# PEST: A Knowledge Based System for Product Promotions


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# 1 Introduction

In this paper we address the issues involved in developing a **knowledge based system** (KBS) [Jac90], [Fro86] for constructing promotions of various kinds of produce within supermarkets [R.J89]. We are currently working with a large retail company which supplies both expertise and sample data.

Specifically, the system under development is to be used to determine the promotional layout and "worth" of promotions within the **fresh produce** section, *i.e.* vegetables, salads and fruit. "Worth" translates into a measure of how good the promotion is perceived to be, taking into account direct financial gain as well as more general factors, such as making more customers visit the store.

The system is intended to be used by produce buyers as an aid to constructing effective promotions, but will also have users in Higher Education and as a training tool for managers and buyers in retailing.

# 2 The Disciplines Involved

## 2.1 Retail

Supermarkets include amongst their most critical success factors the continued increase of sales and profitability. Retail promotions have been adopted as an operational technique to achieve such increases in both the short and long term, with typically 30–40% of sales coming from promotions.

The identification of the contribution of any individual product's promotion to long or even short term gains is contentious due to the number of other factors which influence the sales and profit figures (for example; customer care, competitor activity, advertising and the weather). Nevertheless there are criteria within the supermarket chains by which promotions are judged to be a success or not.

The company partnering us in our research stocks approximately $15,000$ products, ranging through fresh and frozen foods, ambient temperature groceries and household goods. Fresh produce (in this company) accounts for approximately 7% of sales and is therefore seen as being of significant importance to the company. The promotion of fresh produce is also important for creating and maintaining customers' perceptions[1] of the company's price competitiveness and particularly of its quality.

## 2.2 Computing

Large retailers keep an extensive record of previous sales, uploaded from Electronic Point of Sale (EPOS) systems. Such a wealth of data seems ideal for computational exploitation [PM90], [Wal91]. There is variety of avenues of research in the retailing area. We concentrated on one specific area but would also like to draw attention to the others later in this paper.

The project was funded to look at KBS applications in retailing, so this was the governing factor in the choice of the targetted area; namely promotions. This is a process dominated by "human" skills and appears to be amenable to KBS methods.

The process by which the relevant knowledge is acquired is on–going, and so the points below form a dynamic, iterative system as our working model is refined and corrected by the company.

- **Access to the relevant individuals within the company**

Firstly we needed to build a good working relationship with the research company. There were some reservations about being made obsolete by "intelligent machines" too, so finding the appropriate stance was important. We have eager management support which makes life easier.

- **Access to the relevant sales data**

Naturally the research company, and indeed all commercial enterprises, are likely to be reluctant to disclose "sensitive" information. Our development system is therefore not public–access and holds the acquired data in a private database.

[1] *immediate* in–store perceptions are important as fresh produce is usually positioned in the first visible aisle

• **Suitably codified knowledge of the application area**

The knowledge held by the various employees was sampled by means of fairly unstructured interviews. The process was iterative so that questions raised as the model was built could be reposed in the light of our experience, and took place over a period of approximately 10 months.

• **Development system**

Three machines were eventually in place for the development of the prototype system. One of them also has an INGRES database installed for holding all the sales data we gather.

The prototype is being coded in a system called *DECISIONPOWER*, provided through contacts in the retail and computing divisions of I.C.L., whom we wish to thank for their continuing input and support on both the retailing and technical fronts. DECISIONPOWER provides versions of:

**Prolog** SEPIA Prolog and CHIP (constraint system)[2]

**KHS** a message–based **X11**[3] graphics system within Prolog.

**SEDUCE** a loosely–coupled database interface, in our case to INGRES via INGRES/SQL[4].

## 3 The role of the system

There is a definite process which takes place in the assessment of the value of promotions, and which we can model.

The initial role of the system is to be that of a **tutor**, following attempts to construct promotions and advising on preferred actions or on better user choices at various points in this process.

[2]Produced by ECRC, Munich
[3]The X Window System is © M.I.T.
[4]INGRES and INGRES/SQL are trademarks of Ingres Corporation

We have named the proposed system **PEST**, which stands for **P**romotional **E**xpert **S**ystem **T**utor [5].

# 4 Product Classification

We categorise products into three types when considering them for promotion.

## 4.1 Mandatory Products

As an example, consider the time of year when the Wimbledon Tennis Championship takes place. The strong association of strawberries with Wimbledon is well–known. From the retailer's point of view then, strawberries are considered **mandatory** promotions at this time. A mandatory promotion fulfils the customers' expectations of the retailer and presents a positive marketing image.

The *principle of mediocrity* here means that everyone will be promoting mandatory products. Thus one may be forced to promote even if there is a short–term loss. The long–term corporate contribution of such promotions is seen as ample compensation.

It is also vital to promote a seasonal product as soon as supply is received at the start of its season. Customers, when made aware of a product coming into stock will, it is hoped, continue to purchase the produce throughout the season. The margin on seasonal produce often improves during its season. In such cases a return on the margin investment in the promotion can be achieved within a matter of weeks.

[5] We are making little or no distinction between the appellation "expert system" and "knowledge based system". Besides, you can't pronounce **PKBST**.

### 4.2 Key–Line Products

Key-line products are high profile products with large turnovers, that are of known value to the company. They are the core sales and profit earners for the department. Promotions of these products will attract much customer interest; generate turnover; potentially achieve good profits and help build the right image for the promoter. Salad tomatoes, bananas, potatoes and common eating apples are all examples of key-lines in fresh produce.

### 4.3 Discretionary Products

The discretionary product classification encompasses the rest of the fresh produce range. Common products out of season and all the less common products are discretionary. Promotions of these products are usually not as successful as mandatory or key–line promotions, but can still deliver a message of depth or breadth of range and value–for–money, especially if carefully timed.

## 5 Promotional Criteria

### 5.1 Critical Promotional Criteria

When carrying out a fresh–produce promotion, there are two factors which turn out to be so important that we treat them separately.

#### 5.1.1 Supply Levels

Fresh–produce requires a good, stable supply. By its very nature, fresh–produce tends to be susceptible to variations in quantity and quality (for example, an unexpected frost can deplete both quantity and quality of lettuce in one fell swoop).

Consequently, if there is reasonable doubt about the supply of non–mandatory produce then the promotion does not occur, regardless of what other factors indicate.

### 5.1.2 Competitiveness

A promotion which is not price–competitive is also rejected. The price of a promoted product must be the lowest (or equal lowest) amongst retail competitors. It is perceived as unacceptable to be undercut on promotions of non–mandatory items.

Note, however, that mandatory products will be promoted even if they should fail these checks. The fact that they failed can be passed through to later stages in the promotion construction process.

## 5.2 The Remaining Criteria

### 5.2.1 Strategic and Tactical Suitability

**marketing factor** including use of pictures, leaflets, themes, demonstrations, generic advertising, competitions.

**special product** an exotic or innovative product can help project a special image for the company of breadth and depth of range.

**new products** are promoted frequently to raise and maintain customers' awareness. New, in this case, usually means in terms of presentation and packaging, but not always.

### 5.2.2 Customer Deal

Customers can be informed of promotions through various techniques, but their perception of the deal will be the key to whether or not they purchase. The four significant variables affecting this perception of promotional activity[KCS91] are described below.

1. the strength of the *Basic Offer* is an estimate based on factors such as the depth of price cut, the amount of added value [W.D92];
2. the *Level of Competition* takes into account the combined strengths of other competitive offerings both in-store and in competitors' stores;
3. the strength and frequency of *Previous Offerings* of this product is calculated to indicate their effect on the current promotion. There is a timing consideration here and offers of other similar products should also be considered;
4. *Produce Quality* Excluding onions, all fresh produce stocked by the research company is Class $I$; however within this grade there can be differences in quality. As a consumer, one can observe the variation in quality of certain products, *e.g.* green peppers. This will affect the customers' perception of the deal.

### 5.2.3 Buyer Deal

Turnover, gross profit and gross margin are three of the performance indicators by which buyers (and the company) are measured. The worth of the promotion for a buyer is based on the degree to which the promotion enables the targets for these indicators to be met.

The estimate of worth forms the basis of the decision whether to promote or not. The actuality of performance is a measure of worth and therefore of the buyer. At this stage in the planning process though, the buyer has no control over determining where a product will be displayed. Therefore it is impossible to estimate turnover and thereby profit.

Thus the only performance indicator which a buyer can control at this stage is the margin. It may also be worthwhile for a buyer to consider the product substitution effects of a promotion, on their overall performance for buying their group of products. A promotion may increase sales of one product but at a cost to other products within the group.

The model assesses a buyer on their handling of these two factors.

# 6 Modelling the Promotional Process

The problem is to choose a portfolio of promotions and we have chosen to model this process in two discrete steps.

## 6.1 The Promotional Worth

In section 5 was listed the criteria by which a promotion is judged. The system poses the relevant questions from this section to build an internal[6] estimate of the worth of the suggested promotion [TC93].

## 6.2 In–store Layout

Fresh produce is placed both on-shelf and in four "bins" in the middle of the aisle. The goods placed in the bins have a higher visibility than of those on the shelf.

There are various rules about what can and cannot go in which bin. For example, it is normally the case that fruit will go into the first two bins and vegetable and salad into the second two. Within this division come more rules about which goods can and cannot share bins.

## 6.3 Layout Constraints

Given the potentially large number of products which *could* be promoted in the bins (see section 2.1), a brute–force attempt at determining a layout is likely to suffer a combinatorial explosion. The paradigm of generate–then–test causes an intractable amount of work.

The use of a **constraint solver** [JJY90], [Lel88], where the rules are specified before the potential solutions are generated (constrain and then generate) would

[6]"internal" in the sense that this worth is part of the model and not deemed to be the way the buyers do it

seem to be a potential solution, as the layout problem is essentially a kind of scheduling problem [Laj92].

A number of other techniques exist for such problems, and these are also to be investigated, for example

**neural networks** a neural network with some form of learning algorithm [RM86], learning either *in–situ* or pre–trained; see also [DTI93].

**genetic algorithms** genetic algorithms have been successfully employed in scheduling problems [Nak91].

### 6.4 Explanation Facilities

It is perceived as important that the system contain a good explanation facility. The amount of money involved in promotions is very high (see section 2.1) and so confidence must also be high. Unjustified recommendations would not engender any confidence in the ability of the system.

Current work is focussing on incorporating explicit acquired knowledge for explanations – we envisage a form of "commentary" process to annotate various decision–making processes. Attempting a general solution is beyond the scope of the project.

## 7 Future Work

### 7.1 Phase II of PEST

At the time of writing we are successfully prototyping the first stage of PEST, namely constructing the worth of a promotion.

Investigations into the most suitable approach for the layout problem are in–

hand. It may turn out that there are no really suitable off–the–shelf techniques easily usable, and that a number of heuristics may have to be developed to support this operation.

As the current instance of the model proves itself, its scope will increase. Subsequent iterations with detailed feedback from buyers within the retail company will incorporate the layout of the goods within bins and shelves.

### 7.2 Explanation Facilities

The provision of generalised explanation facilities is a research field in its own right [Wus91]. Full explanation facilities require not only an internal representation of the knowledge, but a mechanism for its retrieval *as language*, see [Den93] and also [Fer83].

Special–case solutions to this do not appear to be infeasible, and a further possible goal of the project is the assimilation of a specialised explanation mechanism into PEST.

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