MAPP working paper no 18
March 1994
ISSN 0907 2101

A model for marketing planning of new products

Anne Martensen
Project no 4

Executive Summary

1. A model for forecasting the sales of a new product is presented. This model allows to predict the sales development of a new product before it is actually launched on the market.

2. The model makes separate forecasts for the volume of trial and repeat purchases. It also incorporates a special model to explain consumer awareness of the new product.

3. Consumer awareness is explained by distribution (shelf facings and in-store promotion), advertising and giving away free samples.

4. The trial model incorporates the total market potential, the probability of being in a buying occasion, and of being in a retail outlet where the product is distributed.

5. The repeat model bases the repeat probability on the preceding purchasing sequence. It is based on a distinction between those who prefer, those who are indifferent in the long run, and those who are indifferent and will reject the product after some time.

6. The model requires three types of data input: market data, market research data, and marketing plan data. Using these data, prediction can be made by a user-friendly PC programme.

7. An example is shown demonstrating that the predictions made by the model were in good accordance with reality.

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1. Background

Today the ability to develop and introduce new products is a fundamental condition for companies to "survive" and hold their own in the intensified competition. Development and introduction of new products are characterized by three conditions:

- The process is very expensive.
- It may take a long time from the generation of a new product idea till the product can be launched.
- Chances are small that the product, after the introduction, will be a success.

Companies have several ways of reducing both the total costs in connection with the development and launching of a new product, and the risk of failure in connection with a launching. One possibility is to use models which can forecast the sales of a new product long before it is introduced on the market.

The literature in this field describes several sales forecasting models, including TRACKER (Blattberg & Golanty, 1978), ASSESSOR (Silk & Urban, 1978), LITMUS (Blackburn & Clancy, 1980 and 1982), NEWS (Pringle, Wilson & Brody, 1982), BASES (Lin, Pioche & Standen, 1982, 1986; Lin & Standen, 1984) and TESI (Erichson, 1987a, b) and Olsen (1988, 1990, 1992).

The author of this paper has systematized and evaluated these and other new product sales forecasting models (Martensen, 1991). In the light of this and on the basis of relevant consumer behaviour theories, a new sales forecasting model for new products is developed.

The purpose of the present paper is to present and discuss the most important parts of the mathematical specification of the new model. A large part of the consumer behaviour theory and other theories, which form the basis of this model, has been studied before, and to a large extent references will be made to this (Martensen, 1991, 1993a).

2. Characteristics of the new sales forecasting model

The primary characteristics of the new model are that it must:

- be a pre-test market model, which can forecast the sales of a new product before it is introduced on the market or is tested on a test market,
- permit a sales forecast period by period,
- permit a forecast of how sales is composed of trial volume and repeat volume period by period,
- include important marketing variables, in order that the effect of each variable on sales and interaction between variables can be studied.

The last characteristics imply that alternative marketing plans can be evaluated, rendering the model a decision support tool in the formulation of the final marketing plan.

3. Structure of the model

Two aspects of the model are that the sales are specified period by period, and that the sales can be divided into trial volume and repeat volume. The natural starting point is therefore in the following general specification:

(1) $S(t) = T(t) + R(t)$

where

t	=	Time period number (t = 1,2,...)
S(t)	=	Total Sales in time period t
T(t)	=	Trial volume in time period t
R(t)	=	Repeat volume in time period t

The new product is introduced in period 0. Period 1 is the first period after introduction, period 2 is the second period after introduction, etc. The length of the period can be chosen arbitrarily, eg 1 month, 4 weeks or 1 week.

Let us look at the trial volume, T, and the repeat volume, R, separately.

Trial

The trial volume depends partly on the size of the target group and partly on the average number of units bought by the consumer at the trial purchase:

(2) $T(t) = TM \cdot TRIAL(t) \cdot UT$

where

TM = Target Market Size (Number of consumers, households or similar)

TRIAL(t) = The probability of a TRIAL purchase of the new product in period t by a consumer picked at random from the target group

UT = The average number of Units purchased at Trial

As can be seen, the trial volume in a given period is the product of 3 factors. TRIAL(t) is a probability and is influenced eg by awareness factors such as advertising, sampling and distribution and the consumers' buying intentions of the new product.

The cumulative trial purchase probability - the penetration - is in period t:

$$(3) \qquad PENETRATION(t) = \sum_{i=1}^{t} TRIAL(i)$$

Repeat

Also the repeat volume of the new product depends on the size of the target group and the average number of units a consumer purchases at repeat. The repeat volume in period t is:

$$(4) \qquad R(t) = TM \cdot \sum_{j=1}^{t-1} REPEAT_j(t) \cdot UR$$

where

$REPEAT_j(t)$ = The probability of making a REPEAT purchase of the new product at the j'th purchase occasion after trial in period t, j=1,2,3,....,t-1

UR = The average number of Units purchased at Repeat

(4) is a sum from j=1 to t-1. It is assumed that a consumer makes 0 or 1 purchase of the product category in each period (this also applies to trial purchase). As a trail purchase must always take place before a repeat purchase, the consumer will in period t at the most have the possibility of making his (t-1)'th repeat purchase.

The REPEAT values in (4) reflect the repeat purchase structure, ie how consumers' repeat purchases of the new product develop over the repeat purchase occasions and thus over time.

The concrete calculation of T(t) and R(t) requires a model of TRIAL(t) and $REPEAT_j(t)$, which is presented in the following. But first the awareness model, which is a condition for the trial model, is specified.

4. The awareness model

The first requirement for any purchase is that the consumer is aware of the product. In order to model the trial purchase, a number of assumptions must be specified, partly for how consumers can become aware of the new product, and partly for the effect of these awareness factors on the consumers.

The awareness factors and their interaction

In the model it is assumed that a consumer can become aware of the new product on the basis of the following three awareness factors:

- advertising
- distribution:
  * the placement in the shop ("shelf facings"), and
  * other in-store promotion activities
- samples

Distribution as an awareness generating factor, apart from the normal in-store promotion, also means that the placement of the product on the shelf in the retail outlet in itself generates awareness.

Furthermore, it is assumed that any consumer can be influenced by one or more of these three awareness factors in each period, which leads to *seven mutually exclusive awareness categories* for each period:

1) Distribution alone ("shelf facings"/in-store promotion)
2) Advertising alone
3) Sampling alone
4) Both distribution and advertising
5) Both distribution and sampling
6) Both advertising and sampling
7) Distribution, advertising and sampling

All consumers belong to one of these seven awareness categories, or an eighth category, which consists partly of consumers who have not yet become aware of the product, and partly of consumers who have been aware of the product, but have "forgotten" their awareness. The company's marketing effort will decide the probability of becoming aware and the probability for each of the seven awareness categories.

The probabilities of becoming aware caused by the above mentioned factors are defined as:

$p_d(t)$ = The probability of becoming aware caused by distribution ("shelf facings"/in-store promotion) in period t

$p_a(t)$ = The probability of becoming aware caused by advertising in period t

$p_s(t)$ = The probability of becoming aware caused by sampling in period t

Independence is assumed between the three awareness factors. The probability of becoming aware in a given period of time caused by a combination of the factors can be calculated by the use of p_d, p_a and p_s, and the following probabilities are given by:

Distribution alone:	$p_1(t)$	=	$p_d(t)\ (1-p_a(t))\ (1-p_s(t))$
Advertising alone:	$p_2(t)$	=	$p_a(t)\ (1-p_d(t))\ (1-p_s(t))$
Sampling alone:	$p_3(t)$	=	$p_s(t)\ (1-p_d(t))\ (1-p_a(t))$
Both distribution and advertising:	$p_4(t)$	=	$p_d(t)\ p_a(t)\ (1-p_s(t))$
Both distribution and sampling:	$p_5(t)$	=	$p_d(t)\ p_s(t)\ (1-p_a(t))$
Both advertising and sampling:	$p_6(t)$	=	$p_a(t)\ p_s(t)\ (1-p_d(t))$
Both distribution, advertising and sampling:	$p_7(t)$	=	$p_d(t)\ p_a(t)\ p_s(t)$

It is assumed that there is an upper limit for the part of the target group that can become aware at all: A_{max} = Maximum attainable awareness. It is impossible to go beyond this upper limit regardless of the size of the company's marketing effort; this upper limit is often less than 1.

We assume that before introduction no awareness generating activities have been carried out; at the start of period 1 it is therefore possible to influence the A_{max} share of the target group.

In order to calculate the seven awareness category probabilities $p_1(t)$, $p_2(t)$,...,$p_7(t)$, we must know $p_d(t)$, $p_a(t)$ and $p_s(t)$. Let us look at which assumptions can be made about these, and how models can be formulated for the effect of distribution, advertising and sampling.

Models of the awareness factors

Awareness caused by distribution

The effect of distribution includes both the "shelf facings" effect and the effect of in-store promotion activities.

The "shelf facings" effect can be expressed by:

SHELF(t)	=	The probability of becoming aware of the product caused by its placement in the retail outlet in period t

Apart from this, it is possible for the company to carry out special in-store promotion activities in order to generate further awareness. The probability of generating such awareness is expressed by:

INSTORE(t)	=	The probability of becoming aware of the product caused by in-store promotion activities in period t

Using the two unconditional probabilities - SHELF(t) and INSTORE(t) - the total distribution effect can be calculated (assuming independence between the effects):

(5) $p_d(t) = SHELF(t) + INSTORE(t) - SHELF(t) \cdot INSTORE(t)$

Awareness caused by advertising

The advertising response model, where the probability of becoming aware is the response variable (p_a), is formulated in the short run, ie the advertising effort in one period means that one can only become aware in the same period. Both consumer behaviour theory and empirical observations point to a *concave response function* as the most realistic shape, and such a shape is chosen here and will be formulated by:

(6) $p_a(t) = 1-e^{-aGRP(t)}$

where

GRP(t) = Gross Rating Points (total number of exposures delivered by the media schedule for the new product) in period t

a = Awareness coefficient (a>0)

This formulation is used in other sales forecasting models, including NEWS (Pringle, Wilson & Brody, 1982), LITMUS (Blackburn & Clancy, 1980), NEWPROD (Assmus, 1975) and partly TRACKER (Blattberg & Golanty, 1978).

A point of criticism of (6) is that this formulation does *not* take into consideration the *advertising effort of the competitors*. Not only the absolute size of the advertising effort for the product has importance, but the product's advertising effort in relation to the advertising effort of the competitive products. One way of taking this into account is to use the term *share of voice*:

SOV(t) = GRP(t) for the product / GRP(t) for the product category

It must be noted that advertising costs (or budget) may of course be used instead of GRP, so that SOV(t) becomes the advertising costs of the new product in relation to the total advertising costs of the product group.

Hereby share of voice becomes the company's share of the total advertising effort in the product category.

SOV(t) can be included in equation (6) by replacing GRP(t) with SOV(t) in the following way:

(7) $p_a(t) = 1-e^{-aSOV(t)}$

where

a = Awareness coefficient (a>0)

Parameter a in (7) is of course not the same as parameter a in (6).

Formulation (7) means that when the company uses a certain advertising effort for a period of time, the awareness effect in that period will be less if the competitors advertise to a great extent, than if the competitors advertise to a small extent.

Awareness caused by sampling

The probability of becoming aware caused by sampling naturally depends on how large a share of the target group receives a sample. It is also assumed that the probability of becoming aware is 1 when having received a sample. Therefore $p_s(t)$ can be specified as:

(8) $p_s(t)$ = Sample coverage in period t

Also in this case it is assumed that awareness generating takes place in the same period as the sample is sent out.

The above way of developing the awareness model renders an extension of the model with more awareness factors relatively simple, if so desired.

Total awareness

The selected way of studying awareness offers the possibility of forecasting total awareness period by period. Total awareness in period t can be calculated on the basis of the following equation:

(9) $A(t) = A_{min} + r(A(t-1) - A_{min}) + (A_{max} - A_{min} - r(A(t-1) - A_{min})) \sum_{i=1}^{7} p_i(t)$

where

A_{min} = Minimum awareness

A_{max} = Maximum awareness

r = Awareness retention coefficient

$p_i(t)$ = The probability of becoming aware in period t caused by the i'th awareness category (i=1,2,...,7)

The calculation of the total awareness includes an A_{min}-value, as can be seen in (9). This A_{min}-value is the lower limit of total awareness. Without awareness activities, A(t) in the long run approaches A_{min}.

The retention coefficient, r, is the probability that an aware consumer in period (t-1) still will be aware in period t, ($0 \leq r \leq 1$). Retention and forgetting of awareness over time, especially advertising effect, has for years been discussed and empirically clarified by many, among these Zielske (1959), Zielske and Henry (1980), Lodish (1971), Wells (1975), Pringle, Wilson and Brody (1982), Bagozzi and Silk (1983) and Brown (1985). The results of the empirical studies point to a *retention coefficient of 98% per week* when the relevant measure is brand awareness.

The inclusion of a retention coefficient can also be seen in several of the existing sales forecasting models, eg NEWS (Pringle, Wilson & Brody 1982), LITMUS (Blackburn & Clancy, 1980) and BASES (Lin & Standen, 1984).

Total awareness from the seven awareness categories can be calculated as simple as $\sum p_i(t)$, because the awareness categories have been defined as mutually exclusive.

The structure in (9) is also used in other models in the area of sales forecasting, even though awareness generating factors are included in other ways, cf Martensen (1991, p. 380). Also outside the sales forecasting area this structure has been used for advertising models, eg Zufryden (1978, 1989).

The new aspect in (9) is that all awareness factors can be included in this structure in a simple way.

5. The trial model

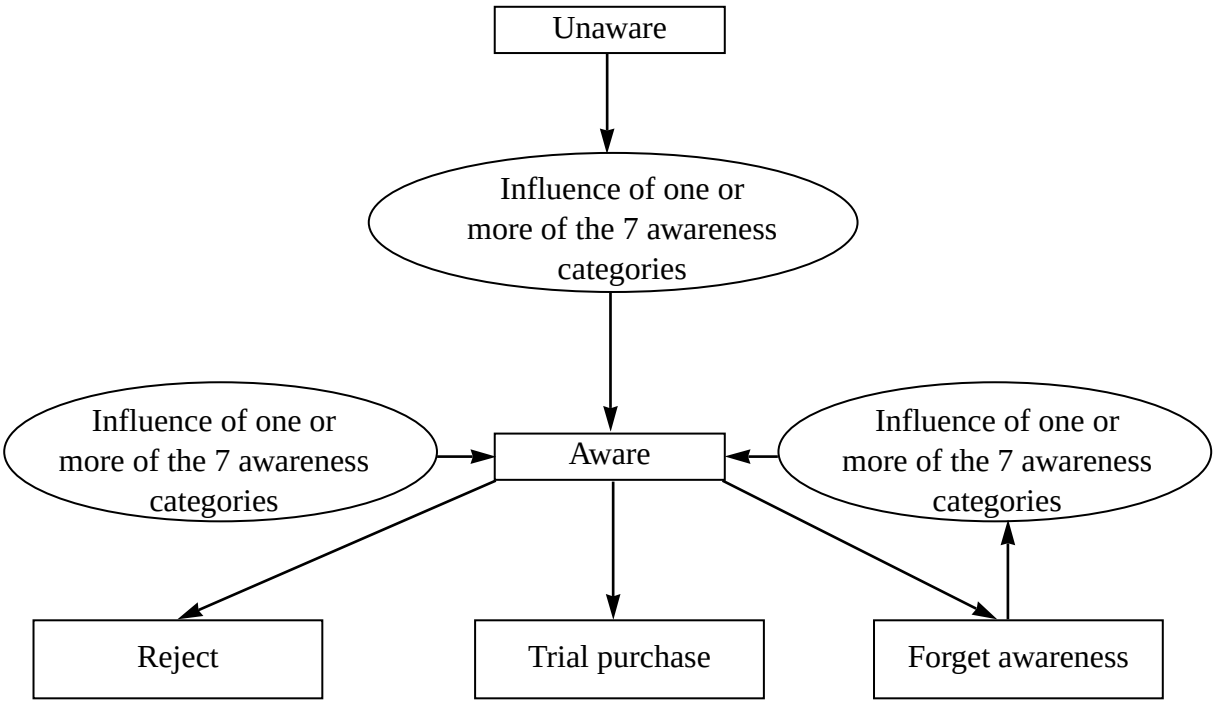
The structure of the trial model

Let us look at how the three awareness generating factors can influence consumers from being unaware of the product to making a trial purchase. The phases which consumers pass through, and which the model is built upon is illustrated in Figure 1.

At period 0 - time of introduction - in principle all consumers in the target group are unaware of the product. When the product has been introduced, the company has the possibility of rendering the consumers aware of the product - of course with varying strength and content over time. On the basis of these activities, in each period some consumers become aware of the new product, ie they proceed in the process. The other consumers will continue to be unaware of the product, and will therefore - for the period - remain at this stage in this phase.

The share of unaware consumers will gradually decrease, as long as awareness generating activities are carried out.

Figure 1. The process from being unaware of a product to a possible purchase of the product



Consumers who are aware of the product in a period, have in this period the possibility of:

- making a trial purchase of the product

- rejecting the product (because they do not like the product idea itself or the activities which are carried out for the product)

- remaining aware because they have no need for the product category in this period or because they cannot "get hold of" the product (distribution problem)

- forgetting their awareness of the product

Let us comment on each of the four stages based on Figure 1.

The first group, *the group of trial purchasers*, have reached the last stage in the process from being unaware of the product to trying it.

The second group consists of consumers who are *aware of the product but reject it.* It is assumed that these consumers do not change their attitude when new awareness generating activities are launched in the future.

What remains are the group of aware consumers and the group of consumers who forget their awareness, both of which can be continuously influenced by awareness generating activities.

The third group, consumers who *retain their awareness*, remain in this state from one period to the next, and after this have the possibility of falling into one of the four mentioned groups.

The fourth group, consumers who have *forgotten their awareness in one period*, will in the following period either remain unaware (forgotten awareness) or become re-aware, and thereby return to the awareness state.

As can be seen in Figure 1, the group of aware consumers and the group of consumers who forget their awareness of the product, can be exposed to one of the seven awareness categories in *each* period. In other words, *allowance is made for the type of awareness (advertising, distribution, samples or a combination of these) as well as the number of influences over time (0,1,2,...).*

For example, a consumer can be exposed to advertising in period 1, distribution in period 2, nothing in period 3 and advertising and samples in period 4. This gives another effect than if the consumer is not exposed in period 1 and 2, but to advertising, distribution and samples in period 3, and samples alone in period 4.

Such a complex influence pattern takes place in reality, and therefore the model takes this into consideration. Let us now look at how this sequence can be modelled.

Development of the trial model

The potential trial purchasers

The share of the target group, which has the possibility of making a trial purchase, can be called potential trial purchasers, and will in period t consist of consumers who:

1) are about to buy the product category in period t, and
2) are aware of the product in period t, and
3) have not tried the product up to period (t-1), and
4) have not rejected the product up to period (t-1)

This share of potential trial purchasers at period t, can be defined as:

POTTRIAL(t) = The probability that a consumer in the target group, who buys the product category in period t, is aware of the new product and has not yet tried it or so far not rejected it.

On the basis of the above, the share of potential trial purchasers in period t can naturally be modelled in the following way:

$$(10)\quad POTTRIAL(t) = q[A(t) - \sum_{j=1}^{t-1} TRIAL(j) - \sum_{j=1}^{t-1} NONTRIAL(j)]$$

A(t) is defined in regard to equation (9). The remaining three quantities to the right in (10), viz q, TRIAL and NONTRIAL, will be discussed below.

The probability of being in a purchase occasion

Parameter q in (10) can be defined as:

q = The probability of being in a purchase occasion for the product category in a given period

and the connection to the purchase cycle for the product category (PC) is:

$$q = 1 / E(PC)$$

where E(PC) is the expected value (mean) of the purchase cycle.

q is assumed to be constant.

For fast moving consumer goods it seems a priori reasonable to assume that a constant part of all users of a product category will purchase in each period - of course excluding seasonal fluctuations.

If, eg, a given product category on average is bought every fourth period, a priori 25% of the product category's consumers are expected to purchase in each period. Ie the probability that a consumer picked at random buys the product category in a given period is 25%. Regardless of when a new product is introduced, and when awareness generating activities are carried out, there will always - may be after a certain adaptation period - be 1/E(PC) who purchase the product category in a given period.

Trial purchasers of the new product

TRIAL(t) in (10) is defined as the probability of a consumer, picked at random from the target group, trying the new product in period t.

TRIAL(t) will naturally be a share of the potential trial purchasers in period t, POTTRIAL(t). Potential trial purchasers are aware of the product, and their awareness over time can have been brought about by one or more of the seven awareness categories, combined with the fact that after introduction both forgotten awareness and new awareness influences can occur. When identifying *in period t, which categories have influenced aware consumers* it can be done in the following way:

$$(11) \quad w_i(t) = \frac{\sum_{j=1}^{t} p_i(j) r^{t-j}}{\sum_{k=1}^{7} \sum_{j=1}^{t} p_k(j) r^{t-j}} \quad ; i=1,2,...7$$

where

$w_i(t)$ = The probability that an aware consumer's awareness in period t, is caused by awareness category i

and $p_i(j)$ and r have been defined previously.

It can be seen from (11) that allowance is made for the fact that *awareness in period t can be generated in one or more earlier periods, and forgetting is included by the use of a retention rate* according to the same principle as in the total awareness model.

The numerator in (11) is a weighted sum of awareness category i's influence over time, where the weights are given as quantity r^{t-j}, which expresses a decreasing effect backwards in time.

If the numerator is calculated in this way for all seven awareness categories, and these seven quantities are added, the denominator in (11) results. We then see that $w_i(t)$ in (11) gives the i'th awareness category's weight in relation to the influence of all the awareness categories. This is a conditional probability, where the condition is an aware consumer. Therefore $w_1(t)+w_2(t)+...+w_7(t)=1$.

The probability of a consumer in the target group trying the new product in period t is therefore:

$$(12) \quad TRIAL(t) = [\, w_1(t)\, \beta_0 + w_2(t)\, D^*(t)\, \beta_0 + w_3(t)\, D^*(t)\, U\beta_{0S} + w_4(t)\, \beta_0 + w_5(t)\, \beta_0^* + w_6(t)\, D^*(t)\, \beta_0^* + w_7(t)\, \beta_0^* \,]\, POTTRIAL(t)$$

where

β_0 = The probability of trial, given the consumer is aware of the product

β_{0S} = The probability of trial, given the consumer has used a sample of the product

β_0* = Maximum of β_0 and $U\beta_{0S}$

$$U = \text{Share of sample users} = \frac{\text{Share of the target group who use a received sample}}{\text{Sample-coverage}}$$

D*(t) = The probability that the new product is available to the consumer in a retail outlet in period t (adjusted weighed distribution)

On the basis of weighted distribution D(t), D*(t) is calculated. D*(t) takes into account the fact that a consumer makes purchases in several shops and therefore has a greater probability of becoming aware of the product than just the distribution level. The model's adjustment of D(t) to attain D*(t) is made on the basis of empirical data.

The quantities in square brackets are the share of POTTRIAL(t), resulting in trial purchase in the period.

Rejectors of the new product

The last quantity in equation (10) is NONTRIAL(t), which can be defined as the probability that a consumer in the target group in period t decides to reject trial purchase of the new product at any time in the future.

When the probability of trial purchase is β_0, the probability of not making a trial purchase will, of course, be $1-\beta_0$. Therefore the probability that a consumer in period t decides to reject a trial purchase of the new product, is given by:

$$\begin{aligned}(13)\quad NONTRIAL(t) &= [\, w_1(t)(1-\beta_0) + w_2(t)(1-\beta_0) + w_3(t)(1-U\beta_{0S}) \\ &\quad + w_4(t)(1-\beta_0) + w_5(t)(1-\beta_0^*) + w_6(t)(1-\beta_0^*) \\ &\quad + w_7(t)\,(1-\beta_0^*)\,]\, POTTRIAL(t) \\ &= [\, (w_1(t) + w_2(t) + w_4(t))(1-\beta_0) + w_3(t)(1-U\beta_{0S}) \\ &\quad + (w_5(t) + w_6(t) + w_7(t))(1-\beta_0^*)\,]\, POTTRIAL(t)\end{aligned}$$

As can be seen from the definition of NONTRIAL(t), as well as equation (13), a consumer who has once rejected the product, can not in a later period regret his decision and make a trial purchase.

6. The repeat model

In sections 4 and 5, the awareness model and the trial model were discussed; now the repeat purchase process will be dealt with. As an introduction to the trial model, potential trial purchasers were studied; now the potential repeat purchasers' allocation over time will be looked at.

Potential repeat purchasers

Potential repeat purchasers are the share of the target group, who have tried the new product, and who in period t are in a buying situation of the product category, ie:

$POTREPEAT_j(t)$ = The probability that a consumer in the target group in period t makes the j'th purchase of the product category after trial purchase of the new product

For a potential repeat purchaser of the new product it is assumed that the consumer has made a trial purchase of the product. Therefore, the potential first time repeat purchasers are expressed in the following way:

$$(14) \quad POTREPEAT_1(t) = \sum_{i=1}^{t-1} TRIAL(i)g(t-i)$$

where TRIAL(t) is defined in equation (12), and where:

g(t) = The probability that the time between 2 successive purchases of the product category is t periods

g can here be perceived as the probability distribution for the interpurchase time, and this of course is connected with the purchase cycle of the product category.

(14) expresses the transition from trial purchase of the new product to the next purchase of the product category. Let us generalize this by looking at the transition from one purchase occasion to the next purchase occasion of the product category.

In general, the probability that a consumer purchases the product category in period t for the j'th time after the trial purchase of the product, is:

$$(15) \quad POTREPEAT_j(t) = \sum_{i=j}^{t-1} POTREPEAT_{j-1}(i) \cdot g(t-i) \; ; \; j=2,3,...$$

The structure in this equation (15) is identical to the structure in (14) and can therefore be interpreted in exactly the same way.

The reason for the lower limit of the sum in (15) being j, is that in order to make the j'th purchase of the product category (after the trial purchase) in period t, there must prior have

been j purchases (ie trial purchase of the new product and (j-1) purchases of the product category afterwards). This means, that the (j-1)'th purchase of the product category after the trial purchase, can be made in period j at the earliest.

Repeat purchases of the new product

The share of consumers in the target group who repeat purchase the new product in period t, can be calculated as:

$$(16) \quad REPEAT.(t) = \sum_{j=1}^{t-1} REPEAT_j(t)$$

where

$REPEAT_j(t)$ = The probability of a repeat purchase of the new product in period t, on the j'th purchase occasion of the product category after trial purchase

$REPEAT.(t)$ = The probability of repeat purchase of the new product in period t

(16) is just a sum of all possible repeat purchase occasions in a given period.

Consumers who repeat purchase the new product in period t at the j'th purchase occasion of the product category after trial purchase, must of course be a certain share of the potential repeat purchasers in the period, and therefore we have:

$$(17) \quad REPEAT_j(t) = \beta_j POTREPEAT_j(t)$$

where

βj = The probability that a consumer, who has tried the new product, will buy it on the j'th purchase occasion after trial.

It appears from the definition of β_j that it is a conditional probability, where the condition is trial purchase. It can been seen that the repeat purchase probability β_j depends on the purchase occasion number j. Modelling the purchase occasion of the product category, and hereafter, in those periods when the product category is bought, modelling the probability of buying the new product, is inspired by the PREDICTOR model (Yankelovich, 1987) and especially by Olsen (1988). In models such as Litmus (Blackburn & Clancy, 1980) and NEWS (Pringle, Wilson & Brody, 1982), time periods correspond to the purchase cycle for the product category: In this way the purchase occasion for the product category is taken into account, and the repeat behaviour in these purchase occasions are modelled, but this approach is less satisfactory, because the model is not a stochastic model. In the following sections a model of β_j will be developed.

Outlining the model of the repeat purchase probability β_j

It is assumed in the existing models in this area that β_j is a decreasing function of the repeat purchase number, and thereby also of the purchase occasion number. Ie that β_j decreases from purchase occasion to purchase occasion, and β_j will in the long run fall toward a lower limit $\beta\infty$. Eg in NEWS (Pringle, Wilson & Brody, 1982), LITMUS (Blackburn & Clancy, 1982), Eskin (Eskin, 1973), Eskin and Malec (1976), Kalwani and Silk, (1980) and BASES (Lin, Pioche & Standen, 1982) such a decreasing shape is assumed for β_j. These models and their functional shape for the repeat purchase probability have been thoroughly discussed and compared by Martensen (1991).

In the following, a model of the repeat purchase probability β_j will be developed, which partly takes into consideration this decreasing shape with the lower limit $\beta\infty$, and partly takes its base in theories dealing with the repeat purchase behaviour of consumers.

Repeat buying behaviour varies in different consumer segments, depending on loyalty. This is studied by Tranberg and Hansen (1985) on Danish market data. The new product model SPRINTER (Urban, 1970) has divided the repeat purchasers into preference and loyalty classes with different behaviour, and Urban has formulated this in a mathematical model. Ottesen (1977, p. 163) illustrates the awareness-to-trial-to-repeat process, where a consumer, who has tried the product, goes on to one of the three groups: "reacts with preference", "reacts with indifference", "reacts with rejection". Ottesen (1977) does not model this, but a mathematical formulation can be seen in Olsen (1988). Based on the above mentioned grouping, Ottesen (1981, pp. 119-120) later developed a device called a *Market map*, which is a classification of consumers in a market into various groups. In the first classification, consumers are divided into two groups, ie those who know and those who do not know the product. Next, consumers who know the product are divided into triers and nontriers. Finally, those who have tried the product are split into three groups, viz in consumers who

1) have a *preference* for the product
2) are *indifferent* to the product
3) have *rejected* the product

This classification of consumers who know the product and have tried it is especially relevant in studying the repeat purchase process, and the repeat model will be based on this *Market map* classification. Olsen (1988) uses the same classification and has modelled the process, and Olsen has developed a model for key terms, which altogether make up the Market map.

By dividing the consumers in the above way, consumers are given the possibility of being completely or partly loyal to the product or the possibility of completely rejecting it.

The structure for the repeat model can be illustrated as shown in Figure 2.

The ideas in Figure 2 will be commented briefly. Consumers, who are aware of the new product and try it in a given period, are of interest. The model assumes that the consumer,

after the trial purchase and before the next purchase of the product category, reacts in one of the following four ways. S/he will:

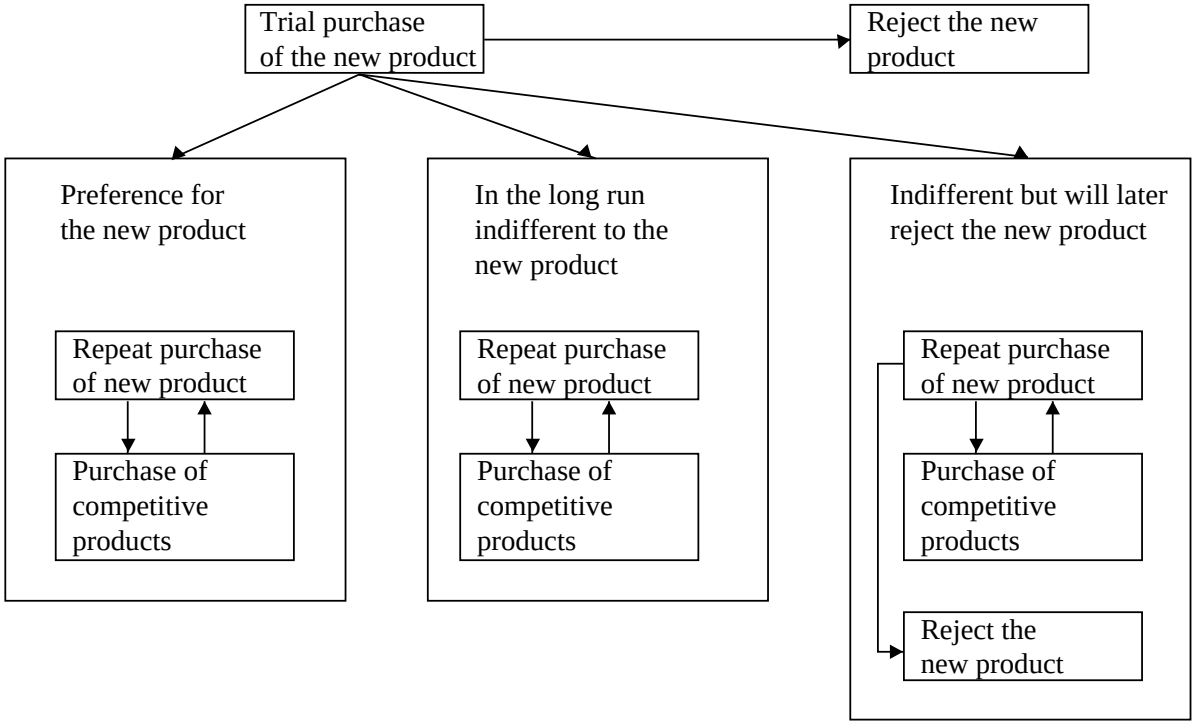
- *reject* the product, possibly as a result of the product not coming up to expectations, the price being too high in relation to the quality or competitive products, etc.,

- *prefer* the product and therefore repeat purchase the product,

- become *indifferent* to the product in the long run and repeat purchase the product,

- become *indifferent* to the product and repeat purchase it, but sooner or later reject the product.

Figure 2. Structure of the repeat model β_j



It is assumed in the model that consumers who have decided to reject the product will not have the possibility of buying the product later in the forecasting period.

Figure 2 shows that the difference between, on the one hand, preferers and indifferents in the long run, and, on the other hand, indifferents, who at a certain point will reject the product, is the fact that the first two groups of consumers do not have the possibility of rejecting the product within the forecasting period. However, neither preferers nor indifferents do in the long run have to be 100% loyal to the product. They may also choose one or more alternative products from the product category. Dividing consumers into three groups offers the possibility of considering the various loyalty patterns.

The structure follows the earlier mentioned theory by Ottesen (1977, p. 163) regarding the groups of "preferers" and "rejectors", but extends it by dividing the group of "indifferents" into two types of indifferents.

Olsen (1988) has formulated a trial-repeat model as a stationary Markov chain with six states. A consumer will be in one of the model's six states in each period. Three of the states are the mentioned segments "preference", "indifferent" and "rejects" as seen in Ottesen (1977, p. 163). To get from the trial state to one of these three states, some consumers pass through a state, where the consumer has not made up his mind yet regarding his future buying behaviour.

It can be mentioned that in Olsen's (1988) model, the probability of being aware is constant in the periods to be forecasted and the company's decision variables are not included, but it is mentioned that it is possible to let all the parameters in the model be a function of the decision variables. In section 2 it is argued that the model must include important marketing variables in order to study the effect of the individual variable on sales. Olsen (1992) later extended his model so that it also explicitly includes competition between the new product and competitive products. In our model, competiton is only taken explicitly into consideration in the awareness model (cf the section *Awareness caused by advertising*), but implicitly in the trial and repeat model through the estimation of the parameters, where the consumer's perception of the competitive situation is reflected.

Developing the model of the repeat purchase probability β_j

The modelling of the repeat purchase probability β_j is based on the above mentioned *Market map* classification of triers into three groups; we can define:

ω_1	=	The share of triers who have preference for the product
ω_2	=	The share of triers who are indifferent to the product in the long run
ω_3	=	The share of triers who start by being indifferent to the product but who sooner or later will reject the product.

The sum of these three shares naturally is 1.

To what extent a consumer from one of these three groups will buy the product in a given period naturally depends on how often purchases are made in the product category. But even if a consumer is in a purchase situation, it is not certain that the consumer will choose the new product. It depends on how loyal the consumer is, ie the number of brands to choose from in a given purchase occasion.

The probability that a consumer, in a purchase occasion, chooses the new product, depends on to which of the three groups the consumer belongs. We can therefore define:

π_{1j} = The probability that a consumer, who prefers the product, repeat purchases the product on the j'th purchase occasion after trial

π_{2j} = The probability that a consumer, who in the long run is indifferent, purchases the product on the j'th purchase occasion after trial

π_{3j} = The probability that a consumer, who starts by being indifferent but sooner or later rejects the product, purchases the product on the j'th purchase occasion after trial

These probabilities are linked to the *repeat purchase probability* β_j*:*

(18) $\beta_j = \omega_1\pi_{1j} + \omega_2\pi_{2j} + \omega_3\pi_{3j}$

The first term to the right of equation (18) is the probability that a consumer has preference for the product and repeat purchases it on the j'th purchase occasion after trial, the second term is the probability that a consumer is indifferent in the long run and repeat purchases the product on the j'th purchase occasion, and finally, the third term in equation (18), is the probability that a consumer is indifferent, but rejects the product sooner or later, and repeat purchases the product on the j'th purchase occasion.

For the sake of simplicity it is assumed that:

(19) $\pi_{1j} = \pi_1$

(20) $\pi_{2j} = \pi_2$

This means that both π_{1j} and π_{2j} are constant and independent of j, and therefore it is assumed that the loyalty structure is independent of the purchase occasion number in the forecasting period.

About the consumers who are indifferent and who at some time will reject the product, it is to be expected that - ceteris paribus - the more frequent the consumers have purchased the product category and thereby also the product, the greater the probability of rejection of the new product at the next purchase. It is a characteristic of this consumer group that they reject the product sooner or later.

On this basis it can therefore be concluded that the probability of purchasing the product at the j'th purchase occasion, given trial purchase of the product, must be a decreasing function of the purchase occasion number, when these indifferent consumers are studied. One way of modelling such a decreasing function shape is the following, based on the Bernoulli process as a description of the repeat purchase behaviour:

(21) $\pi_{3j} = \theta^j \cdot \pi_3$

where

θ = The probability of, on a purchase occasion, not to reject the product

π_3 = The probability that an indifferent consumer, who sooner or later rejects the product, chooses the product in a purchase occasion, given the product has not been rejected.

From this it appears that the probability of purchasing at the j'th purchase occasion decreases with the purchase occasion number j toward 0 ($\theta^j \rightarrow 0$ for $j \rightarrow \infty$).

On the basis of the above assumptions about the π's in (19), (20) and (21) and the assumption $\pi_2 = \pi_3$, ie that the two groups of indifferent consumers have the same probability of choosing the new product in a purchase situation, (18) can be written as:

(22) $\beta_j = \omega_1\pi_1 + \omega_2\pi_2 + \omega_3\pi_2 \cdot \theta^j$

(22) shows that when $j \rightarrow \infty$, $\theta^j \rightarrow 0$ and therefore $\omega_3\pi_2\theta^j \rightarrow 0$. In the long run:

$\beta\infty = \omega_1\pi_1 + \omega_2\pi_2$

A new model for β_j has been developed, where the theoretical basis is a modification of Ottesen's (1977; 1981, pp. 119-120) classification of the market into consumer groups. In some cases the repeat purchase model in (22) is identical to Olsen's purchase probability (1988, p. 29), even though the formulations of the models are different. Apart from this, the present repeat purchase probability model has not been applied elsewhere, and it must be emphasized that the structure is very flexible, because it can easily be expanded to include several loyalty groups or other types of loyalty groups with varying repeat purchase behaviour.

The interpurchase time model

In equations (14) and (15) the interpurchase time model g(t) is included. Previously g(t) was defined as the probability of the interpurchase time between 2 purchases of the product category being t periods.

Martensen (1993a) has previously discussed several different probability distributions, which can be used for a realistic description of the time between two successive purchases of the product, and concludes that the lognormal distribution is a realistic choice. The lognormal distribution has favourable qualities in relation to the purchasing process, and it has also been used before as an interpurchase time model for fast moving consumer goods with good results; eg Lawrence (1980, pp. 212-220).
Estimates of mean interpurchase time and 95% fractile in the interpurchase time distribution can determine the parameters in the lognormal distribution (Martensen, 1993b).

The lognormal distribution is a continuous distribution and the sales forecasting model is a discrete period model, but the continuous distribution can easily be used for calculation of probabilities in a discrete model; cf Lawrence (1980) and Martensen (1993b).

7. Parameter estimation and required data

In order to use the model developed, it is necessary to estimate its parameters.

This section clarifies how parameters can be estimated in practice, and how values can be assigned to marketing variables. This model is a pre-test market model, and the estimates must therefore be based on data which are obtainable before launching the new product.

See Table 1 for data requirements of the new model. Market description, Marketing research, and Marketing plan data are distinguished.

Market description data

The market description data consist of six different types of information.

First, the company must specify the potential target group for the product; often it will be possible to determine the size of the target group on the basis of secondary sources.

Secondly, the company must specify the average number of units purchased by a consumer at a trial purchase, UT, and at a repeat purchase, UR, respectively. The average purchase quantity depends, of course, on the definition of one standard unit.

Concerning the seasonality index for the product category in each period, the historical sales figures for the category can be used, if the new product belongs to an established product category. If, on the other hand, it is a "completely new" product, where the new product forms the product category, the seasonality index must be determined subjectively.

The next two quantities, mean interpurchase time, E(PC), and the 95% fractile in the interpurchase time distribution, $PC_{0,95}$, are used to estimate the interpurchase time model; cf the section on the interpurchase time model. The interpurchase time is a random variable, and the 95% fractile is defined as the time value where 95% of all observed interpurchase time is smaller and 5% is larger.

If the new product belongs to an established product category, the company will have no problems in estimating these parameters; presumably secondary sources can be used, and possibly market research data for other products in the product category.

If, on the other hand, the product is so new that it creates a completely new product category, the company will have to make a subjective estimate of these parameters.

Table 1. Required data

Market description

- Target market size (TM)
- Average number of units purchased at trial (UT)
- Average number of units purchased at repeat (UR)
- Product category purchase cycle:
    1) Mean (E(PC))
    2) 95% fractile ($PC_{0,95}$)
- Seasonality index for the product category sales in each period (SI(1), SI(2)...)

Marketing research

- Awareness-to-trial probability (β_0)
- Trial-to-first repeat probability (β_1')
- Awareness-to-trial probability after use of a sample (β_{0s})
- Preferers' share of triers (ω_1)
- Indifferents' share of triers in the long run (ω_2)
- Probability that a preferer repeat purchases on a buyingoccasion (π_1)
- Probability that an indifferent consumer repeat purchases on a buying occasion (π_2)

Marketing plan

Distribution

- Weighted distribution in each period (D(1), D(2)...)
- "Shelf facings" awareness probability (SHELF* is connected with SHELF)
- In-store promotion awareness probability in each period (INSTORE*(1), INSTORE*(2),... which is connected with INSTORE(1), INSTORE(2),...)

Advertising

- Share-of-voice in each period (SOV(1), SOV(2),...)
- Awareness coefficient (a)
- Minimum awareness (A_{min})
- Maximum awareness (A_{max})
- Awareness retention rate (r)

Sampling

- Sample coverage in each period ($p_s(1)$, $p_s(2)$,...)
- Sample usage rate (U)

Marketing research data

The first three parameters to be estimated are purchase probabilities, and estimates for these can be obtained, eg, by carrying out a concept/product test by interviewing consumers from the target group. The consumers are exposed to the concept and/or advertising for the product, and are interviewed about their intentions to buy the new product. The measured buying intentions are used to estimate the awareness-to-trial probability β_0.

Then the consumers are given the new product, and after having had the chance to try the new product at home, the consumers who are concept-positive are interviewed again about their buying intentions (the product test). This gives an estimate for the trial-to-first repeat probability β_1'.

In the model it is assumed that consumers who have become aware of the new product via a sample and have used it, may have another probability of making a trial purchase (β_{0s}) than consumers who have become aware via distribution or advertising (β_0).

An estimate of the trial purchase probability after using a sample (β_{0s}) is obtained from a product test. All respondents taking part in the concept test, ie both the concept-positive and non-concept-positive ones, are given a product sample, and are contacted later. Respondents, who at this point have tried the product, are interviewed about their buying intention, and these buying intentions are used to estimate β_{0s}.

Finally, four parameters are estimated, which all have influence on the calculation of the repeat purchase probability β_j:

ω_1	=	The share of triers who prefer the product
ω_2	=	The share of triers who are indifferent to the product in the long run
π_1	=	The probability that a preferent consumer purchases the product when buying the product category
π_2	=	The probability that an indifferent consumer purchases the product when buying the product category.

Also the parameters ω_3 and θ must be estimated. By definition $\omega_3 = 1-\omega_1-\omega_2$. And it is not necessary to estimate θ, when we have an estimate of:

β_1'	=	The probability of repeat at least once in the long run, given trial

Here we do not look at a certain repeat purchase occasion, but in the long run, and therefore π_1 and π_2 will not be included, and from (22) we get:

(23) β_1' = $\omega_1 + \omega_2 + (1-\omega_1-\omega_2)\theta$

$\Leftrightarrow$ θ = $(\beta_1'-\omega_1-\omega_2) / (1-\omega_1-\omega_2)$

It should be possible to obtain estimates of ω_1, ω_2, π_1 and π_2 from the product test or possibly from an extended in-home-product-use test.

Another way of estimating ω_1 and ω_2 is to study the *Market map* (cf section *Outlining the model of the repeat purchase probability β_j*) for the products within the product category and evaluate the new product's position on the market in relation to competitive brands.

Information on ω_1 and ω_2 may well be obtained from a consumer study, including questions about how many times out of x the consumer intends to buy the new product.

Data from the marketing plan

Information on the planned activities within distribution, advertising and sampling can be obtained from the company's marketing plan.

The company ought to have relatively good information about the market for the new product and consequently a reasonably good basis for either determining or estimating the remaining input data: Weighted distribution in each period, the new product's share-of-voice in each period (or the probability of becoming aware caused by advertising in each period), minimum and maximum awareness and sample coverage and sample use.

Let us take a closer look at two of the parameters in relation to distribution, SHELF and INSTORE.

The" shelf facin"g effect, SHELF, is the probability that a consumer in a given period becomes aware of the product created by its placement in the retail outlet. It is a probability for a period, where the period length can be chosen arbitrarily. SHELF can be interpreted as a product of three probabilities: First, the probability of becoming aware, created by the placement of the product on a purchase occasion in a shop where the new product is available; second, the probability of being on a purchase occasion in a given period, and third, the probability that the new product is available to the consumer in a retail outlet in the period:

(24) SHELF(t) = SHELF* · q · D*(t)

where

SHELF* = The probability of becoming aware of the product, via its placement on the shelf, given the product is available in a retail outlet on a purchase occasion.

Only SHELF* remains to be estimated. Our definition of SHELF* relates to where the new product will be placed in relation to competitive brands in the retail outlet. The more conspicuous the product is on the shelf, the more space it is given on the shelf, the larger SHELF* will be. Obviously both conditions depend on the number of competitive brands, their strength on the market and their position on the shelves.

The model assumes that SHELF is constant in the periods studied. The model may of course always be refined by letting SHELF vary over time to reflect a varying interest and possibility of promoting the product in the retail outlet both on the part of the sales force and the retailer.

The in-store promotion awareness parameter, INSTORE(t), can be defined as the probability that a consumer will be aware of the product, created by in-store promotion activities in period t. The parameter INSTORE can be interpreted in the same way as SHELF in equation (24):

(25) $INSTORE(t) = INSTORE^*(t) \cdot q \cdot D^*(t)$

where

INSTORE*(t) = The probability of becoming aware of the product on a purchase occasion created by in-store promotion activities in a retail outlet where the product is available

The value of INSTORE*(t) naturally depends on the extent and the type of the planned promotion activities.

In practice the company will be able to estimate the parameter INSTORE*(t) by estimating this parameter's two quantities:

(26) INSTORE* = P(In-store promotion aware, given purchase occasion in a retail outlet with in-store promotion)
· P(In-store promotion, given the product is available in the retail outlet)

The last probability in equation (26) is the share (weighted) of retail outlets where in-store promotion activities are carried out, among the retail outlets where the product is available, and this share is determined by the company in the marketing plan.

The other probability in equation (26), ie the probability of becoming aware by in-store promotion activities, given the consumer on a purchase occasion is in a retail outlet with in-store promotion activities, must be estimated. It is possible for the company to carry out a study in a limited selection of shops, where the product is placed on the shelves and backed up by the planned promotion activities, as if it were a true launching. Consumers who make a purchase from the product category are interviewed about their awareness of the new product, and what has brought about this awareness. If the company carries out such a study, an estimate for SHELF* will also be obtained, as there will be detailed questions as to the source of awareness.

8. Empirical illustration of the model: The launch of a curd cheese in Italy

How does the model work in practice? The empirical application of the model will be demonstrated by a practical example. The model is available in a user-friendly PC programme which will be used in this section. There is a report for each month in the first year after the launch of the new product.

In 1984 a large food company considered a launch of a new cheese product, a curd cheese, in Italy. The company planned to distribute the product to speciality shops as well as to supermarkets.

The product has since been launched in Italy, which gives us the possibility to compare the estimated sales of the product with the actual sales.

Market description

The total number of households in Italy is approximately 18.5 million. On the basis of similar cheese products already on the market, the company estimated the size of the target group to be 14.6 million households.

Based on experience from other cheese products, the company also estimated that the average number of units bought at a trial purchase to be 1 unit, and the average number of units bought at a repeat purchase to be 1.1.

The company estimated that on average there would be six weeks between each purchase in this product category. Furthermore the company expected 95% of the consumers to have made a purchase of the product category within seven weeks.

This type of cheese is subject to seasonal fluctuations, which can be seen from a summary of input data (Table 4).

Marketing research

In February 1984 a concept/product test was carried out. The concept test resulted in a trial purchase probability of 41%, and the product test resulted in a repeat purchase probability of 57%.

Unfortunately the company gave no information about the value of ω_1 (preferer share), ω_2 (indifferent share in the long run), π_1 (the probability that a preferent consumer, will repeat purchase it on a purchase occasion), and π_2 (the probability that an indifferent consumer will repeat purchase it on a purchase occasion). An estimate must therefore be made of these parameters, and the subjective estimates are:

$\omega_1 = 10\%$ $\omega_2 = 15\%$ $\pi_1 = 90\%$ $\pi_2 = 45\%$

In other words this means that the total share of consumers, who either are preferent or are indifferent in the long run, will be 25% (10%+15%), and that the probability of making a repeat purchase of the new product is twice as high for a preferent consumer as for an indifferent consumer - 90% and 45%, respectively.

The marketing plan

Let us now look at the information to be used from the company's marketing plan.

First, information of the expected weighted distribution of the product for each of the first 12 months after the introduction is needed. As mentioned before the cheese product was actually launched, and the product was included in the Nielsen Retail Index. The weighted distribution indicated in Table 2 is based on the Nielsen data, which are measured on a 60-day basis. Therefore the distribution level for the intervening months must be estimated.

Table 2. Distribution and advertising

Month	Weighted distribution	Weighted distribution as model input	GRP	Prob. of becoming aware via advertising
1	38	38	0	0
2		45	630	40
3	52	52	0	0
4		57	373	26
5	62	62	42	3
6		65	82	6
7	67	67	84	7
8		67	95	7
9	66	66	547	35
10		67	143	11
11	68	68	458	31
12		68	0	0

Secondly, the company considered carrying out a number of promotion activities.

The company planned advertising campaigns on television and in the printed media, with the main emphasis on television (84% of the media budget). The media budget for the first year, converted to GRPs, was to be allocated as shown in Table 2.

By use of the advertising response model (without regard to competitors' advertising budget, which was unavailable), this GRP effort can be converted to advertising generated awareness in each period. The advertising generated awareness is shown in Table 2. 630 GRPs in month 2 result in an awareness probability created by advertising of 40%; and similarly for the other months.

Further, it was decided to conduct in store promotion activities, such as demonstrations in the retail outlets, from October to December 1985. The company believed that these in-store promotion activities could be carried out in 10% of the outlets (weighted). Naturally these outlet demonstrations generate product awareness. The probability that a consumer becomes aware, generated by these demonstrations, given that the consumer on a purchase occasion is in one of these retail outlets, is 50%, ie half of the consumers become aware in this situation.

Estimates of the probability of becoming aware by in-store promotion activities, given the consumer on a purchase occasion is in a retail outlet where the product is available, is shown in Table 3. In the model this probability is called INSTORE*.

As the point-of-purchase activities only are conducted from October to December 1985, the probability of becoming aware on this basis will of course be 0 in all other months. The demonstrations in the retail outlets are carried out relatively late in the introduction sequence, viz nine months after introduction. As the mean purchase cycle is 42 days, these activities will have no important effect on repeat purchase and sales in the first year after introduction.

It is necessary to estimate the "shelf facings" effect, SHELF*, ie the probability that a consumer becomes aware of the new curd cheese through the placement on the shelves on a purchase occasion.

Only few products can be compared directly with this new curd cheese, which points to a big "shelf facings" effect. On the other hand the category of fresh "soft" cheeses, to which the new product belongs, is big. The case material does not reveal the number of brands in this product category, but there is no doubt that the number is large. The probability of becoming aware of the product through its placement on the shelf is therefore believed to be small, and therefore the "shelf facings" parameter SHELF* is assumed to be 7%.

Three parameters more must be estimated: The company found that a lower limit of awareness was 5%, ie the awareness level would never get below 5%, even though awareness generating ceases at some point. The company also estimated that the maximum attainable awareness would be 85%, which means that no matter how extensive a promotion budget the company would be willing to use for the product, the last 15% of the target group would never be reached, ie become aware of the product. The awareness retention rate is assumed to be: r = 0.90 per month.

This was the input data needed to run the model. Let us now look at the output of the model.

Table 3. Estimates of the probability of becoming aware of the new curd cheese by in-store promotion activities for the first 12 months after introduction

		Probability of becoming aware by POP activities, given buying occasion in a retail outlet:	
Month	**Share of retail outlets with POP activities (%)**	**With POP (%)**	**Where the product is available (%)**
1	0		0
2	0		0
3	0		0
4	0		0
5	0		0
6	0		0
7	0		0
8	0		0
9	0		0
10	10	50	5
11	10	50	5
12	10	50	5

Application of the model

The summary of input data in Table 4 shows the well known parameters and estimates. Furthermore "sample usage rate", "trial probability after sample usage" and "sampling coverage" are of course 0, as no sampling activity is carried out in the case.

The company did not estimate total awareness over time, ie awareness generated by distribution, in-store promotion and advertising. Total awareness was calculated by the programme by using the previously outlined guidelines, and the result for the case is shown in Table 4. After the first year on the market, nearly 60% of the target group had become aware of the product. In month 11, both advertising and demonstrations in the retail outlets were carried out, creating a total awareness of nearly 64%, which is the highest value attained in the first year.

The probability of trial and the probability of repeat are computed month by month, and the sum of these is the probability of purchase. Furthermore the cumulative probability of trial, ie the penetration, is found. Moreover the market share for each month is shown in the last column in Table 5.

Table 4. Programme output: Input data and adjusted distribution and total awareness

Market description

Target market size	14,600,000
Number of units purchased at trial	1.0
Number of units purchased at repeat	1.1
Mean product category purchase cycle	42.0 days
95% fractile of product category purchase cycle	49.0 days

Marketing research data

Trial probability	41.0%
Trial to first repeat probability	57.0%
Trial probability after sample usage	.0%
Preferers of triers	10.0%
Indifferents of triers	15.0%
Preferers' choice probability	90.0%
Indifferents' choice probability	45.0%

Marketing plan

Shelf facings effect	7.0%
Sample usage rate	.0%
Maximum awareness	85.0%
Minimum awareness	5.0%
Awareness retention rate	90.0%

Month	Awareness from ad prob %	Sampling coverage %	Awareness from POP prob %	Distri-bution %	Adj dis-tribution %	Awareness total %	Season index
1	.0	.0	.0	38.0	41.1	5.4	81.0
2	40.0	.0	.0	45.0	51.7	38.2	87.0
3	.0	.0	.0	52.0	59.0	36.1	116.0
4	26.0	.0	.0	57.0	64.2	47.6	100.0
5	3.0	.0	.0	62.0	69.2	45.8	116.0
6	6.0	.0	.0	65.0	72.1	45.6	113.0
7	7.0	.0	.0	67.0	74.0	45.9	93.0
8	7.0	.0	.0	67.0	74.0	46.2	70.0
9	35.0	.0	.0	66.0	73.1	58.0	84.0
10	11.0	.0	5.0	67.0	74.0	57.4	130.0
11	31.0	.0	5.0	68.0	75.0	63.6	106.0
12	.0	.0	5.0	68.0	75.0	59.2	104.0

Table 5. Programme output: Probability of trial, probability of repeat, total probability of purchase, the cumulative probability of trial (penetration) and market share

Month	Probability of trial %	Probability of repeat %	Probabilty of purchase %	Cumulative probability of trial %	Market share %
1	1.35	.00	1.35	1.35	1.89
2	4.38	.34	4.72	5.73	6.61
3	2.43	1.37	3.80	8.16	5.32
4	3.04	1.68	4.72	11.20	6.61
5	1.40	2.15	3.55	12.59	4.97
6	.71	2.17	2.88	13.30	4.03
7	.42	2.10	2.52	13.72	3.53
8	.27	2.04	2.31	13.99	3.23
9	2.07	2.00	4.07	16.06	5.70
10	1.00	2.45	3.45	17.06	4.83
11	1.54	2.54	4.08	18.59	5.71
12	.13	2.78	2.91	18.72	4.08

Table 5 shows that in the first month 1.35% of the target group is expected to make a trial purchase of the product and the purchase will not be repeated. This is of course a consequence of a mean purchase cycle of 42 days; if a consumer has made a trial purchase in the first month, only a limited number will buy the product again in the same month. But as the trial purchase increases, the probability of repeat purchase will of course also increase.

In the fifth column in Table 5 the cumulative probability of trial purchase can be seen, ie penetration. After the first year, nearly 20% of the target group will have tried the product, and penetration will probably be stabilizing, if no activities are planned in the second year.

The last calculations undertaken by the computer programme are trial volume, repeat volume and total sales volumes, and the cumulative figures. These figures are shown in Table 6.

From Table 6 it appears that the company can expect to sell 5.5 million units of this new cheese in the first year, distributed on 2.3 million units trial volume and 3.2 million units repeat volume.

Furthermore Table 6 shows that the forecasted trial volume in the first month is 159,000 units and reaches a peak already in month 2 with more than 500,000 units, followed by a high trial volume in months 2 and 4 and partly in month 5, which is in full accordance with the massive promotion activity carried out in months 2 and 4. After this the trial volume falls in the following three months with only a few advertising activities and then rises once more in months

9, 10 and 11, where there is a massive advertising campaign. In month 11 advertising activity is 0, and therefore a considerable fall in the trial volume occurs in this period (22,000 units).

The repeat volume is small at the beginning and gradually, as more and more try the product, it increases, and sooner or later it stabilizes. The repeat volume has not yet stabilized, due to the fact that still new consumers try the product. Moreover the repeat volume fluctuates according to the same pattern as the trial volume, only brought forward by about one purchase cycle.

Table 6. Programme output: Forecasted trial volume, repeat volume and total sales volume and the cumulative figures

Month	Trial volume (000)	Repeat volume (000)	Total volume (000)	Cumulative trial volume (000)	Cumulative repeat vol. (000)	Cumulative total vol. (000)
1	159	0	159	159	0	159
2	517	44	562	677	44	722
3	287	177	465	965	222	1187
4	359	218	578	1324	441	1765
5	165	279	444	1489	720	2210
6	89	303	393	1579	1024	2603
7	52	293	346	1632	1318	2950
8	33	285	319	1666	1603	3269
9	263	279	542	1929	1882	3812
10	126	342	469	2056	2225	4281
11	260	472	733	2316	2698	5014
12	22	518	540	2388	3216	5555

The model forecast compared with actual sales

This new cheese product was actually launched January 1, 1985. Nielsen Retail Index recorded the sales in 60-day periods, and the actual sales measured for the first year after launch appear in Table 7.

Table 7 shows the model's forecasted sales per 60 days, and a comparison of the forecasted sales and the actual sales. There are of course differences between the forecasted and actual sales, and especially in months 3-4, 5-6 and 7-8 there are major differences. There may be many reasons for these differences. First of all, as this is a model, differences between the model and reality must of course be expected. The two most significant reasons for the differences are probably:

- Some of the model input data are subjective estimates and therefore the model input data will in some cases not be identical with the situation.

- Competitor reactions.

Finally the cumulated forecasted sales and the cumulated actual sales are almost identical after the first year; the difference is only 93,000 units, corresponding to a difference of only 1.6%.

Table 7. Actual sales (Nielsen Retail Index), forecasted sales and difference between actual and forecasted sales

Month	Actual sales per 60 days (000)	Forecasted sales per 60 days (000)	Difference (000)
1 - 2	612	722	-110
3 - 4	830	1043	-213
5 - 6	1082	838	+244
7 - 8	1062	666	+396
9 - 10	908	1012	-104
11 - 12	1154	1274	-120
Total	5648	5555	+93

9. Conclusion

In this paper a sales forecasting model for fast moving consumer goods has been developed. Let us emphasize some of the new elements in the model, and underline our contribution to the research in this area.

As regards the awareness model it is especially worth emphasizing the submodel for advertising. Here allowance is made for competitors' advertising efforts, and the term "share of voice" is introduced.

The three awareness generating factors, advertising, distribution and samples, influence the consumers from being unaware to making a trial purchase.

The consumers, who are aware in a given period, are left with four different possibilities:

- Make a trial purchase of the new product

- Reject the product, because they do not like the product idea itself or the activities which are carried out for the product

- Remain aware because they do not need the product category in this period or because the product is not available in the consumer's retail outlet

- Forget awareness of the new product

Compared to other models in the area, the classification and modelling of this is a considerable improvement, owing to the fact that the group of aware consumers and the group of consumers, who forget their awareness, can be influenced by one or more of the seven awareness categories in each period. In this way allowance is made for the type of awareness (caused by advertising or distribution or samples, or a combination of these), and the number of influences over time (0,1,2,...,) - an influence pattern which is extremely realistic in practice.

The theoretical basis for the repeat purchase model has been Ottesen's (1977; 1981, p. 119-120) *Market map* classification of the consumers on a market. It is assumed that the consumer, after the trial purchase and before the next purchase of the product category, makes up his mind about future purchase behaviour, ie if the consumer will:

- Reject the product

- Prefer the product and therefore repeat purchase the product

- Become indifferent to the product in the long run and therefore repeat purchase the product

- Become indifferent to the product and repeat purchase it, but sooner or later will decide to reject the product

In the modelling of the repeat purchase probability $\beta_{j,}$ this classification of the triers is used; the shares of the last 3 groups (ω_1, ω_2, ω_3) and the probability of buying the product on the j'th purchase occasion after trial for each group (π_{1j}, π_{2j}, π_{3j}) are combined in the repeat model.

The developed model for the repeat purchase probability β_j is very flexible, as it can easily be expanded to include several loyalty groups or other types of loyalty groups with varying purchase behaviour.

The repeat model also includes an interpurchase time model, and the lognormal distribution is chosen. This interpurchase time model is new in the area of sales forecasting and is not seen used in any other existing sales forecasting model.

A purpose of this paper is also to illustrate how the model can be used in practice. This was demonstrated in Section 8, where the model was applied to an authentic example, viz the launch of a new cheese product in Italy. A fair agreement between forecasted and estimated sales was found, and the model was able to "catch" the fluctuations in the sales.

The application of the model as a forecasting model has been demonstrated with the presented example. But the model can also be used as a decision support system for the company to find the "best" marketing plan for a new product to be launched. A decision not to launch a new product can be drawn from an inexpedient marketing plan, and not necessarily a poor product. The model can be used to generate improved marketing plans. In this connection it is important that the model includes marketing variables, because only in this way can the model be used for **marketing plan optimization**. We believe that a future direction of development and use of sales forecasting models for new products will be within optimization of the marketing plan for launching a new product, and not only as a tool for forecasting sales for just one marketing plan.

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