the Scheme began to look for different systems of codifying this technology in terms of different areas of the market, and then translating the technology into that area and seeking diffusion within it. The challenge for the Scheme was as stated earlier: to develop its knowledge of uses so that it could find these 'areas' of the market.

The forms of knowledge underlying such an approach contrasts strongly with those underlying the approach to predicting the degree of penetration which came in a report from the Chief Scientist's Group, Energy Technology Division (1983):

> "In general, it has however been assumed that when a given technology becomes cost effective, deployment of the technology will then commence. The full economic potential of the technology will not, of course, be realised immediately. Deployment takes time…. What we needed therefore was some form of simple penetration model which would indicate the quantity of any given

> resource which, given that it was cost effective, would be taken up by particular dates in the future. Various studies of the uptake of new technologies by industry or of new products by domestic consumers have been made, and we decided to draw on these. A typical penetration curve is the 'sigmoid' curve…. a second type of penetration curve is the 'log-normal' curve…. we recognised that diffusion of innovation is a complex phenomenon, so we were conscious that the model adopted was simple. Nevertheless, the main feature of the two diffusion curves used are well established in the available literature and data on the timescales of penetration are robust."

Assuming that such a curve could be drawn, the problem facing the DEn/ETSU Passive Solar Technology project was the likelihood that the time it would take the market to reach its full potential would be considerably longer than the time frame within which the policy makers were prepared to commit funds. Under such circumstances, predicting the rate at which the process of diffusion would take off would therefore be much more critical than predicting the eventual long-run level of market penetration in formulating strategies for intervention.

Modelling diffusion processes

One study which in fact tried to model market penetration of solar energy in the UK was Susan Batty's (1980). She tried to develop and test an exploratory model of market growth in domestic solar water heaters using structural modelling techniques which tackle the analysis and forecasting of complex social phenomena with imperfect data. Her results were based on a pilot study of a small group of experts, mainly in solar research. In her conclusion she stated the following:

> "Information on the growth of the solar market in the UK is scarce and unreliable. The pilot study yielded rather more information on the deficiencies of the survey design and of factor measurements than on the substantive issue of market forecasting.... The next stage of this study will use a series of much shorter interviews with a stronger focus on an expert's clearly defined area of knowledge.... the emphasis on the use of expert panels, feedback and group discussion is not merely a data collection device, but is intended to assist individuals in clarifying their own judgements."

If an examination at this level of detail with a group of experts proved so difficult, and even lead to the experts clarifying their own views, what was the Chief Scientist's simple model representing at its level of aggregation? It is of course possible, ex post, to describe what has happened in terms of a particular shape of curve over some time-frame, as indeed most of the diffusion model studies have done, but this does not necessarily provide a useful ex ante assessment. Day, Shocker & Srivastava (1979) have this to say in their paper on Customer-Oriented approaches to identifying Product-Markets when commenting on technology substitution analysis:

> "A simple approach to forecasting the course and speed of the substitution process is to project a function having the appropriate logistics curve, using historical data to determine its parameters.

> This curve-fitting method overlooks many potential influences on the process, such as: the age, condition, and rate of obsolescence of the capital equipment used in the old technology; the price elasticity of demand; and the "utility-in-use" or relative performance advantage.... Recent efforts to model substitution rates have focused on relative "utility" as the basis for improvements in forecasting ability. The procedure involves identifying the relevant attributes and performance characteristics of each of the competing technologies, followed by ratings by experts of the extent to which each alternative possesses each attribute in each end-use market. Finally, an overall utility for each usage situation is obtained.... While criticism can be made of the model structure and the seeming reliance on measurable physical properties to specify the attributes, the value of the basic approach should not be discounted."

Neither the Chief Scientist nor Susan Batty were in fact basing their analysis on the customer himself. Both of them relied in their different ways on expert knowledge of the market: the former through what was published, the latter through expert panels. The lessons learnt by The Demonstration Scheme however indicate that this would never be enough where diffusion was an issue: The Demonstraton Scheme had to become expert, but in their case they ended up having to become experts in the different forms of customer expertise. They discovered that their focus had to be very much on relative 'utility-in-use' between competing technologies in relation to specific 'usage situations' in each 'end-use market' as defined by the customer. What kinds of problems have to be faced in becoming an expert on others' expertise, and how can this be incorporated as part of a marketing strategy?

Source Effects and Experts

The existence of a 'source effect' indicates that the source of the expertise - the expert - exerts a significant influence on both what is known and also the way in which things are known. A good example of the extent to which this can be an issue is to be found in a company in the USA. This company accidentally commissioned from two research houses two attitude research studies (Struse 1979) covering the same product category with "precisely the same objectives." At no point was comparison of the different approaches explicitly discussed or raised as an objective. The company however got substantively different results from the two studies and the actions indicated were drastically different for both advertising and new product development. The comparison called into question the company's basic presumptions about the insensitivity of research results to technique.

The company went back over the research it had commissioned and sought to find ways of explaining the existence of the differences. The following three questions summarise the issues they had to address:

> (a) To what extent did the content of the researchers' views correspond with the available facts?
>
> (b) To what extent were the researchers' views internally consistent: was it possible to generate conclusions from their views which contradicted their other conclusions?
>
> (c) In what ways did each group of researchers formulate their views and were those formulations congruent with respect to each other: were the researchers saying the same things only using different words, or were there significant structural differences between the ways in which the views were constructed?

These questions also provide an approach for describing the nature of source effects which we can generalise into a set of concepts for the validation of any particular model.

Modelling and Error of the Third Kind

The feasibility study of a modelling approach to the marketability of solar energy systems (Mitropoulos 1983) provides the example which is immediately relevant to this study. The model is based on the dynamic integration of the responses of four groups of agents, namely consumers, suppliers, banks/building societies and government. The model's output is intended to provide the market penetration in various degrees of aggregation, and the feasibility study discusses (among other things) the use of panels formed from people belonging to the four groups of agents. The following quote indicates Mitropoulos' awareness that he might share some of Batty's problems when he comes to collect the data:

> "Econometric and statistical techniques may be employed for the parameters' estimation. However, they might prove less powerful than it is thought, mainly due to multicollinearity and to the existence of simultaneous processes. Under some assumptions other techniques, like Kalman filter, can be used and a combination of

> various heuristics coupled with the modellers' and the experts' educated guesses may serve the same purpose. As a concluding remark to this data collection process, a hidden assumption should be revealed, which points towards some degree of stationarity in the approach. Panels' data mirrors the contemporary perception, not only about solar energy but about all economic and social activities. Therefore, by forecasting the behaviour of a market in the future based on such data, one tacitly assumes that structure would not be influenced by changes in these perceptions."

Linstone (1977) made this same point in arguing that even though the forecaster was as accurate as possible in measuring the things he wanted measured, the tendency nevertheless was to discount heavily the impact of future or past discontinuities in world events, and tacitly to reinforce the presently established paradigm as to 'what the future holds for us.' Mitroff (1977) has gone further in accusing technological forecasters of avoiding addressing the problem of the Error of the Third Kind - the probability of solving the 'wrong' problem when one should have solved the 'right' problem. For Mitroff, the real problem was to ask the right questions before adopting any particular method of generating answers.

In what sense then would it be fair to say that Mitropoulos's modelling approach is addressing the wrong question, and what would a 'right' question look like? McLean (1977) argued that the process of formulating a view went through two stages: firstly there was the stage of problem finding involving the formation of a conceptual structure; and secondly there was the stage in which this structure was used to derive the consequent behaviour of the system using complex mathematics. In his view, modelling technologies had been developed to cope with the second stage and the second stage **only.** Mitropoulos masks the problems of the first stage behind "data and estimation" and behind the plausibility of his own presentation of the problem given his own credibility as an expert in the "integrated dynamic modelling approach." As with all experts he has created a source effect, but he has not addressed the first stage problem overtly (nor to be fair was it necessarily his brief, but that is to shift ownership of the problem, and not the problem itself). Whatever question he is addressing is therefore nor readily available to us to question.

The descriptive approach

McLean's approach to solving the problem of the missing question is by using techniques for structural modelling. His own technique developed at the Social Policy Research Group is called SPIN. SPIN is a selection of procedures for analysing the structure of "system dynamic" type models of socio-economic systems. In particular they identify feedback processes, analyse subsystem structures and perform "pulse analysis" to test the dynamic properties of the model. These techniques make use of a linear 'interaction matrix' which represents the interactions between model variables in a simple numeric form. This simplifies the model structure for the purposes of understanding and analysing the model and can be derived from highly complex models. The technique therefore takes the researcher back out of the second stage towards the first stage and gives him a way of thinking about the properties of the structure of the model itself. Mass (1981) discusses the benefits of going through this kind of analysis, although without the benefit of McLean's methods, in order to

diagnose 'surprise' model behaviour. Such surprise behaviour reveals valuable insights into the structural properties of the model which, if replicated in the world, can produce behavioural and policy insights. However, such surprise behaviour can also provide insights into the true nature and therefore appropriateness of the questions which the model is answering. Either way, the researcher is left with the problem of developing and debating the appropriateness of the conceptual structure itself.

McLean's criticism of modelling technologies is fair because they make heavy use of modelling languages on computers, and these languages are procedural. Weizenbaum (1976) makes the point in his chapter "Against the Imperialism of Instrumental Reason":

> "...the computer is a powerful new metaphor for helping us to understand many aspects of the world, but it enslaves the mind that has no other metaphors and few other resources to call on. The world is many things, and no single framework is large enough to contain them all, neither that of man's science nor that of his poetry, neither that of calculating reason nor that of pure intuition."

Procedural languages are a special kind of language which form a subset within the class of descriptive languages. Another way of describing McLean's first and second stages is to say that the second is concerned with developing procedural knowledge whereas the first is concerned with developing descriptive knowledge. Michael (1977) argues that the systems approach on which SPIN's structural modelling is based should not be used by planners as a means of closing down debate by providing answers, but rather as a descriptive approach through which more people could engage in debate about the important questions. As Churchman (1977) points out however, complexity is the experience of a multiplicity of questions, the answers to which do not easily fit together within a person's span of knowledge. If the planner's response to the experience of complexity is therefore to build ever more complex models of answers without ever developing his ability to ask more complex questions, then his models will be unlikely to be used by him to foster debate, and instead will be more likely to reflect a desire to avoid it.

What then would a descriptive approach look like, and if procedural languages provide the wrong metaphor, would a descriptive language be any better? An example of the descriptive approach without the use of computers is to be found in Axelrod (1972). Using the verbatim transcripts of a high-level policy group discussing whether or not to continue the British intervention in Persia, the cognitive maps of the participants were derived by coding the texts into two lists: one of concept variables and the other a list of causal assertions. The assertions made by each person were then put together to construct each person's cognitive map. The results showed that although the maps were quite large, the decision makers took stands which were consistent with their large cognitive maps. The results also indicated that although the maps were large and highly interconnected, they were structurally simple, and these simplifications happened to be ones that made the decision-making problem relatively easy to solve. The content of the maps corresponded well to the known facts, they were remarkably internally consistent, and they were sufficiently easily combined (being based upon a common list of concept variables) for their congruency with respect to each other to be checked. Such a process should be quite feasible therefore in our case, although we cannot assume that it will be quite so easy to answer our

questions relating to the source effects created by a much larger and more disparate group of experts.

The mathematical basis for developing a descriptive language exists in 'category theory' (Arbib & Manes 1975), which provides a way of describing domains of mathematical discourse characterised in a very general way, and thus an array of tools for stating results which can be used across a wide mathematical spectrum. Its key concepts build on the idea of 'arrows' which represent relations or mappings which can be built up into 'structures'. Category theory then develops the concept of a 'functor' as a relationship between structures which is the formal equivalent of our notion of congruency between different formulations (structures). What is interesting about Category Theory is that it provides a means of describing congruency in terms of the different structures of relations which define the different formulations. If a descriptive language on a computer had this capability, then it would be possible not only to represent the formulations of different experts, but also to represent descriptions of the congruency/ incongruency between different formulations, as well as providing a tool which could test for consistency. In this way we would have an analytical tool for exploring the source effects of different experts.

Much of the impetus behind the development of Category Theory in fact came from computer science, in which researchers were trying to develop and describe different computer languages. These languages grew out of the logic programming capabilities of computers which were primarily descriptive and not procedural. These logic programming capabilities were used for psychological modelling of human problem solving abilities and for knowledge based expert systems (Hammond 1982). The languages implemented for constructing knowledge based expert systems provide us with the capabilities described earlier, and therefore give us a way of developing the methods needed for supporting the development of conceptual structures. PROLOG is a particular implementation of a logic programming language which is accessible to us on micro-computer (Clark & McCabe 1980). Through the use of PROLOG then, we have a means of addressing ourselves to McLean's first stage by describing the views of experts in the Passive Solar Technology field, and being able therefore to debate the nature of the descriptions they create: their source effects.

Customer Segmentation

The earlier discussion on the problems of predicting penetration identified two key questions which needed to be addressed:

1. What choices would the producer's view of the market lead him to offer his customers; and
2. What choices would the customer's view of his needs lead him to make in relation to the choices on offer to him?

The methodological problems of addressing the first of these questions through the use of experts have been discussed, and a course of development has been put forward through which it might be possible to question the appropriateness of some of the source effects inherent in particular experts' views of the market. The pursuit of this avenue of methodological development through the use of PROLOG allows the internal consistency of views to be examined, and the congruency/incongruency between views to be explored. It does not however get ‘me’ as an aspiring expert off the hook of having to judge the ways in which these views correspond to the 'facts': that I too (or indeed DEn/ETSU) should create a source effect is an inescapable consequence of seeking to intervene in others' affairs. What then are the methodological problems of addressing the second of the questions above?

Businesses have to maintain their own coherence based on the characteristics of their technology and products if they are to continue functioning as businesses. In doing this they inevitably create a source effect. It is to be expected therefore that marketing managers should reflect this source effect in how they define their markets in terms of their products. It is obviously a good thing that they should set about modelling their customers who buy their own and competing products, in order to predict their preferences and behaviour. Such an approach has obvious diagnostic value to the manager in deciding how his business is to market its products to its customers, since to define a market solely in terms of products' physical attributes would be inadequate, as this would exclude the characteristics and needs of the customer altogether in defining the nature of the market; and leave the manager without any 'expert' basis for arguing about how what should be marketed to whom. We can start addressing the second question above therefore by learning how the marketing manager tries to answer it.

Customers come in all shapes and sizes, and the key issue facing the marketing manager is to cope with this heterogeneity by managing a response to an aggregate of their choices at the market level. One of the most robust empirical findings for customer behaviour is that customers exhibit variability in their purchase decisions over time. This varied behaviour can often be shown to result in stable relationships at an aggregate level (Ehrenberg 1969), but inevitably the explanation at the individual level is much more complex and indeed contentious. Beyond what might genuinely be called inexplicable varied behaviour, McAlister and Pessemier (1982) categorised various forms of explanation. These include derived behaviour as a result of multiple needs and/or changes in the choice problem, and directly caused behaviour related to the attractiveness of changed behaviour in its own right both as a result of individual motivations and personal identity, and also as a result of affiliations to others.

Such a wide range of alternative explanations for varied behaviour at the individual level provides the marketing manager with a host of empirical and practical

problems in any attempt to actually interpret the key influences on variation in any particular market. It is important to recognise this range of potential causes however for two reasons: firstly, because aggregate concepts based on strong market segments will often imply customer purchase patterns which will not actually be observed. As a construct in its own right, segmentation is not invalid if it fails to reflect the extent of the underlying customer heterogeneity, but the danger will be in extending its use further than can be justified by its original derivation. Secondly, it is important because it reminds the marketing manager that he will probably be unable in any particular case to identify the specific causes of varied behaviour. Any model therefore based on aggregations of behaviour needs to be applied with caution.

Nevertheless, the marketing manager needs to be able to aggregate customer behaviour to some level between the very broad overall market at one extreme and the individual at the other. This is particularly true if he is trying, as we are in the passive solar study, to consider differing speeds of response by the customer. Hence he needs ways of aggregating customers along dimensions which satisfy the classical statistical criterion: the intraclass variability must be small compared to the interclass variability. Some of the most common ways of representing this heterogeneity include:

(i) traditional socio-economic dimensions
(ii) demographic dimensions
(iii) general attitudinal dimensions
(iv) usage situation dimensions

It is only when he can identify a particular dimension which characterises a considerable degree of the customer heterogeneity that the marketing manager can start to talk realistically about the nature of the diffusion and adoption process.

Traditional socio-economic dimensions

Much traditional segmentation analysis is based on socio-economic dimensions. The use of such dimensions can be justified on two rather different grounds. Firstly, the direct justification for their use relies on the fact that differing economic groups are, by definition, likely to take different views with respect to the time value of money. Hence when faced with an exactly equivalent economic choice different groups can be expected to choose differently. This was the basic principle used in the previous SWH study.

Secondly, the indirect justification for their use relies on there being a proxy for other factors in predicting innovative behaviour. Robertson (1971) for instance, suggested that innovativeness was positively correlated with income, education and occupational status. Thus with increasing affluence comes the possibility of striking a different balance between concerns for quality and constraints of price. Under such circumstances, any substitutability between products as a result of their physical characteristics can be overlaid with substitutability as a result of equivalence of function for the customer: quality lies in the eyes of the beholder after all. Whatever the customer's reasons therefore, the ability to be competitive and responsive to the customer on the basis of providing qualitative service opens up the possibility of responding to such forms of demand - exemplified by solar technology. Such sensitivity to the customer's context however involves the producer in a higher design component in the way in which he responds, and therefore requires the ability to operate locally.

Demographic dimensions

To segment a market on the basis of locality requires demographic segmentation, thus providing the means of assessing competition from the point of view of supply and distribution costs. It has also been widely recognised in popular understanding, if not in marketing texts, that where people choose to live tells us something not only about their economic circumstances but also about the types of persons they wish to be associated with. If such commonality of attitudes that exist in the case of house purchase can be assumed to transfer to other customer choices, then there should be a means of characterising local environments that will help to distinguish between different segmentations of customers.

In the UK this is exactly what the ACORN system can be used for although it was originally developed as a means of categorising local housing needs. It has been used for a variety of marketing purposes, most of which are based on the premise that ACORN discriminates more accurately than other descriptors such as social class. An example of the way in which ACORN has been used is to discriminate in terms of certain product fields: heavy users of brown sauce versus heavy users of Table Wine for instance. Tonks (1981) has reported the use of ACORN categories to discriminate different customer groups for a restaurant chain.

General attitudinal dimensions

Attitude research amongst customers has provided much of the basis for customer segmentation. However, when Bird and Ehrenberg (1970) looked at the relationship between customer attitudes and brand usage, they found that customers' average attitudes to brands were directly proportional to the level of usage of those brands in ways which varied with attitude but which broke down as the attitude became descriptive of the physical nature of the product itself. They distinguished therefore between evaluative attitudes at one extreme, and descriptive attitudes at the other. Thus evaluative attitudes were better thought of as ways of describing the characteristics of a product field from the point of view of those customers with experience of the products in that product field. Moreover they found little data to support a relationship between changes in evaluative attitude and changes in behaviour. Such attitude data therefore described the characteristics of the customer's experience but certainly could not be assumed to be predictive of changes.

Bird, Channon and Ehrenberg (1970) took this a bit further to see the extent to which the 'brand usage' above meant present brand usage. They found that the proportion of customers who expressed a favorable attitude towards a brand was generally higher amongst its current users than amongst former users and lowest amongst those who had never used it at all. There were deviations from this which were a function of brands' age, particular physical characteristics and performance, but recency of experience clearly also had an effect on attitude. Finally, when an earlier study (Bird & Ehrenberg 1966) looked at the relationship between intention-to-buy and brand usage, they found that intention-to-buy was directly proportional to the square root of usage in ways which varied with the product field. Again the level was a function of the level of past usage, so that dying brands were rated higher than average, and new but growing brands were rated lower. Significantly however, intention-to-buy did not predict future usage.

At best therefore, such attitude research seems to do little more than tell the marketing manager what is or have been the characteristics of users of his products based upon their evaluative attitudes. Certainly this may give him a starting point from which to draw on his own experience and judgement in formulating his marketing plans for the future, but the data he collects is still dependent on the way in which he defines his product field in terms of what are for the customer descriptive attitudes. As long as he then aggregates this data across customers, it will at best only be able to support a homogenising view of the customer in a way which reflects the producer's source effect.

Usage Situations

A way in which more attention can be paid to the customer's descriptive attitudes and which can segment a number of repeat purchase markets is based on the different usage situations for particular products or services. This makes it possible to combine all of the foregoing measures. Obvious examples include "technical" choices i.e. soft drinks as mixers as opposed to drinks in their own right, and "context" dominated choices such as evening meals for two adults compared with fast-food for the family. There is reasonable evidence that provided the alternative usage situations are widely and consistently recognised, usage situation segmentation can provide an effective means of distinguishing between product or service offerings. For instance, Miller and Ginter (1979) investigated the extent to which the situation in which the customer used the product was a significant factor in describing brand choice and customer behaviour. They found that:

(a) purchase levels of specific brands varied differentially across situations,
(b) attitude importances varied differentially across situations,
(c) perceptions of specific brands varied differentially across situations, and
(d) situation-specific measurement of attitude importances and perceptions improved prediction of brand choice over general (non-situational) measurement.

They concluded that given the results of their research, it would appear that the use of non-situational models was equivalent to aggregating data across different contexts, and that the differences between situations would contribute to the unexplained variance of the measures.[i]

Segmenting the market for Passive Solar Technology

It is apparent that the particular context in which solar technology is being bought will be a significant factor influencing the rate of diffusion of the new technology. In assessing levels of penetration therefore, it will be imperative that we not only take situational factors into account, since it is these factors which seem critical in whether or not the technology gets taken up; but also that we explore how the customer defines the product field in the first place, since we have no historic usage data from which we can assume a definition of the product field. How are we to set about doing this?

Returning to Bird and Ehrenberg's (1970) distinction between descriptive and evaluative attitudes, if it is assumed that the customer has both a desire for

distinctiveness and innovative purchase behaviour and also an equal desire for affiliation and hence imitative purchasing behaviour, then the marketing manager can take a step further by making a number of related hypotheses:

(i) he can characterise certain customer groups in terms of particular constellations of social and economic dimensions,

(ii) he can assume that the choices between options with specific descriptive attributes carry relatively the same meaning in terms of evaluative measures within the various groups but not between them, and

(iii) he can assume that these meanings have high salience in the purchase decisions of these groups.

On the basis of these assumptions the marketing manager can segment customers into different groups on the basis of different constellations of evaluative measures as applied to particular sets of choices; and relating such groups to their likely responsiveness to innovative choices in particular markets. An example of one attempt to do this is given by Sadler who proposed the following for Solar Energy Housing: (Sadler)

Group	% Popn	Concerns	Attributes	Solar Htg potential
Inner directed				
Self Explorers	15%	Self awareness Social issues Environment	Financially better off Innovative Educated professionals	High
Social Resisters	13%	Local issues Environment Consumerism	Fairly well off Conservative-traditional Save and invest	Moderate
Outer directed				
Experimentalists	12%	Not socially aware Try anything new	Young, single Few home owners	Very low
Conspicuous Consumer	17%	Fashion	Materialists Middle income	High once it catches
Need directed				
Belongers	19%	Feel secure Home, family Work	Middle income Plain, practical Traditional	Low
Aimless	9%	None	Elderly, poor On own, reactionary	Very low
Survivors	15%	Survival of self and status quo Money	Limited financially Traditional	Very Low

Day, Shocker and Srivastave (1979) propose a number of ways of defining the product field itself based on customers' descriptive attitudes: technology substitution analysis has already been commented on. Where the customers are experts, this seems a reasonable approach. Where the customers' decision processes are not so well known however, decision sequence analysis, based on the analysis of protocols of customers' decision-making deliberations, provides an alternative. The problem here is choosing which customers you want to treat as experts. Mapping the perceptions of such customers creates the same problems as the analysis of evaluative attitudes as

soon as any attempt is made to aggregate the data. The first stage in such a process would appear to be to gather evidence of individual customers in a way which avoids as far as possible the need to aggregate i.e. to allow customers the maximum opportunity to create their own source effects in relation to which we can work. We might expect that we could construct some general measures of both flexibility (the extent to which the particular item can support various different usage situations) and matching (the extent to which current usage requirements are supported by the particular item).

Coupling Produces to Multiple Customer Segments

The different producers active in the market for Passive Solar Technology create an industry infrastructure which constrains and channels the choices which the customer is being offered in terms of the forms of transaction with customers which the producers are prepared to support. These transactions can be thought of as producer situations. The nature of these producer situations reflects the source effects being created by the producers. Any intervention in the market will inevitably create its own source effect as well. In seeking to assess the marketability of passive solar technology, we are looking for a basis from which to create such a source effect.

The analysis of the market from the customer's point of view produces another set of situations and associated choices which are usage situations. These usage situations are particular combinations of highly preferred options reflecting distinct forms of need on the part of the customer in particular situations, and expressed as particular combinations of relevant choices. There is no reason why the groupings of choices on offer in the producer situations should match those defined by the customer as being relevant in terms of his usage situation. This means that it is possible for the customer's needs to be eccentric if the particular set of choices relevant to his needs in a usage situation find no expression in and are not matched by any one producer situation; and for the producer's capabilities to be redundant if his capabilities can support more usage situations than are needed by his customers.

The more the producer specialises in designing responses specific to his customers' usage situations in the particular contexts in which his customers are to be found, then the better the match will be and therefore the less producer redundancy there will be. The converse of this is that the more eccentric are the needs of the customer in relation to all the available producer situations, the more the customer would be forced to 'shop around' in order to find the individual options he needs to satisfy the requirements of his usage situation. As long as we can assume that there will be some markets where the existence of eccentricity is inevitable, then there will be a requirement for marketing strategies which can couple with such eccentric customers effectively.

Returning to the problems of the DEn/ETSU project, then what the Demonstration Scheme set out doing was based on assumptions which ignored the existence of producer redundancy with respect to its customers as originally defined. What they ended up doing was to develop a new strategy for defining their market as a heterogenous set of customers. The strategy they ended up with was different because while at the outset, they were seeking to couple with customers on the basis of a single 'product' defined in terms of the technology, they ended up coupling with customers on the basis of multiple 'products' defined in terms of the customer and his usage situation.

The conclusion of this paper is that, far from being anomolous, their experience is characteristic of a distinct form of marketing problem which is also characteristic of passive solar technology.

Others (Wensley & Day 1983) have noticed similar differences in seeking to outline a new paradigm for marketing. The approach developed in this paper provides another way of describing this new paradigm. If the customer's needs have a tendency in general to be highly eccentric with respect to the producer, then the producer is in a position to choose the 'niche' or Need which best suits his capabilities as a producer and to specialise in its production: an N-type strategy. This seems to be a characteristic strategy in growth economies where consumer products have been based on relatively low technology. On the other hand, if the producer's capabilities have a tendency to be redundant with respect to the customer because of the customer's tendency to change or differentiate his needs with respect to others, then the producer must find ways of coupling his capabilities to a wider range of usage situations if he is to reduce his redundancy: a K-type strategy. 'K' stands for knowledge since this strategy depends critically on the producer's ability to know how to couple. This seems to be a characteristic strategy in low growth but relatively affluent economies based on relatively high technology. Solar technology requires a K-type strategy. This distinction can be thought of in the following terms:

	Customer Eccentric	Producer Redundant
Coupling of capabilities fixed/rigid	r-strategy	
Coupling of capabilities flexible/adaptable	N-strategy	K-strategy

The r-strategy is the one in which neither producer nor customer has any advantage, and what works is what happens to survive at the time: the strategy here is based upon there existing a coincidental match between the customer's needs and the producer's capabilities. (Not really a conscious strategy, but rather an accident of history). The N-strategy then is the one familiar to marketing managers in which the producer organises himself to supply a particular need or 'niche' which best suits his capabilities. The K-strategy is our new paradigm in which the N-strategy is no longer a stable option, and the producer has to develop the Knowledge which enables him to couple with multiple usage situations ('niches' or needs) defined by heterogenous customer segments.

In conclusion therefore, to achieve penetration of the Solar Technology Market, producers will need to find ways of being K-strategists in the ways in which they couple with their customers; and in assessing the marketability of Passive Solar Technology we are going to have to learn to think like K-strategists.

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End Notes

[i] The following note links the approach being developed by us to methods for analysing Discriminant Hyperspace in order to be able to taxonomise customers. The earlier discussion on the problems of predicting penetration identified two key questions which needed to be addressed:

1. what choices would the producer's view of the market lead him to offer his customers; and
2. what choices would the customer's view of his needs lead him to make in relation to the choices on offer to him?

After some of the difficulties inherent in answering these questions had been raised, the methodological problems of addressing the first of these questions through the use of experts were discussed, and a course of development was put forward through which it might be possible to question the appropriateness of some of the source effects inherent in particular experts' views of the market. The pursuit of this avenue of methodological development through the use of PROLOG has been fruitful. As a method it has allowed the internal consistency of views to be examined, and the congruency/incongruency between views to be explored. It has not however got ‘me’, as an aspiring expert, off the hook of having to judge the ways in which these views correspond to the 'facts: that I too (or indeed ETSU) should create a source effect is an inescapable consequence of seeking to intervene in others' affairs. This note therefore aims to explore the methodological problems of addressing the second of the questions above, and proposes a course of development through which this question of correspondence might also be pursued.

Quite apart from the problems inherent in defining a product-field in the first place, it is possible that marketing managers do not feel that there is sufficient unexplained variance to warrant their adding the additional layer of complexity involved in taking account of situational variation. Other plausible reasons might be that they do not have available to them methods which allow them to digest that quantity and complexity of data, or that they simply do not ask those kinds of questions - source effects again. True, non-metric multidimensional scaling (Doyle) can be used on disaggregated data to produce perceptual or preference spaces of groups of consumers in relation to particular types of situation, but how does the manager know when to stop disaggregating, and how does he re-integrate what he has disaggregated in order to interpret the data without ending up having to think on behalf of every line manager in his organisation? In our case, the importance of assessing levels of penetration make it imperative that we not only take situational factors into account, since it is these factors which seem critical in whether or not the technology gets taken up; but also explore how the consumer defines the product field in the first place, since we have no historic usage data from which we can assume a definition of the product field. How are we to set about doing this?

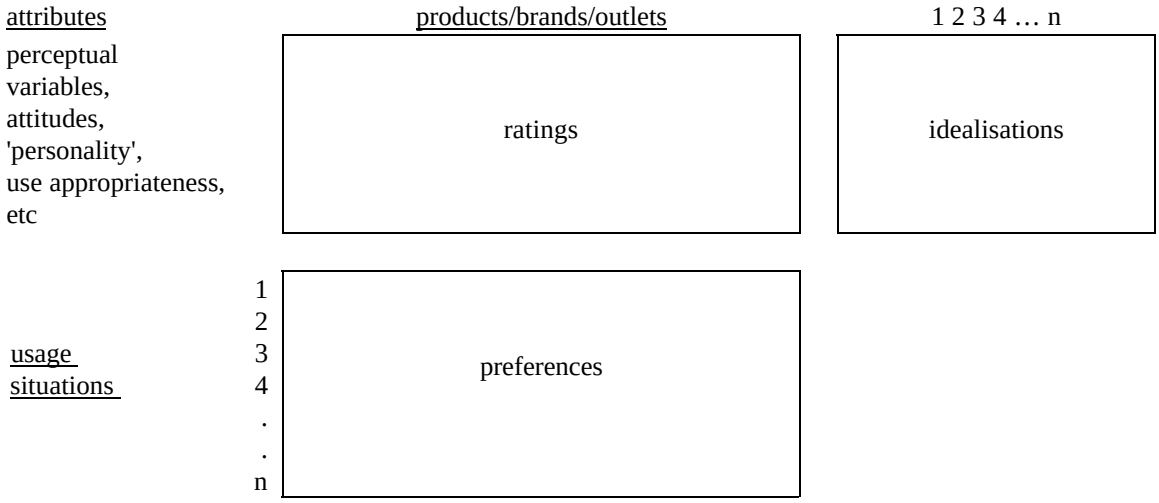
Day, Shocker and Srivastave (1979) propose a number of ways of defining the product field based on customer judgements: Technology substitution analysis has already been commented on. Where the customers are experts, this seems a reasonable approach. Where the customer's decision processes are not so well known however, decision sequence analysis, based on the analysis of protocols of customers' decision-making

deliberations, provides an alternative. The problem here is choosing which customers you want to treat as experts. Perceptual mapping creates the same problems as the analysis of attitudes as soon as any attempt is made to aggregate the data. The best course seems to be to collect customers' judgments of product substitutability directly in relation to usage situations. The procedure recommended for identifying product fields in this way is in three stages:

1. Free response plus repertory grid and focused group methods are used to elicit usage situations associated with generic need.
2. A typology of usage situations is then developed from a principal components analysis of the products-by-uses matrix. Both uses and products are plotted in the reduced space, and a typology of uses derived from factorial combinations of different levels of the independent dimensions of this space.
3. A new sample is employed to obtain a measure of the suitability or appropriateness of each brand or product for each of the usage situations in the typology.

Such a process of analysis provides us with a set of brands or products which collectively span all of the distinct kinds of usage situation associated with the generic need. How then do we collect and analyse the customer's views of the choices in relation to the usage situations relevant to his needs?

The answer seems to lie in an approach formulated by Stefflre (1972) and developed in the UK by Alan Frost. It involves collecting data in the following format:



Each consumer is asked to define his own set of usage situations in which he buys from the field of products, and to quantify how much he spends in each one of those situations. He is then asked to rate the products in terms of a set of attributes, elicited in the ways familiar for the elicitation of consumer attitudes, in relation to an ideal product for each of his situations. Finally he is asked to define his preferences for the products in the product field relative to his ideal, which is assumed to be 100%. This data is then split up so that there is for each usage situation a level of spend and one set of ratings of the product field as a whole in relation to an ideal product. How is this

data to be analysed and aggregated so that it can be of some use to the marketing manager?

The trick seems to be not to think in terms of aggregating across attributes, but rather aggregating across situations. The best approach for doing this comes from numerical taxonomy. Fisher (1936) first proposed that in distinguishing between the characteristics of distinct objects, the concept of a discriminant hyperspace should be adopted defined in terms of those characteristics which discriminate between the objects. The angles between the axes of the hyperspace should reflect the correlations between the characteristics, and the unit distances along each axis should be stretched in inverse proportion to the standard deviation. Some of the original set of attributes will be redundant and will have to be discarded because they add no further information to the other attributes about the differences between the objects (Davies 1981). A further adjustment of the lengths of these axes then has to be made until the distances of the objects from the origin of this discriminant hyperspace is as highly correlated as possible to the original relative preferences.

This adjustment is in effect a variation of the sensitivity which the situation-specific idealisation has to the variance of the different attributes. The resultant hyperspaces are not hyperspherical, but instead are squashed and distended in such a way that they all have different topologies. These hyperspaces can be compared with each other by describing them in terms of canonical variates on orthogonal axes and using Gower's rotational fit statistic (Smith & Sohal 1973), defined in terms of the squared distances between corresponding objects in the different hyperspaces. From this it becomes possible to define which ‘squashed' discriminant hyperspaces have the same topologies and therefore define the same relative preferences in the situations on which they are based. In this way we have a way of segmenting situations in relation to the way in which the customer experiences the situation. The data on spend associated with each situation can then be aggregated for each situational segment to provide an analysis of their relative market shares, and as long as new products can be mapped into these hyperspaces in terms of the original set of attributes, the analysis can be re-worked to predict interactions between existing products and new ones.