A E R O S O L S   A N D   A L T E R N A T I V E S

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"AEROSOLS AND ALTERNATIVES"

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Summary

Aerosol products have been widely used in both the home and industry for over thirty years. Consumption has grown steadily from their introduction until the mid 1970's when they became implicated in a major environmental controversy. This caused scientists, governments and the media to question the usefulness and necessity of the aerosol package and put both the products and the industry under increasing scrutiny which continues to the present time.

The purpose of this study is to examine the case for and against the aerosol product, analyse the current commercial and technical status and make forecasts of the future business potential. A further objective is to examine the alternatives available to Johnson Wax Ltd both in terms of maintaining current products in non-aerosol form and also by way of alternative and improved business opportunities. This is pursued by development of an External Search and Multi-step Evaluation procedure (E.S.M.E.). The development of the procedure is described together with the results from its implementations.

The study concludes that aerosols are in decline and that Johnson Wax Ltd should maintain a programme for alternative business opportunities in order to ensure survival and growth. A pilot study which demonstrates how this might be achieved is presented together with a proposed future business development plan. This plan makes full use of the skills held by the S.C. Johnson corporation and although it is orientated to Johnson Wax Ltd (the UK subsidiary), is intended to bring benefit to the whole organisation. Such a procedure is likely to have widespread application to industry in general.

KEY WORDS: AEROSOLS; ALTERNATIVES; FORECASTS; BUSINESS; MARKETS

D E D I C A T I O N

To my family for their endurance.

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ERIC A.ROTHEIM - INVENTOR OF THE AEROSOL

CHAPTER 1: INTRODUCTION

The 'aerosol' has been established in Europe for approximately 30 years. Its origins go back to 1825 when an Englishman by the name of Charles Plinth, invented the concept of pressure packaging in the form of the soda water syphon. Plinth's idea of packaging a product under pressure in order that it could be later expelled in a controlled manner was extended to produce an atomised spray for dispensing insecticides by the Norwegians in 1939. The development was then taken up by the Americans and the pressure packaged products which produced a spray seemed to be more popular than those producing a liquid stream.

The sprays came to be misnamed 'aerosols' because many of the early designs did in fact produce a degree of atomisation similar to a true aerosol. However, although at the present time a small number of medicinal products are true aerosols, the majority of pressure packed sprays produce atomised particles which are too large to be correctly described in this way. Nevertheless, the term 'aerosol' was adopted by the media and the industry, and is still widely used today in the sense of describing the range of pressure packaged items. It will thus be used in this study.

The rapid growth of the aerosol industry throughout the United States, Europe and other parts of the world, together with the increase in the range of product categories will be described later, but it may be said that this development has continued virtually unchecked since the 1950's.
In 1974 a hypothesis was advanced by Molina Rowland (1), which basically claimed that one of the ingredients used to manufacture many aerosols could be causing serious environmental damage with subsequent effect on

world health. This hypothesis has attracted the attention of the media and of world governments. It is known as the 'ozone depletion controversy', and is discussed in Chapter 4. However in introducing this subject, it is perhaps appropriate to say that this controversy has proved to be the first major check on the development of aerosol markets throughout the world. Thus while the conclusions from the hypotheses may not preclude further aerosol development using alternative materials, they have caused many to question whether aerosols are really necessary.

In view of the fact that the aerosol industry employs approximately 1,000,000 people around the world, with a total capital investment of 1 billion sterling, it is not surprising that both the industry and the trade associations are concerned about the future. Already there have been some published predictions (2), (8), and Part I of this study examines available data and endeavours to make forecasts for the short and medium term, then moderate them by taking account of likely world developments. Part II carries out a case study on the options and alternatives facing a major aerosol manufacturer namely Johnson Wax Limited. This is important for, like many multi-national companies, future plans place a heavy emphasis on continued growth and development and it may be that the aerosol product cannot continue to deliver its share of the profits required by such plans. It is intended that this study will not only point the way for the company, but that it will also identify attractive business opportunities by attempting to match new product ideas with the company's skills. The ultimate objective of the study will be to recommend a business development plan for Johnson Wax Limited to follow in the pursuance of these new opportunities.

The overall plan of the thesis is illustrated in Figure 1.1 below.

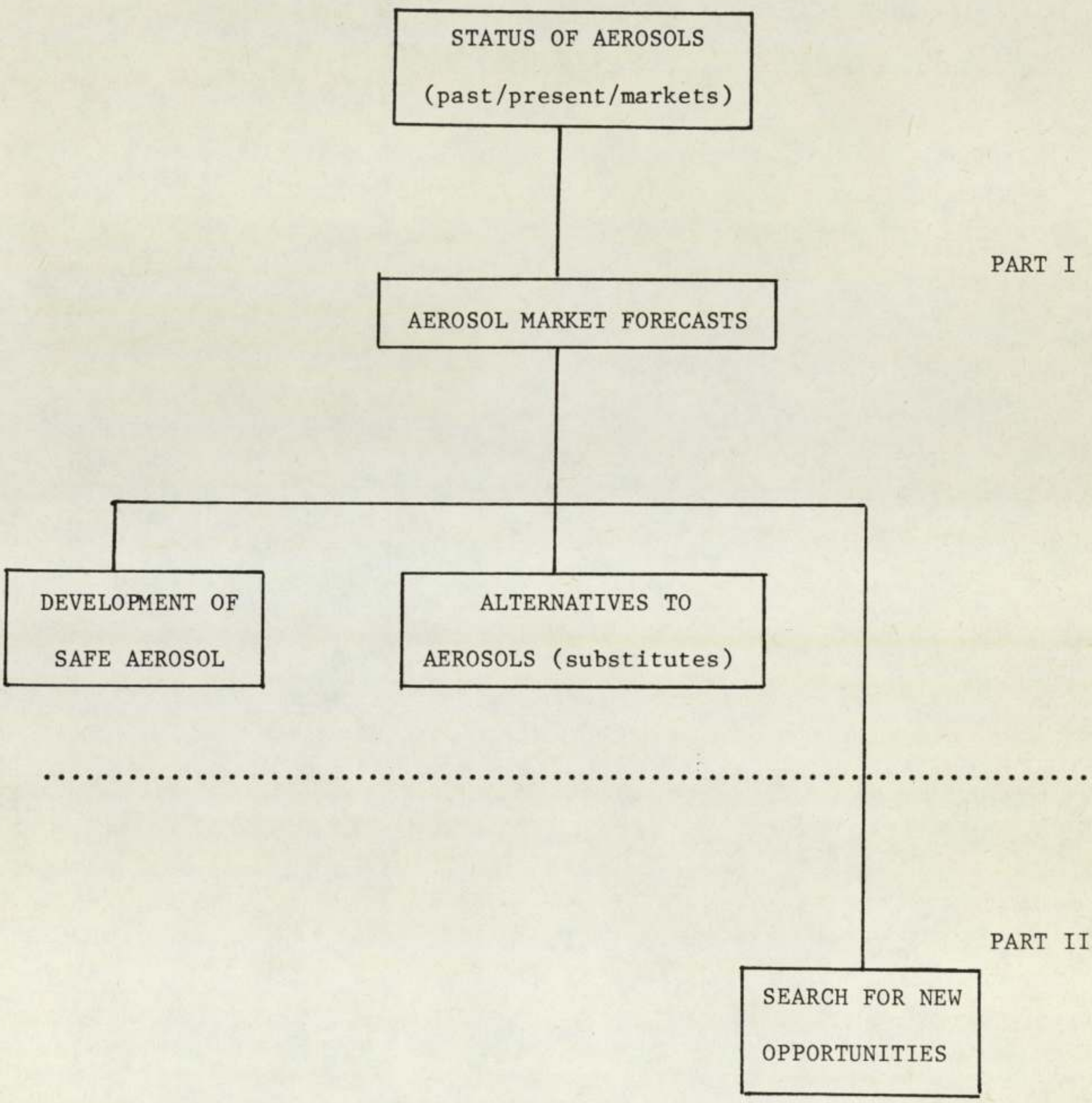


FIGURE 1.1 OVERALL PLAN OF THE THESIS

CHAPTER 2: THE AEROSOL INDUSTRY

2.1 THE PRODUCT AND THE INDUSTRY

2.1.1 The Product

As explained in the introduction, the term 'aerosol' has become widely accepted as describing the complete spectrum of pressure packed products, ranging from finely atomised airfreshener sprays through to shave foams, creams and even food products which issue in the form of a paste. An aerosol comprises:-

(a) a container of material, capable of retaining the contents under pressure without physical or chemical interaction.

(b) a valve which, when opened (by finger action), can release the contents in a controlled manner - usually in the form of an atomising spray.

(c) an overcap to protect the valve and avoid accidental spray during storage and transit.

(d) an active product formulated to perform some specific prupose, e.g. kill insects or polish furniture.

(e) a propellant to pressurise and force the active product through the valve to the exterior often in the form of an atomised spray. The propellant is usually a liquefied gas or a gas dissolved in an active product.

A typical aerosol package is illustrated in Figure 2.1.

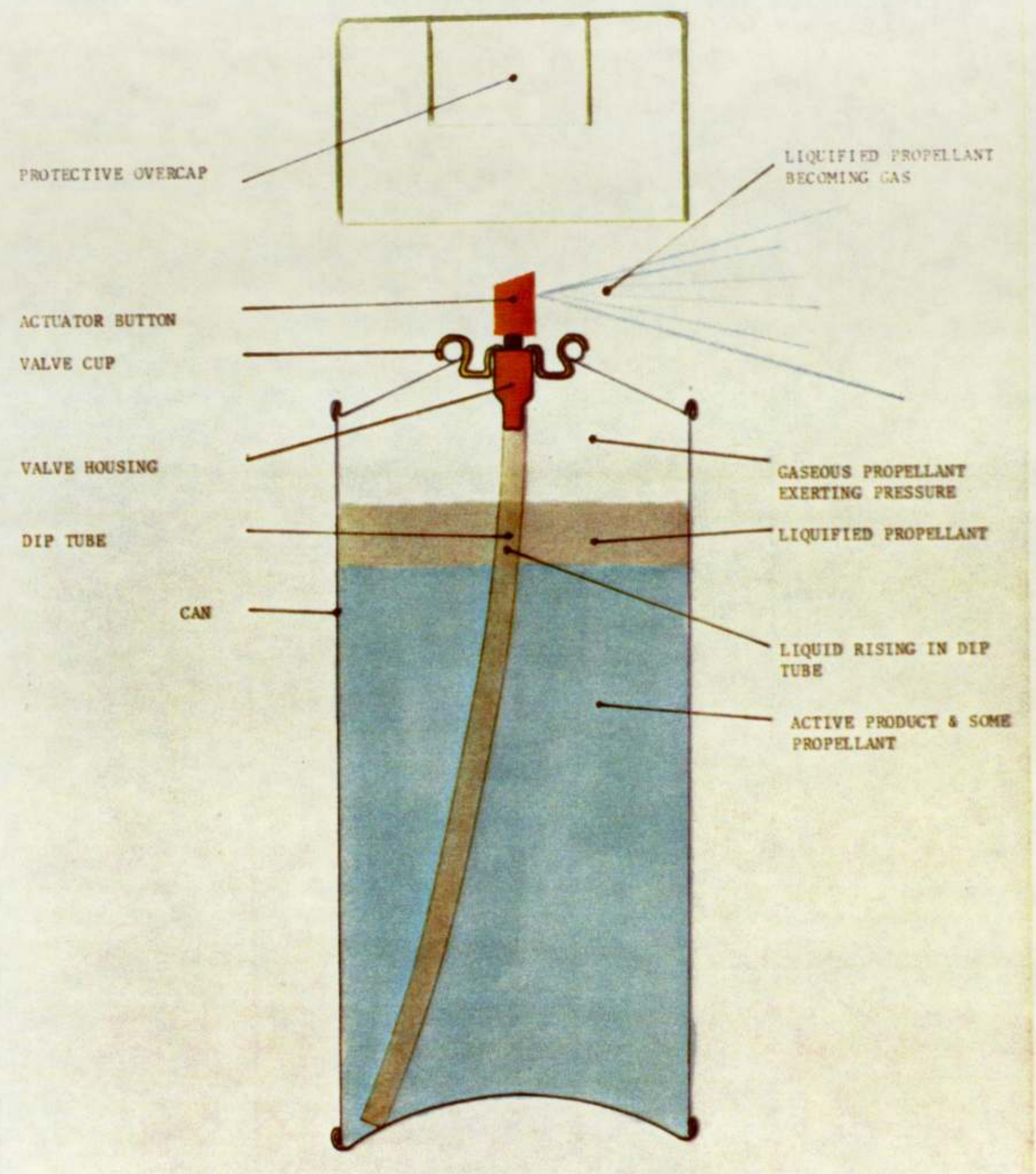


FIGURE 2.1 TYPICAL AEROSOL PACKAGE

2.1.2 The Industry

The aerosol industry is a worldwide one, although the bulk of the production is divided between the United States and Western Europe. Figure 2.2* illustrates the contribution from each major area in terms of units filled. By reference to this data it was concluded that by studying Western Europe and the United States, a fairly accurate picture would be obtained of the trends in the aerosol industry as a whole. However data from other areas would be utilised when available.

The industry may be considered to be made up of five main sections as follows:-

Manufacturers of aerosol components.
Manufacturers of aerosol propellants.
Manufacturers of aerosols (fillers in their own right or contractors)
Marketing and distribution of aerosols.

Sometimes a company formulates, manufactures and markets its own products e.g. Johnson Wax Limited. The various sections will now be considered in greater detail.

2.1.2.1 Aerosol Components

Aerosol components mainly comprise the can and the valve. Other components such as the plastic overcap or the fibreboard outer cartons are usually manufactured by those companies dealing generally with packaging materials and are non-specific to aerosols.

* Some inaccuracy is apparent

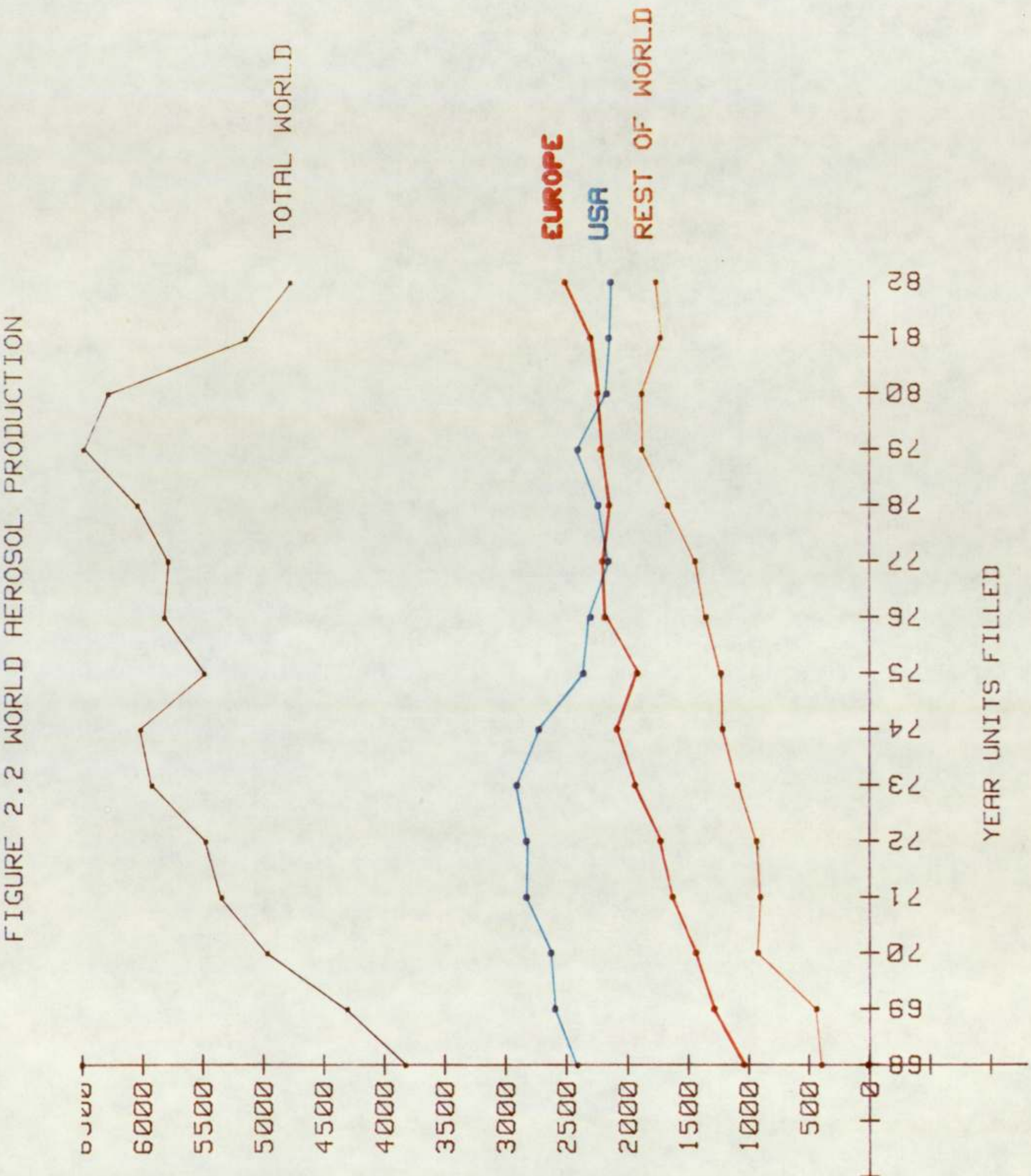


FIGURE 2.2 WORLD AEROSOL PRODUCTION

(a) Aerosol Cans

Table 2.1 shows the type of materials that are used to manufacture aerosol containers and the differences between them (2). Table 2.2 shows the comparative useage of tinplate versus aluminium in Europe (2). There seems to be little doubt that the aluminium can is dearer everywhere throughout Europe than the tinplate can (3), although the cost of both is increasing. Glass containers have so far failed to make much commercial impact. Each of the above materials will now be discussed separately:

Tinplate - Table 2.3 shows the producers of tinplate aerosol cans in Europe and the United States (2). Tinplate aerosol cans are made in a similar way to tinplate food cans namely, by rolling up a sheet (previously lithographed with artwork and use instructions), seaming via a high-speed welding process, and then rolling on the forged top and the bottom. It has been estimated (2) that the total tonnage of tinplate used for aerosol cans in Europe is of the order of 135 - 150,000 tons per annum. Similarly in the United States, the estimated figure is 1,110,808 tons (4).

Aluminium aerosol cans:- These are usually impact extruded which should mean that the manufacturing process is more flexible and that more aesthetically pleasing shapes can be economically produced. However this advantage is offset by the inability to pre-print the cans prior to manufacture. Larger can sizes are not of monobloc construction but are two-piece with a bottom seamed on to a drawn upper. Table 2.4 lists some of the manufacturers of aluminium cans (2), (4).

TABLE 2.1 AEROSOL CAN MATERIALS COMPARED

Property	Aluminium	Plastic	Tinplate	Glass
Strength	Very Good	Good	Good	Poor
Corrosion resistance	Good but may need lacquer	Good	Very good if tin layer intact but may need lacquer. Poor if tin layer damaged	Excellent
Self-decorative	Acceptable unpainted	Good	Not acceptable unpainted	Good
	Contours good and can be varied		Shape dull and fairly fixed	
Acceptance of Decoration	Printed decoration restricted	Good	Full range of metal-printing techniques	Good
Economics of scale	Not very sensitive	Good	Especially suited to long runs	Not sensitive
Cost	Cheaper where hydroelectricity is available (Finland)	Low if accepted	Cheaper where tinplate is well developed (UK)	High

TABLE 2.2 COMPARATIVE USE OF TINPLATE AND ALUMINIUM

% FILLINGS - 1977

Country	Tinplate	Aluminium
Finland	40	60
France	50	50
F R Germany	55	45
Italy	40	60
Netherlands	85	15
Spain	65	35
Scandinavia	40	60
Switzerland	40	60
UK	90	10
USA	75	25

Glass:- This material is heavy and brittle but can be manufactured in a highly decorative way, and it is completely free from reaction with the product. It tends to be dominant in the fields of perfume and colognes, and also to a lesser extent in the medical/pharmaceutical markets. Because the perfume industry is highly important in France, the production of glass aerosols there is the greatest in Europe° and the United States (2), (4). In general, the market is small (approximately 10% of aerosols), but tends to be stable and is not especially price sensitive. Table 2.6 shows the major manufacturers of glass containers in Europe (2).

° See Table 2·5

TABLE 2.3 MANUFACTURERS OF TINPLATE CONTAINERS

Country	Company	Order of Importance (ranked by units produced)
Belgium	Kroonkurk (Crown Cork)	
France	Carnaud	4
	CEBAL	
F R Germany	Schmalbach-Lubeca	2
	Niedermeyer	
	Bender	
Italy	Bombini	
	Brebbia	
Netherlands	Thomassen & Drijver-Verblijfa	3
Spain	Envases Carnaud	
UK	Metal Box	1
	CrownCork	
	Huntley Boorne & Stevens	
....		
USA	American Can	1
	Continental Can	2
	Crown Cork	3
	Sherwin Williams	4
	Davies Can	)
	Heckin Can	)
	National Can	) equal 5
	Peerless Tube	)
	Sexton Can	)
	Southern Can	)

TABLE 2.4 MANUFACTURERS OF ALUMINIUM CONTAINERS (2) (56)

Country	Company	Order of Importance (ranked by units produced)
Belgium	Chaudfontaine	
Finland	Printal	2
France	Box-Beaurepaire Cebal	
F R Germany	VDM Lechner Holl	3
Italy	Bombini	
Norway	Metallemballasje	
Spain	Santiago Schlit Blanch Envases de Alava	
Switzerland	Boxal-Fribourg Nussbaum Schweizerische	1
UK	Metal Box Neotechnic Engineering	5
USA	American Can Co Aluminium General Corp Apache Container Corp Walter Frank Organisation JL Clark Manufacturing Co Emson Research Inc Impact Container Corp Lechner Taberfabrik SA Peerless Tube Co Victor Metal Products Corp Virjune Mfg Co Inc White Metal Manufacturing Co	4

TABLE 2.5 PRODUCTION OF GLASS AEROSOL (2) (56)

Country	Total Aerosols Filled x 10^6	Glass Aerosols x 10^6
UK	441	51
W Germany	425	25
France	383	117
Belgium	46	1.1
Finland	22	0.02
Netherlands	147	3.0
USA	2354	135

TABLE 2.6 MANUFACTURERS OF GLASS AEROSOL CONTAINERS

Country	Company	% Market Share
Belgium	Verlica-Momoignies	no information
France	Desjonqueres B S N	60% of market 40% of market
F R Germany	Gerresheimer	no information
Italy	Benecchi Bormioli	80% of market 20% of market
Spain	Industrial de Vidrio	no information
UK	Rockware United Gloass	30% of market 70% of market
USA	Wheaton Glass Company Owens of Illinois	)Approximately)equal split

Plastic containers:- In theory there is no technical difficulty in producing plastic containers which will be suitable for aerosols. Clearly there are advantages such as resistance to physical and chemical attack, ease of applying artwork and until the recent oil crisis, the possibility of price reduction. However, a closer examination indicates that the type of plastic materials needed to produce a satisfactory aerosol are expensive and would tend to replace the glass aerosols for luxury applications, as opposed to tinplate and aluminium. There are several companies who claim to be ready to produce plastic aerosols in materials like "Hostaform C" or "Celcon" resins within nine months of receiving a substantial order. Table 2.7 shows companies who claim to have the technology to do this (2), (5).

Costs of aerosol products vary according to the product complexity and the size of the can. Table 2.8 shows some typical cost data for a range of consumer products (6). This cost data reflects the importance of the cost of the components to the overall cost of the finished unit.

European aerosol can pressures are mostly in the range 30 - 40 p.s.i.g. (1.5 - 2.5 Kg/cm^2) but do go up to 50 p.s.i.g. (3.5 Kg/cm^2) for liquid propellants and up to 100 p.s.i.g. (6 - 7 Kg/cm^2) for compressed gases. Some of the cans in the United States operate at 75 p.s.i.g. (5 Kg/cm^2).Sizes can vary from 25 ml for small perfume and toilet water sprays and up to 1000 ml for large hair spray and insecticide packs. Above these sizes the packs become difficult to handle, although larger "industrial" packs do exist. The most common size in Western Europe is 300 - 400 ml, frequently known as the 10 oz pack.

TABLE 2.7 COMPANIES OFFERING PLASTIC AEROSOL CONTAINERS 1977 (2) (56)

COUNTRY	COMPANY
Austria	None
Belgium	None
Denmark	None
Finland	None
France	Sidel
F R Germany	None
Italy	None
Netherlands	None
Norway	None
Spain	None
Sweden	None
Switzerland	None
UK	Mardon Pelorex Metal Box
USA	Celanese Plastics Pelorex Corporation Wheaton Glass Jomar Industries Continental Can Company Union Carbide

TABLE 2.8 TYPICAL AEROSOL PRODUCT COST BREAKDOWN

Item	Cost per Inventory Unit (12 pks)(pence)	Cost per Unit (pence)	%Total
6 oz cans	58.4	4.9	37.2
Valve to fit can	23.4	2	14.9
Secondary Packaging) i.e. shrinkwrap) labels)	2.7	0.2	1.7
Propellant	14.8	1.2	9.4
Active Product	17.4	1.5	11.1
Labour	6.9	0.6	4.4
Sub Total of Direct Costs	123.6	10.4	78.7
Materials Handling	4.4	0.4	2.7
Fixed Costs	24.1	2	15.3
Allowance for losses e.g. scrap	5.1	0.4	3.3
Total	157.1	13.2	100

(b) Aerosol Valves

Aerosol valves are all based on the same principle of operation and there are seven commonly used designs offered by most of the major manufacturers. The patents on valve design have reached or will soon reach the limit of their effectiveness, and the principle designs are by the following companies:-

* Precision;
* Aerosol Research and Development
* Newman Green;
* Risdon (Bespak);
* Coster;
* Perfect;
* Valois;

A typical aerosol valve is shown in Figure 2.3, which illustrates the constituent parts. However, within the basic design there are many variations. One of the major suppliers of aerosol valves in the UK offers 250 different permutations of valve components alone. Five European countries make valves and Table 2.9 shows the approximate share held by each company in the USA and various European countries (2), (4).

TABLE 2.9 MARKET SHARES OF PRINCIPAL AEROSOL VALVE MANUFACTURERS IN 1977 (2) (56)

	%Market Share In:					
Valve Type	USA	France	F R Germany	Italy	Spain	UK
Precision	35	30	50	35	10	45
Aerosol R & D	-	45	5	35	45	35
Newman Green	10		25		45	10
Risdon	20					5
Coster	)			25		
Valois	)15	20				
Perfect	)	5	10	5		
Others	20		10			5

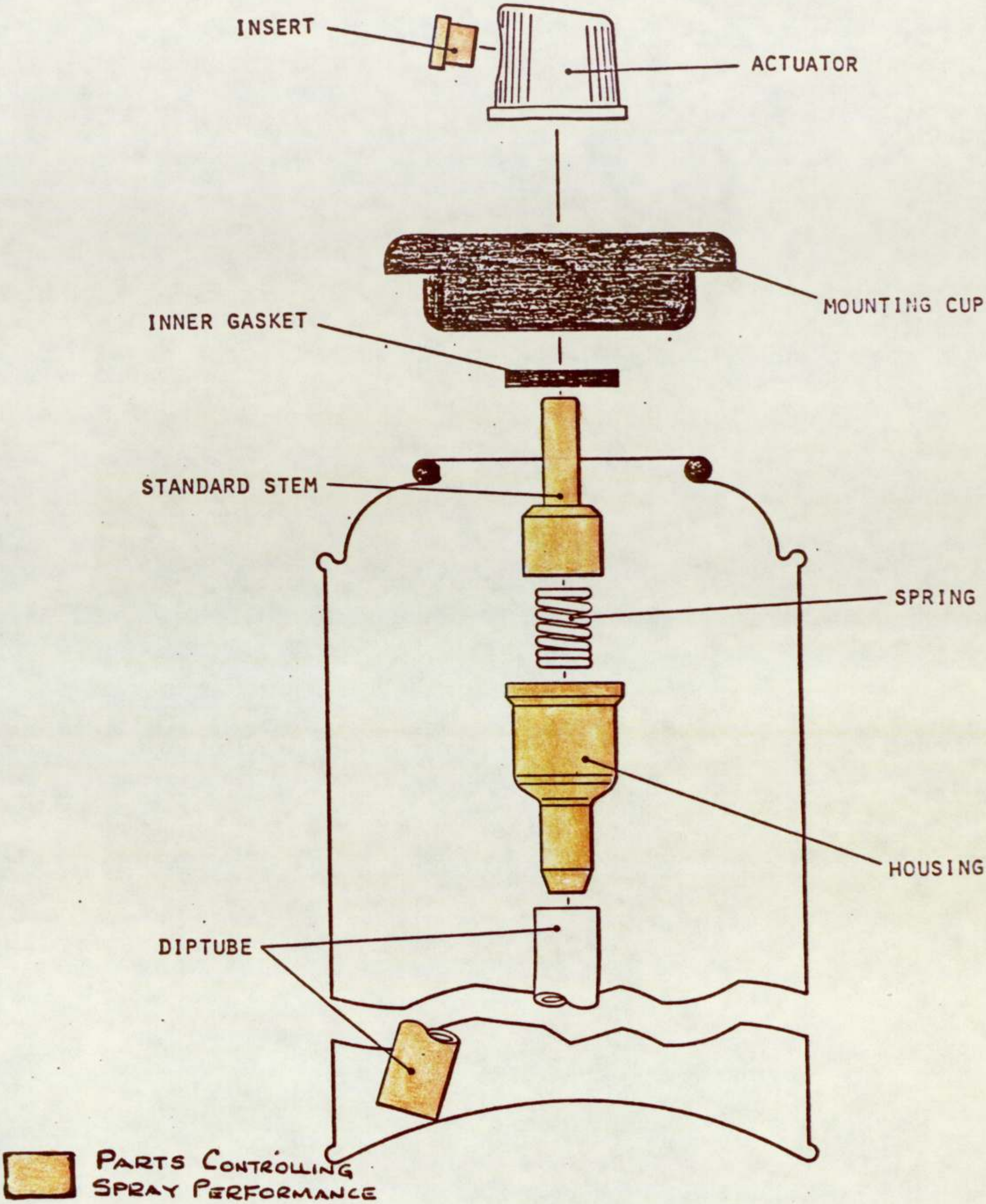


FIGURE 2.3 BASIC PARTS OF TYPICAL VALVE AND CAN

2.1.2.2 Aerosol Propellants

Aerosol propellants fall into two broad categories namely liquifiable gases and compressed gases. In commercial terms there are three liquified gas propellants namely: Chlorofluorocarbons (CFC 11 and 12); Liquified Petroleum Gas (or LPG) and Dimethyl Ether (DME). There are also three compressed gases in use albeit on a much smaller scale. In decending order of use they are Carbon Dioxide (CO_2); Nitrous Oxide (N_2O) and Compressed Air. Compressed Gas/liquefied propellant mixtures are also in evidence.

These propellant systems will now be discussed in more detail individually and a comparison of their properties is presented as Table 2.10 (7). The more recent innovations in aerosol propellant technology are reviewed in Chapter 7 and propellants are further discussed in Chapter 4.

(a) Chlorofluorocarbons (CFC's)

Chlorofluorocarbons are produced by some twenty companies around the world and since the ozone controversy, a good deal is known about production rates and the other uses. In fact, aerosol propellants are still the major end use of CFC's 11 and 12, as is shown in Table 2.11 (8). The record year for production of chlorofluorocarbons was 1974 when 815 x 10^6 lbs of F11 and 976.2 x 10^6 lbs of F12 were produced (8). Aerosols accounted for over 50% of this production. There are eight producers in Western Europe, and of these ICI, Hoechst and Pechiney share about 60% of the market in equal shares (8). Since the onset of the ozone controversy, most CFC producers have sponsored research and taken part in various surveys aimed at establishing the facts behind this controversial issue

TABLE 2.10 COMPARISON OF AEROSOL PROPELLANTS (7)

Comparisons	CFC's 11, 12, 114	New Halocarbons	Hydrocarbons	Dimethyl Ether	Compressed Gases
Current Use	70% of UK aerosols	None in use. Search for alternative to CFC's 11,12,114 continues.	30% of all UK aerosols	Small scale 60 million total since introduction.	Small scale CO_2 de-icers N_2O-foods.
Safety	Inert, stable low toxicity non-flammable	Inert stable toxicity not fully evaluated non-flammable	Relatively inert & stable good record over 20 years flammable e.g. insecticides	Can be reactive toxicity low, highly flammable more work needed.	Low toxicity high pressure needed, non-flammable
Environmental Considerations	Postulate effect on ozone layer	Effect smaller on ozone layer	Part of national organic cycle. Emissions to atmosphere small fraction of total caused by motor cars etc.	Biodegradeable no environmental	No environmental problems.
Handling	As for liquefied gases	As for liquefied gases	As for liquefied gases and using I.P. codes.	Special equipment needed. No established codes.	Special equipment high pressures involved.
Cost	55p/litre	>55p/litre	10p/litre	15p/litre	Comparable to H.C.'s
Availability	Readily available	Not currently available	Readily available	From Holland and Germany only.	Available

TABLE 2.11 WORLD TOTAL F-11 AND F-12 SALES BY CATEGORY FOR YEAR 1977 (8)

	F-11	F-12	Total F-11 & F-12
Sales - thousands of metric tons	315.3	382.8	698.2
% Distribution of sales			
Aerosol Propellant	52.2	45.6	48.6
Refrigeration			
- hermatically sealed	1.6	17.1	10.1
- non hermatically sealed	6.3	23.2	15.6
- total	7.9	40.3	25.7
Blowing Agent			
- closed cell foam	19.0	2.3	9.9
- open cell foam	14.9	3.1	8.4
- total	33.9	5.4	18.3
All Other Uses	6.1	8.7	7.5
	100.0	100.0	100.0

In the USA there are five producers (Dupont being the largest) and the market is divided as follows (9):- Aerosols (34%); Refrigerants (40%); Other markets (26%).

Irrespective of the ozone controversy, CFC's are ideal in terms of an aerosol propellant and Table 2.10 compares the major aerosol propellants from the standpoint of toxicity, cost and general usefulness.

(b) Hydrocarbons

Hydrocarbons (i.e. Propane and Butane blends) are obtained from refinery off-gases and Table 2.10 (7) shows, even when refined and sweetened (to re move malodours), are probably the cheapest aerosol propellant available. They have been used in this role for over twenty years although to a larger extent in the USA than Western Europe. During the period 1979 to 1980, CFC's still predominated in terms of tonnage in Western Eruope but it has been predicted that hydrocarbons will gain wider acceptance in the future (2). The subject is discussed more fully in Chapters 4 and 7.

Table 2.12 gives the suppliers and consumption of propellant hydrocarbons in Europe and the USA (2), (9). The market tends to be shared between the petroleum companies and the companies established in the industrial gases market.

(c) Dimethyl Ether

Dimethyl Ether is a material used on a small scale, mainly in Holland. In total, 60 million aerosols have been filled in Europe over several years (7), and its suitability as an aerosol propellant is said to be enhanced by the fact that it is miscible with water. The material is toxicologically satisfactory and is considered to be biologically more readily degradable than many other propellants, and should therefore pose no environmental problems. However, Dimethyl Ether (DME) is a very flammable liquified gas and is considered by some authorities to be more hazardous than conventional LPG hydrogen propellants (7), (8), (9).

TABLE 2.12 (2)(56) SUPPLIERS OF HYDROCARBON PROPELLANTS

Country	Companies	Aerosols Gross Tonnage (T/Yr)
Austria	O.M.V.	250
Belgium	Belgium Shell Petro Gaz Solvay et Cie	1,500
Finland	Shell	150
France	Air Liquid S.N.P.A. S.E.P.I.C. Solvay	12,000
West Germany	Deutsche Shell Linde Montan-Chemsa Gloria	13,000
Italy	Settala Pergine	6,000
Netherlands	Esso Shell Benegas	4,000
Norway		200
Spain	Emperol	3,000
Sweden	Malmston & Bergwall	250
Switzerland	Pluss-Staufer Surgo	2,500
UK	Calor-Gas Botto-gas Phillips Petroleum	19,500
USA	Phillips Petroleum Standard Oil Others	90,400

The industry has thus not yet worked out specific recommendations for this material, and coupled with the fact that DME is more expensive than LPG, its future is open to doubt.

(d) Carbon Dioxide (CO_2)

This is a compressed gas propellant and is not widely used in Europe or the USA. It's main use is in the production of windscreen de-icers although it has also been used for insecticides and hair sprays. There are no special suppliers of carbon dioxide for aerosols and companies wishing to use it, buy it from the main suppliers of industrial gases. With the onset of the ozone controversy many suppliers of aerosol production machinery conducted experimental studies and were able to modify their equipment for the injection of compressed gas propellants such as carbon di-oxide and nitrous oxide (10) (11). Thus CO_2 can usually be utilised without major plant modifications.

(e) Nitrous Oxide (N_2O)

Practically the only use of nitrous oxide in aerosols is for speciality foods such as creams and sauces (7). The main countries using this technology are USA, France, the Netherlands and Italy and their total production is less than 1,000 tons per year in Europe and in the USA (2). Again there is no special grade available but the gas is bought from the major suppliers of industrial gases.

(f) Compressed Air

As will be explained in Chapter 7, compressed gases tend to involve working at high can pressures unless appreciable gas solubility in the active product is possible. Few products have an affinity for compressed air and the alternative of lower pressure yields poor spray performance (8).

2.1.2.3 <u>Aerosol Manufacturing Equipment</u>

Despite the market penetration of aerosols throughout the world, it is surprising that there are only about half a dozen companies making aerosol filling equipment. Major manufacturers are : Kartridge Pak of the USA; Aerofill of the UK; Pamasol of Germany and Coster of Italy. Other companies such as the Pacific Machine Company make ancillary equipment used on aerosol lines, but as virtually all of these companies supply their products for general filling purposes, it is difficult to establish just how much of their time and effort is spent entirely on aerosols.

2.1.2.4 <u>Aerosol Filling</u>

For the years up to 1980, the bulk of the aerosol industry has been located in Western Europe and the USA and consequently compiled information is more readily available for these areas. In endeavouring to describe the industry it is this information which has been used although the rest of the world situation has been researched in Chapter 3. The industry make up will now be discussed.

(a) Own Product

Most of the documented information has been compiled by the various Aerosol Trade Associations and to a lesser extent by the trade press (12), (13). The most detailed sources relate to Europe and the USA via the statistical records held by the Federation of European Aerosols (14); the British Aerosol Manufacturer's Association (15); and the Chemical Speciality Manufacturers Association of the United States (16). In summary, it may be said that there are some fifty manufacturers in Europe formulating and manufacturing their own products and eighty in the United States.

(b) Contract Fillers

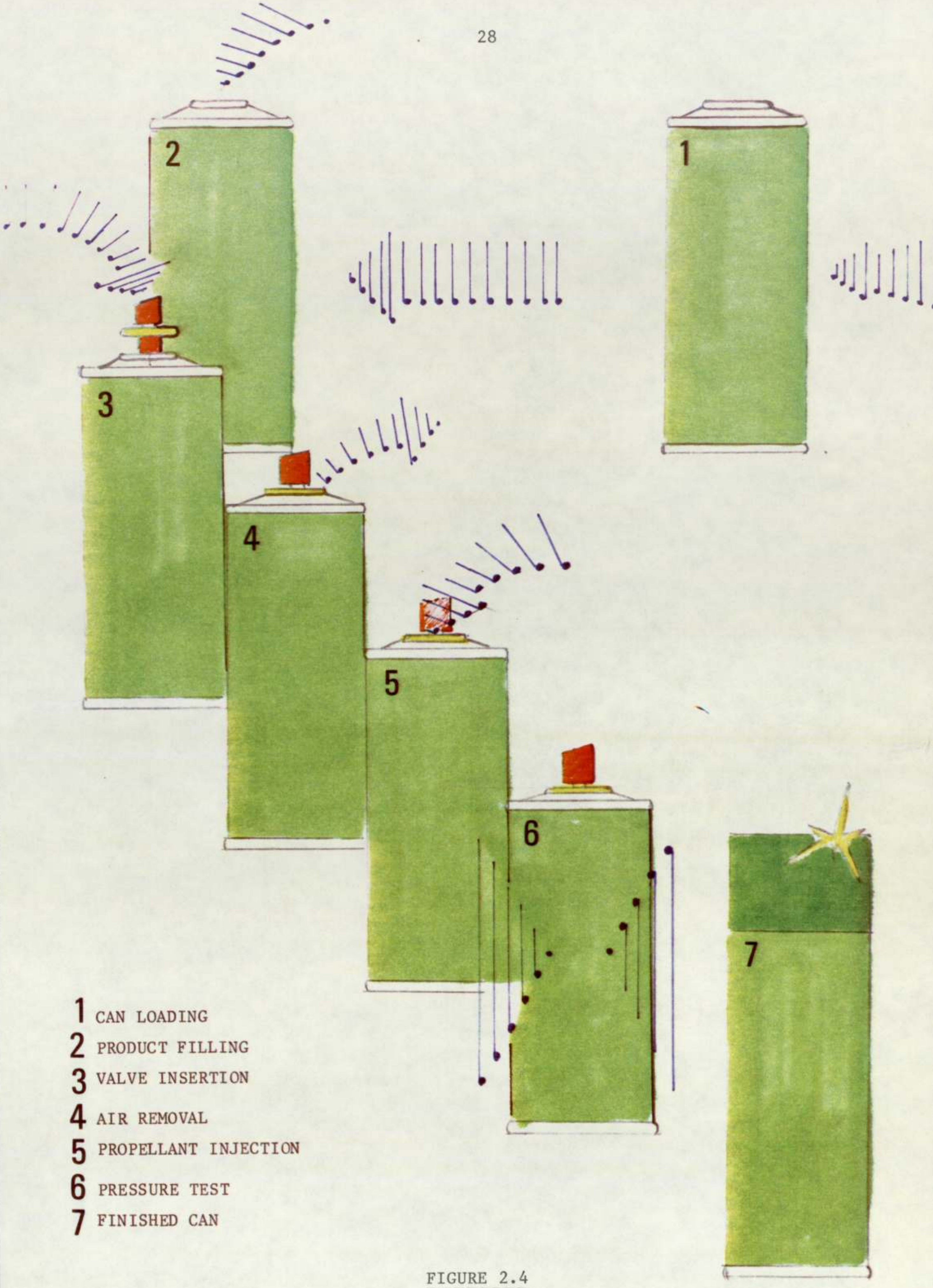
This is the branch of the aerosol industry which specialises in the contract filling of aerosols. Products are either formulated and manufactured by the marketing company and passed to the contractor for filling or the contractor may formulate and fill on behalf of the marketing company. In Europe there are some thirty contract fillers and in the United States the figure is as high as one hundred and twenty. Information is more scanty regarding other world countries.

(c) The Filling Processes

Filling of the actual product is similar to conventional filling processes used for other liquids such as foodstuffs, paints, drinks beverages and household products. The main difference between the aerosol package and other forms of packaging is that the aerosol is pressurised. This is achieved by introducing into a sealed can, a propellant which due to its vapour pressure, or because it is compressed gas, raises the internals of the aerosol can to pressures above atmospheric. There are two variations on the method of introducing the propellant - cold filling and pressure filling.

Cold filling is the process where the active product is first filled into the empty aerosol container and then cooled/refrigerated and liquefied propellant is added. The valve assembly is then crimped on to the aerosol container and the pack is tested for leaks prior to applying secondary packaging. This production method tends to be carried out on a smaller scale, usually for perfumes or colognes where a relatively low degree of atomisation is required from the spray head. This in turn makes possible the use of propellants such as chlorinated hydrocarbons involving relatively low pressures. It does however, represent a greater fire hazard in that many of the active products used, contain flammable materials such as alcohol, and propellant losses tend to be excessive, requiring adequate extraction facilities.

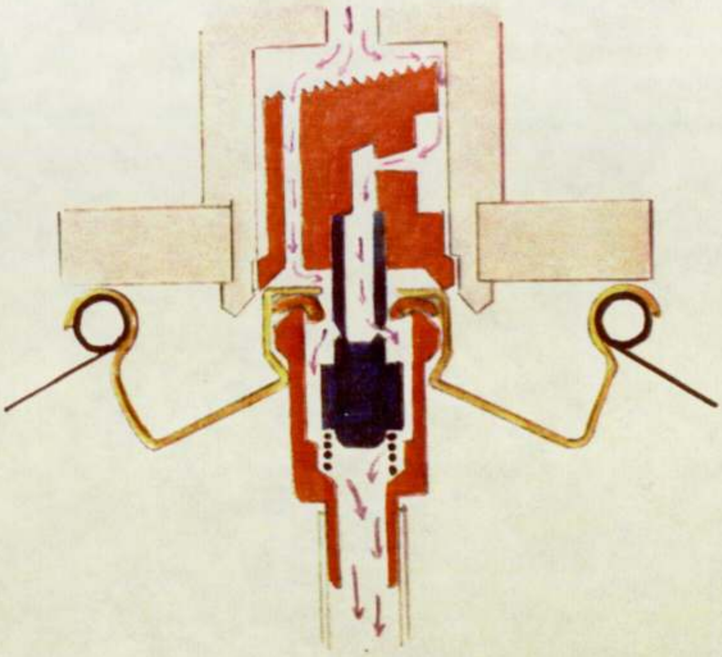
The injection of propellants under pressure is more common in the aerosol industry and a typical process for doing this is shown schematically in Figure 2.4. Basically, the process consists of loading the cans onto the aerosol filling line, filling the active product followed by an insertion of the valve into the can orifice. From this point two further sub-divisions of the filling process are possible. The most common process of propellant injection in Europe and possibly also in the United States is that of pressure filling. During this technique the valve is first inserted into the neck of the can and a vacuum is pulled via a special head which clamps over the neck of the can, and having evacuated the air from the internals, crimps the valve onto the neck thereby effecting a seal. The can then passes to a second head where liquefied propellant under a pressure of several hundred pounds per square inch is forced through the spray actuator and down the valve stem into the can internals. (See Figure 2.5). The sealed and pressurised unit is then pressure tested via the passage and immersion though a water bath set at a temperature of 60°C. This raises the can internal pressure to



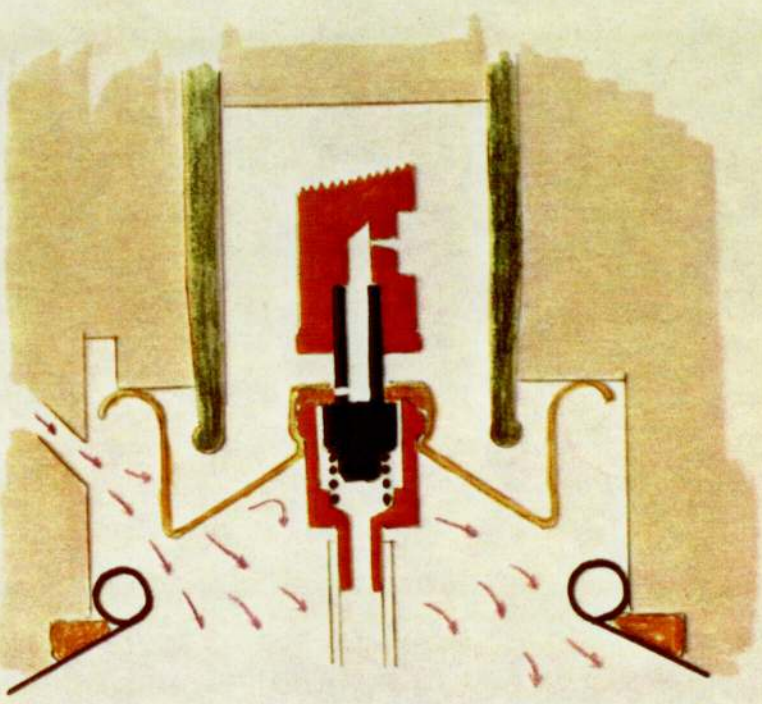
1 CAN LOADING
2 PRODUCT FILLING
3 VALVE INSERTION
4 AIR REMOVAL
5 PROPELLANT INJECTION
6 PRESSURE TEST
7 FINISHED CAN

FIGURE 2.4

GENERALISED AEROSOL FILLING PROCESS



THROUGH BUTTON FILLING



UNDER CUP FILLING

FIGURE 2.5 PROPELLANT INJECTION UNDER PRESSURE approximately two and a half times the anticipated working pressure in use. Leakers are removed from the bath and destroyed, the remainder passing to a secondary packaging and distribution.

A less common process of propellant injection but one which is able to produce cans at a more rapid rate (for a given capital expenditure on equipment) is the so called 'under cup' filling process. This process is identical to the one described above under pressure filling, and illustrated in Figure 2.5 with the exception of the fact that after valve insertion, a single filling head first removes air from the can internals, then injects the liquefied propellant at even higher pressures under the valve cup, prior to crimping it into position and sealing the can. The machine capable of performing the above operation was developed by the American 'Kartridge Pak Company' who are the main, if not the only, suppliers.

2.1.2.5 Marketing and Distribution

The marketing and distribution of aerosols bears a close resemblance to the marketing and distribution of many non-aerosol products. However, during more recent years, marketers have had to give special attention to the criticism directed at aerosols by media and the various forms of legislation and codes of practice aimed at controlling packaging and labelling. As will be discussed in Chapter 4, the change from non-flammable chlorofluorocarbon propellants to flammable hydrocarbon propellants can bring special problems which are specific to aerosol products.

Section 2.2 will describe the main areas of product use and the major product categories which summarise as Hair sprays; other Personal Care products; Insecticides; Household products and a category which includes all the others called 'Miscellaneous'. Hair sprays are mostly marketed by the major multi-national companies specialising in household and personal care products. Most of their production is centred in their own factories,although the more specialised items are contract filled. Marketing strategies used are similar to those used for comparable non-aerosol products, namely the formulation of a product with an added benefit over the competition, derivation of a satisfactory market share by the use of advertising and by special offers and price reductions (dealing).

A similar picture exists for Personal Care aerosols (i.e. anti-perspirants and deodorants) and for Household aerosols. Insecticides tend to be a specialist category with very few companies manufacturing or marketing. The main companies trading in insecticides are those with good Research and Development facilities such as ICI; Murphys; Coopers and specialist divisions of the oil companies such as Shell and BP. Insecticides tend to constitute seasonal business in most countries, the major retail sales period being during summer time when the insect nuisance is at a peak. Marketing strategies are primarily based upon safety with efficacy with the other attributes such as value for money, attractive packaging and fragrance taking a lower priority.

The final category of Miscellaneous aerosol products is so diverse that it is difficult to draw any general conclusions with regard to marketing strategy. Many of the products falling into this classification are made by relatively small companies such as contract fillers under their own label, or specialist companies running a small scale operation such as filling aerosol de-icing sprays on a seasonal basis.

At the present time there are no special arrangements for the distribution of aerosols. Most are retailed through the large grocery markets and to a lesser extent through DIY; Hardware and Garden Stores. Most fillers use contract freight haulage rather than their own vehicles for distribution. At the time of writing, (1983), there are no special requirements for transporting aerosols by road although there are special requirements for storing products which come under the control of the Petroleum Act (17), (18), ((19), (20). These are detailed in Chapter 4.

2.2 THE PRODUCT USES AND THE MAJOR PRODUCT CATEGORIES

2.2.1 Introduction

World consumption of aerosols is currently of the order of six thousand million units per annum ranging over approximately twenty different product types. A typical classification is that used by the British Aerosol Manufacturers Association (15) when they report the UK aerosol fillings on an annual basis. Their latest report is shown in Table 2.13. As can be seen by reference to Table 2.13, most of the products listed are available in alternative forms of packaging such as plastic bottles, metal tins and various pump and trigger dispensing packages. Later, in Chapter 8 comparisons will be made between the aerosol package and alternatives but the purpose of this particular section is to identify and list the various aerosol product categories in preparation for later trend and forecast studies.

2.2.2 Aerosol Uses - General

As stated in Chapter 1, aerosol products have achieved popularity where a clear end benefit was perceived from a product available in the form of an atomised finely divided spray. However, as consumers became more familiar with the aerosol package and manufacturers more expert at marketing, other product attributes became known. These have been described by the British Aerosol Manufacturers Association (21) and by one of the major suppliers of aerosol components namely the Metal Box Company (12) and are listed below:-

Convenience -

This attribute concerns the ease of application associated with a controlled spray and the absence of the need to premix or apply with a cloth.

Safety -

An aspect which is mostly emphasised in respect of freedom from the danger of accidental spillage or the possibility of children drinking the contents. More recent concerns over flammability and inhalation are discussed in Chapter 4.

No Waste -

Freedom from waste is a further controversial attribute of the aerosol which has been defended on the basis that it delivers a measured amount of product to the substrate controlled by finger pressure on the valve. After dispensing the required amount, the container automatically reseals and in this state is able to be stored for long periods without detriment.

TABLE 2.13 B.A.M.A. AEROSOL STATISTICS - 1982

CATEGORY	Total 1978	Total 1979	Reported 1980	Adj +	Total 1980	Reported 1981	Adj	Total 1981	Reported 1982	Adj 1982	Total 1982
Insect Sprays	85.0	60.5	43.9	18.1	62.0	51.7	11.3	63.0	67.0	1.0	68.0
Paints & Lacquers	28.0	28.5	21.8	2.2	24.0	14.8	0.2	15.0	12.2	5.3	17.5
Air Fresheners	35.0	30.0	35.3	1.7	37.0	16.6	7.4	24.0	36.8	0.2	37.0
Waxes/Polishes	44.0	43.5	41.2	1.3	42.5	46.1	2.4	48.5	47.1	0.9	48.0
Oven Cleaners	6.0	5.0	3.6	0.4	4.0	2.1	0.9	3.0	3.0	0.5	3.5
Starches	8.5	13.0	6.8	1.2	8.0	6.3	2.2	8.5	10.2	0.3	10.5
Shoe/Leather)			5.0						1.2		
Glass Cleaners)	9.0	10.0	3.6	0.2	12.0	9.0	1.5	10.5	5.3	0.5	13.0
Other Household)			3.2						6.0		
Hairspray/Dressings	127.0	103.5	90.1	7.9	98.0	98.2	5.8	104.0	86.2	10.8	97.0
Colognes & Perfumes	70.0	64.5	25.0	26.0	51.0	18.0	20.0	38.0	18.4	22.6	41.0
Deodorants/ Anti-Perspirants	49.0	52.5	57.2	3.3	60.5	68.0	4.5	72.5	70.1	8.9	79.0
Shaving Lather	17.5	18.5	12.4	1.6	14.0	17.9	0.6	18.5	13.7	0.3	14.0
Other Personal	2.5	8.0	3.4	0.1	0.5	4.3	0.2	4.5	4.1	0.4	4.5
Medicinal/ Pharmaceutical	44.0	34.0	38.2	0.8	39.0	10.8	35.7	46.5	52.3	0.2	52.5
Automotive	20.0	31.5	23.2	0.8	24.0	15.0	1.5	16.5	20.5	3.5	24.0
Industrial	11.5	13.0	10.3	1.7	12.0	8.8	1.7	10.5	7.4	4.6	12.0
Snow)			0.7						0.7		
Veterinary)	6.5	6.0	1.9	1.2	6.5	5.3	0.7	6.0	2.3	0.8	6.5
Miscellaneous)			2.7						2.7		
	563.5	522.0	429.5	68.5	493.0	392.9	96.6	489.5	467.2	60.8	528.0

These attributes have been recognised by many manufacturers of household, pharmaceutical and vetinary products which is mostly why the range of aerosols is wide as it is today (15). As stated earlier, there are approximately twenty aerosol product categories (Table 2.13) and although their relative importance can vary from country to country, many of them are universally quite small. On the other hand, there are also product categories which contain aerosols that are consumed in relatively large quantities, for example personal care products. The specific end use of aerosols and the classification into categories will now be discussed.

2.2.3 Specific Product Uses in the UK

Hair sprays have been widely used since 1958 and now have approximately 99% of the market for this product category. In general they are used by women in the age group 15 - 50 years but more particularly 24 - 45 years. (22), (23), (24). However, there is also a market for mens hair spray and the product is used by people with longer, more difficult to manage hair. Hair sprays provide the prime attribute of holding the hair in place, and preventing it becoming untidy and blown about by the wind and draughts. This is achieved by the addition of a synthetic resin to a solvent or aqueous base which is applied in the form of a finely divided spray. After evaporation of solvent the resin then coates the hair fibres hence providing the fixative effect. Because the continued use of this type of product can damage or dry out the hair fibres, there are variations in the types of resin selected, such that some hair sprays can be brushed out or washed out more easily. There are also differences in the firmness of hold provided per application. The aerosol is particularly well adapted to this end use because of the readiness with which a finely divided spray can be produced from a convenient and easy to use form of packaging. The alternative pump or trigger sprays have so far failed to gain acceptance.

Other Personal Care products comprise two major sectors, namely anti-perspirants and deodorant sprays then perfumes and colognes. In addition, there is a small category which covers shaving foam, spray on talc and other fairly minor products. Anti-perspirants and deodorant sprays achieved peak popularity about 1975 being of low cost, easy to use and effective in controlling perspiration, wetness and odour. They currently have 58% of the market for this category (26) but are being rapidly caught up by alternative forms of packaging such as pump sprays and anti-perspirant/deodorant sticks. This is thought to be partly because of environmental and health considerations and because some of the stick type packages can be easily placed in the handbag. They are used by males and females mostly in the age group 13 - 45 years (26). The advantage of the aerosol spray in this product category is that it provides a rapid to use, dry (but cold) application to perspiration/odour areas without stickiness or discomfort. Disadvantages are that in applying such a spray, many small powder particles are produced in the breathing zone which can cause sneezing or irritation of the mucous membranes. These inhalation aspects are covered in more detail in Chapter 4.

Aerosol colognes and perfumes are widely used by women in the age group 15 - 40 years (26) being currently preferred over the fragrances in liquid form, primarily due to their price. The aerosol has provided a convenient vehicle for many of the major fragrance houses to market some of their high priced products in a way that most women can afford. Aerosols have currently got 45% of the fragrance market but the category is growing and may outstrip conventional forms of packaging (26). It is applicable to most forms of perfume but not all.

Shave foam is a convenience product obviating the need for a brush and a stick of shaving soap. Most products are formulated to provide two main attributes namely: Lubricity (or lubrication of the skin during shave preventing skin chaffing) and Astringency (which tends to stop bleeding from minor cuts and skin irritation). Alternative forms of packaging in addition to the shaving soap stick are tubes of shave foam. Aerosols currently have 60% of the UK market (27) and while there is little growth at the present time, several newer forms of packaging are being looked at which still give a pressure packed product with greater attributes of lubricity and astringency. These are discussed more fully in Chapter 7. In summary the aerosol version is easy to use and store and makes less mess than the shaving stick or the tube. Prime users are males in the age group 15 - 55 years (27).

Pharmaceutical and vetinary products are a growing category for aerosols although this has taken some time to develop. This is reported to be because the pharmaceutical and vetinary houses had initially little or no expertise in aerosol manufacture and have been late to learn the advantages of such a system (22). It is particularly useful for many of the pharmaceutical and vetinary products that need to be administered via the respiratory tract or sprayed on a skin surface. In addition to producing a finely divided spray the aerosol, offers a sterile and free from infection environment through which these products may be stored for long periods without detriment.

Waxes and polishes are a traditional use for aerosols and they currently have 65% of the UK market (28), (29). They are used by most households who prefer them over the polishes and gloss making products packed in solid or liquid form, due to ease with which they may be used, freedom from waste and the fact that they can be stored for long periods without spoilage. The market has shown little growth in recent years probably due to the changing nature of household furniture and fittings. That is to say much of the furniture being produced needs little maintenance and is often factory treated to yield a built in gloss which can be restored by simple water wash/wipe methods.

Aerosol air fresheners are again used by most households and currently have 35% of the air fresheners market (30). They are competing with other types such as perfume gels, impregnated papers and plastics, and even air fresheners which work by applying a fragrance powder to the carpet or room curtains. They are generally preferred in the situation where strong odours are to be dealt with because of their rapid and intensive action.

Aerosol paints and lacquers are still relatively small versus the total paint market. At the current time they have only 8% of the total market (22), and much of this is related to the auto maintenance industry. They are primarily used by males on car maintenance although a small percentage of this product segment is used as an artistic material (23). In the auto maintenance industry, they compete directly with traditional brush on lacquers and generally speaking compare unfavourably with emulsion oil based paints on a cost effectiveness basis. Concern exists about the safety and toxicological aspect of such products and this is likely to affect this sector of the aerosol industry in the near future (31).

Industrial and automotive products again account for a fairly small part of the aerosol industry. Mostly convenience products such as lubrication sprays, moisture removing sprays, windscreen de-icers and a range of aerosol car polishes for chrome and main bodywork. They are not widely used by industry but are quite popular with the do-it-yourself motorist trade offering as a main benefit the ease of application particularly for the car under sides or parts of the automobile which are difficult to access. Aerosols in general have only 20% of the Auto Care market. This share is declining at the present time (32), (33).

The household cleaners market is also fairly small being concerned with glass cleaners, ceramic and hard surface cleaners and oven cleaners. They tend to be used by most households but only have 28% of the total household cleaners market, mostly due to their relatively higher price and the speed with which such products are used up and need replacement. Clear benefits versus the competitive product in liquid form are difficult to demonstrate.

2.2.4 Selection of Product Categories

As already stated there are approximately twenty identifiable product categories and although the particular groupings used by the various compilers of aerosols statistics such as B.A.M.A. may vary, data on the number of units filled in each category is available on an international basis. Such data will be examined later in Chapters 3 and 6, and while it is preferable to have such information on the individual groups for the assessment of trends and future development, it was decided not to continue with this many categories for the following reasons:-

As shown in Tables 2.13, 2.14 and 2.15

(a) Many of the product categories in the list of twenty are quite small in volume and sterling terms. They were therefore judged to be unlikely to have a major affect on the industry on an individual basis.

(b) It was realised at an early stage that considerable data would be needed in order to make reliable forecasts particularly if these were made on a causal basis. It was also established that much of this data was already published using a consolidated classification of product categories making simplification of the list of twenty highly preferable.

TABLE 2.14 ESTIMATED VALUE OF THE MAJOR AEROSOL MARKETS 1977 (23)

(UK DATA)

Product	Value of Total Market £ $\times 10^6$	Aerosol Share %	Value of Aerosol Share £ $\times 10^6$
Hair sprays	50	99	49.5
Antiperspirants/ Deodorants	35	62	22
Colognes and Perfumes	80	32	25
Insecticides	11	55	6
Waxes and polishes	16	88	14
Air Fresheners	8	59	5
Paints and lacquers	150		10
Industrial	30	14	4
Shave foam	8	37	3
Oven cleaners	3	33	1
Snow/Vetinary products/ Miscellaneous	2	75	1.5

TABLE 2.15 CATEGORISATION OF AEROSOL PRODUCTS

1978 Consumption Per/Capita/	20 Category Grouping	1978 x 10^6 Units	10 Category Grouping	1978 x 10^6 Units	5 Category Grouping	1978 x 10^6 Units
1.52	Insecticides	85.0	Insecticides	85.0	Insecticides	85.0
0.50	Paints & Lacquers	28.0	Paints & Lacquers	28.0	incl.in Miscellaneous	
0.63	Air Fresheners	35.0	Air Fresheners	35.0	)	
0.77	Waxes & Polishes	44.0	Waxes & Polishes	44.0	)Household Products	102.5
0.11	Oven Cleaners	6.0	)		)	
0.15	Starches & Fabric Finishes	8.5	)Household Products	23.5		
	Shoe & Leather Dressings		)(Cleaners)			
0.16	Glass Cleaners	9.0	)			
	Other Household Products		)			
2.27	Hair sprays	127.0	Hairsprays	127.0	Hair sprays	127.0
1.25	Colognes & Perfumes	70.0	Colognes & Perfumes	70.0	)Other Personal	
	Deodorants &		Deodorants & Anti-)		)Care Products	139.0
0.88	Antiperspirants	49.0	perspirants & Other)	69.0	)(All)	
			Personal Care)			
0.31	Shaving Lather	17.5				
0.05	Other Personal Care products	2.5				
0.79	Pharmaceuticals	44.0				
0.36	Automotive Products	20.0	)Industrial &	31.5	)Miscellaneous	110.0
0.21	Industrial	11.5	)Automotive		)incl.Paints,shave	
	(Snow				)foam,Pharmaceuticals	
0.12	(Vetinary Products	6.5	Vet & Pharmaceutical	50.5	)Industrial	
	(Miscellaneous					
10.09	TOTAL	563.5		563.5		563.5

(c) Consumption per capita for many of the product categories in the list of twenty is very small. This has probably discouraged other researchers from collecting and publishing data relative to these product groups. An alternative classification would be to list those product categories for which sufficient units were filled to yield a consumption/capita/year of at least 0.5. Such a classification would comprise ten categories as follows:- (Using UK data).

1)	Hairsprays	- 127 million units
2)	Insecticides	- 85 million units
3)	Colognes and Perfumes	- 70 million units
4)	Pharmaceutical and Vetinary Products	- 50million units
5)	Deodorant and Anti-Perspirant Sprays	- 49 million units
6)	Waxes and Polishes	- 44 million units
7)	Air Fresheners	- 35 million units
8)	Industrial and Auto Products	- 32 million units
9)	Paints and Lacquers	- 28 million units
10)	Household Cleaners	- 22.5 million units

The above classification gives a more identifiable split in terms of the products themselves but as stated earlier, does make the exercise of interpreting and using the data that is already available more difficult.

It was therefore decided that some form of arbitary reclassification would be necessary and a survey of the literature (15), (16), (34), indicated that a re-grouping based on five major product categories seemed to be the one most widely used by the technical press and the industry alike. This classification is illustrated below using UK data and then discussed.

Personal Care Products	- 139 million units
Hair Sprays	- 127 million units
Miscellaneous Products	- 110 million units
Household Products	- 102.5 million units
Insecticides	- 85 million units.

Personal Care Products mostly include personal deodorants and anti-perspirants as well as aerosol colognes and perfumes and shaving foam. The category excludes hair sprays which are so large in relative terms for most countries that they justify their own category.

The Hair Spray category includes one single product although within the cateory there are variations of the type of resins used, the degree of hold afforded by the product and the types of propellant and solvents systems used. In fact the aerosol hair spray product is internationally recognised as being the 'aerosols' most successful end use. Its degree of success may be measured by the fact that 99% of this market is supplied by aerosols.

The Miscellaneous Category is made up of a number of small and medium sized products. It comprises medicinals and pharmaceuticals, paints and lacquers, vetinary products and industrial and automotive products.

The next category has been called Household Products. This comprises air fresheners, waxes and polishes, oven cleaners, starches other smaller products such as cleaners and shoe and leather dressings.

The final category includes Insecticide Products, that is sprays for flying and crawling insects and other specialist house and garden sprays for plant pests.

2.3 TECHNICAL DEVELOPMENTS

The development of the aerosol industry ranges over a period of approximately 120 years although the greater part of the developments have occured during the last fifty years. In order to provide a comprehensive review of these developments, they have been detailed in chronological order in Table 2.16 and illustrated in Plates 2.1 through 2.3. The key references will now be discussed.

Although the present aerosol industry is considered to have received its stimulus from the development of insecticide aerosols in the United States during World War II, considerable information was already known about aerosols and aerosol systems long before this period. The patents issued date back to 1862 and during the period 1862 to 1940, inventions were documented proving that various workers recognised and developed many of the fundamental aspects of aerosols such as the advantages of liquified gas propellant over compressed gases; the use of three phase systems for discharging aqueous products and the value of an expansion chamber in the valve in promoting more finely divided spray patterns. The oldest patent on record is credited to Lynde (35), and concerns a valve with a diptube for discharging an aerated liquid from a bottle. After this initial invention, little happened until 1899 when Helbing and Perch (36) found a method of producing a jet or spray by solubilising the material of interest (listed as gums and resins) in methyl or ethyl chloride. Their invention utilised the heat of the hand to vapourise the chlorinated solvent until sufficient pressure would be generated within the container to eject the product. The invention was intended for medicinal purposes in order to apply a thin uniform coating of the product onto the skin.

The first person to study the parameters controlling the particle size distribution in aerosol spray was Gebauer in 1901. During that year he obtained a patent on an improved system for containing and discharging volatile liquids. This system consisted of a valve on a container. Attached to the valve was a capillary tube and then an expansion chamber ending in a nozzle which opened into the atmosphere. The diameter of the capillary tube was smaller than that of the outer nozzle and Gebauer determined that it was the partial vapourisation of the liquid in the expansion chamber that promoted a finer spray. Gebauer improved his design in 1902 (37) during which the capillary tube leading to the expansion chamber was eliminated and the valve between the expansion chamber and the main body of the receptacle was used as the inlet orifice. According to his studies, when the valve was barely opened, the diameter of the valve orifice was smaller than that of the orifice of the outer nozzle. Under these conditions the liquid discharged as a spray. The valve openings where the valve orifice was larger in diameter than that of the outer nozzle, the product discharged as a jet. Thus the discharge characteristics of the products were controlled by the ratios of the orifice diameters of the inner and outer orifices.

Up to this time the propellant for the early aerosols had been a volatile liquid and compressed gas propellants were described in 1903 by Moore (38). He obtained a patent on an atomiser for perfumes utilising carbon

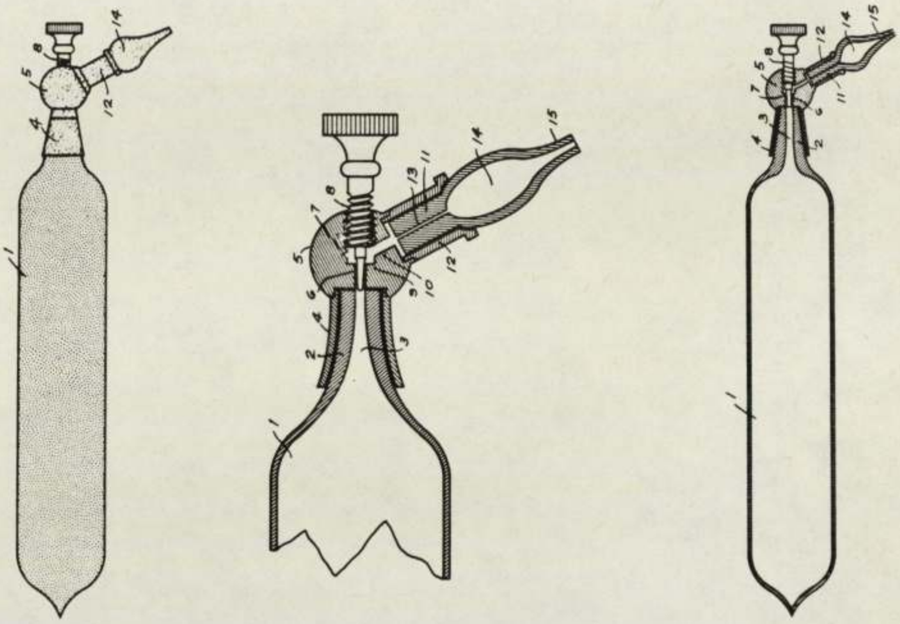


PLATE 2.1 EARLY AEROSOL DEVELOPMENT BY GEBAUER

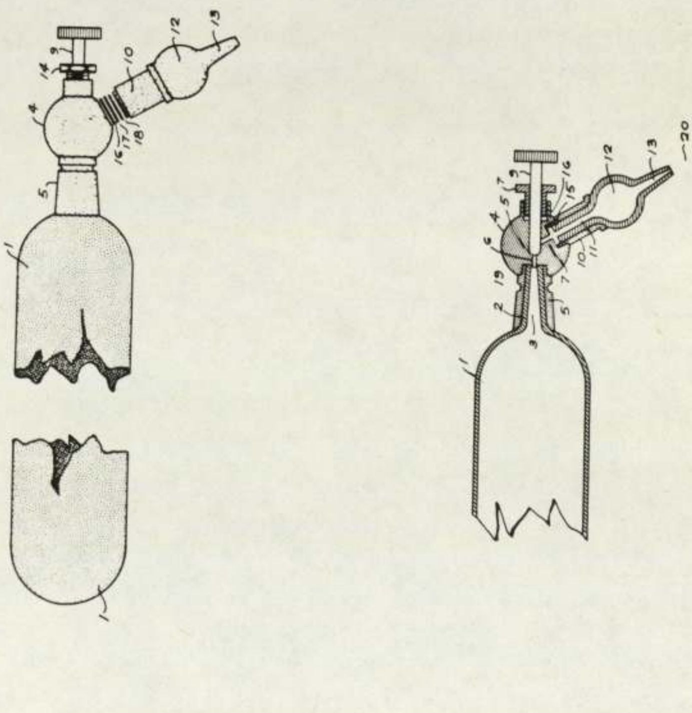


PLATE 2.2 FURTHER AEROSOL DEVELOPMENT BY GEBAUER

dioxide as the propellant. In the atomiser the carbon dioxide was said to have two functions namely: (i) that the pressure of the gas forced the solution of perfume up the diptube and through the nozzle and (ii) in controlling the particle size of the spray emission by a vapour phase tap arrangement. This is in fact the first description of the use of gas or vapour injection into the atomised spray in order to effect a finer particle size.

Further studies with carbon dioxide as a propellant were affected by Mobley (39) in 1921. He obtained a patent on a method for dispensing liquid antisceptics by means of carbon dioxide propellant utilising an apparatus which contained the equivalent of four orifices. In this device, carbonated antisceptic liquid passed through a metering orifice into a chamber equipped with two small orifices. These two orifices imparted a spirally rotating motion to the jet stream before it was finally discharged to the outer orifice. A further use of carbon dioxide propellant for atomising perfumes was described and patented by Lemoine (40) in 1926.

However it was in 1931 that the majority of developments occured relating to the aerosol as known today. These were achieved by Rotheim (41) who is generally accredited as being the inventor of the aerosol package. In 1931 Rotheim patented a method for spraying coating compositions which involved dissolving materials such as lacquers; soaps; resins; and cosmetic products in liquid dimethyl ether in a closed container and discharging the solution through a valve. He observed that the spray characteristic of the product could be varied from coarse to fine by changing the percentage of the ether propellant in the formulation.

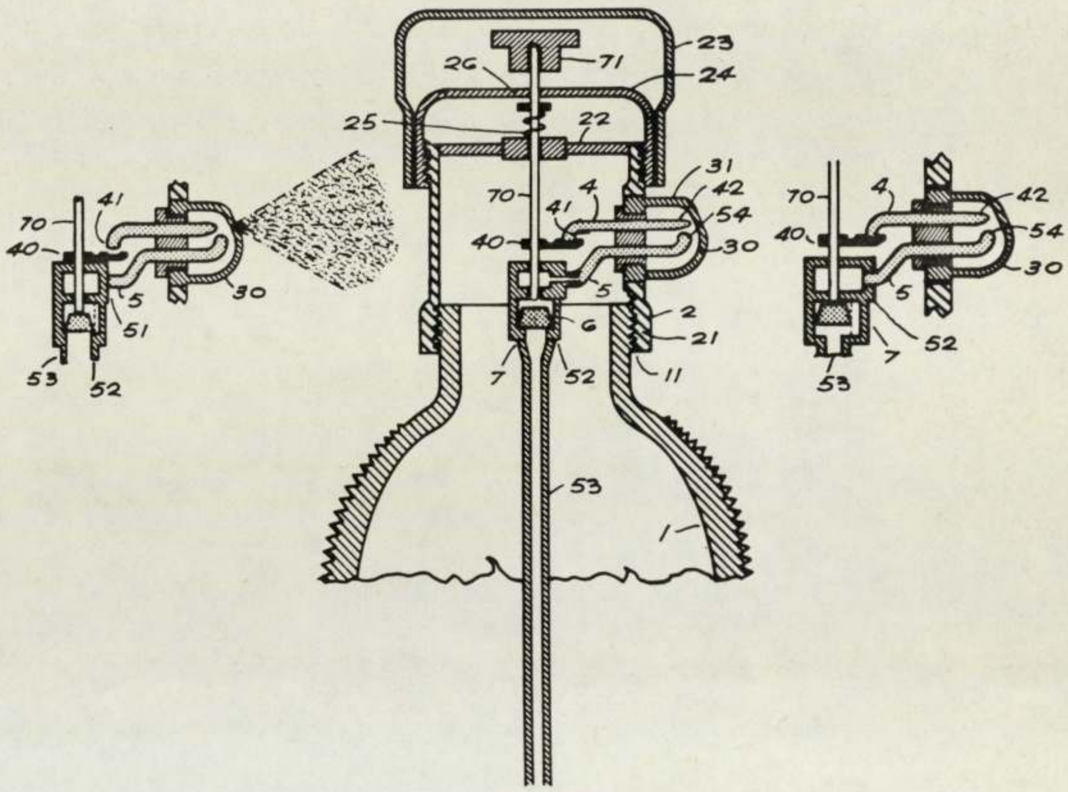


PLATE 2.3 EARLY AEROSOL DEVELOPMENT BY MOORE

He also noticed that the volume of gas resulting from the vapourisation of the ether was about three hundred and fifty times the volume of the initial liquid propellant and that this was a considerably larger expansion than could be obtained with the compressed gas such as carbon dioxide.

In a further patent (42) Rotheim reported that the use of the expansion chamber in the valve gave a finer spray from a liquiefied gas aerosol than from a valve with a single orifice and he also discovered that the construction of the valve required that the orifice leading to the expansion chamber had a smaller diameter than the orifice which opened to the atmosphere. As stated earlier, these principles had already been recognised by Gebauer (37) but Rotheim applied them to the use of what he called liquified gas propellants such as methyl chloride; isobutane; methyl nitrate; vinyl chloride; and ethyl chloride.

Following Rotheim's discoveries, Midgley, Henne and McNary (43) introduced Chlorofluorocarbons as aerosol propellants initially in fire extinguishers where the function of the propellant was to create sufficient pressure to expel the contents and also to act as a flame arrestor. Further developments in fire extinguishers were patented by Bichowsky in 1935 (44). His work utilised chlorofluorocarbons in combination with the fire extinguishing agents such as carbon tetrachloride, sodium bicarbonate and water.

During the same period Rotheim was continuing to work on aerosols and in 1938 was granted a further patent covering insecticidal compositions in which propellants boiling below 20°F were used (45). A claim was made that the use of such compounds provided a more efficient atomisation for the insecticide materials and Rotheim was able to patent the use of propellant mixtures namely combinations of butane and ethane; propane and methyl chloride; ethane and dimethyl ether; and propane and methane. These latter studies combined with his earlier work in 1931 enabled the aerosol product to become a practical proposition and as such it was taken up by the US military during World War II which was in fact the first practical and large scale application.

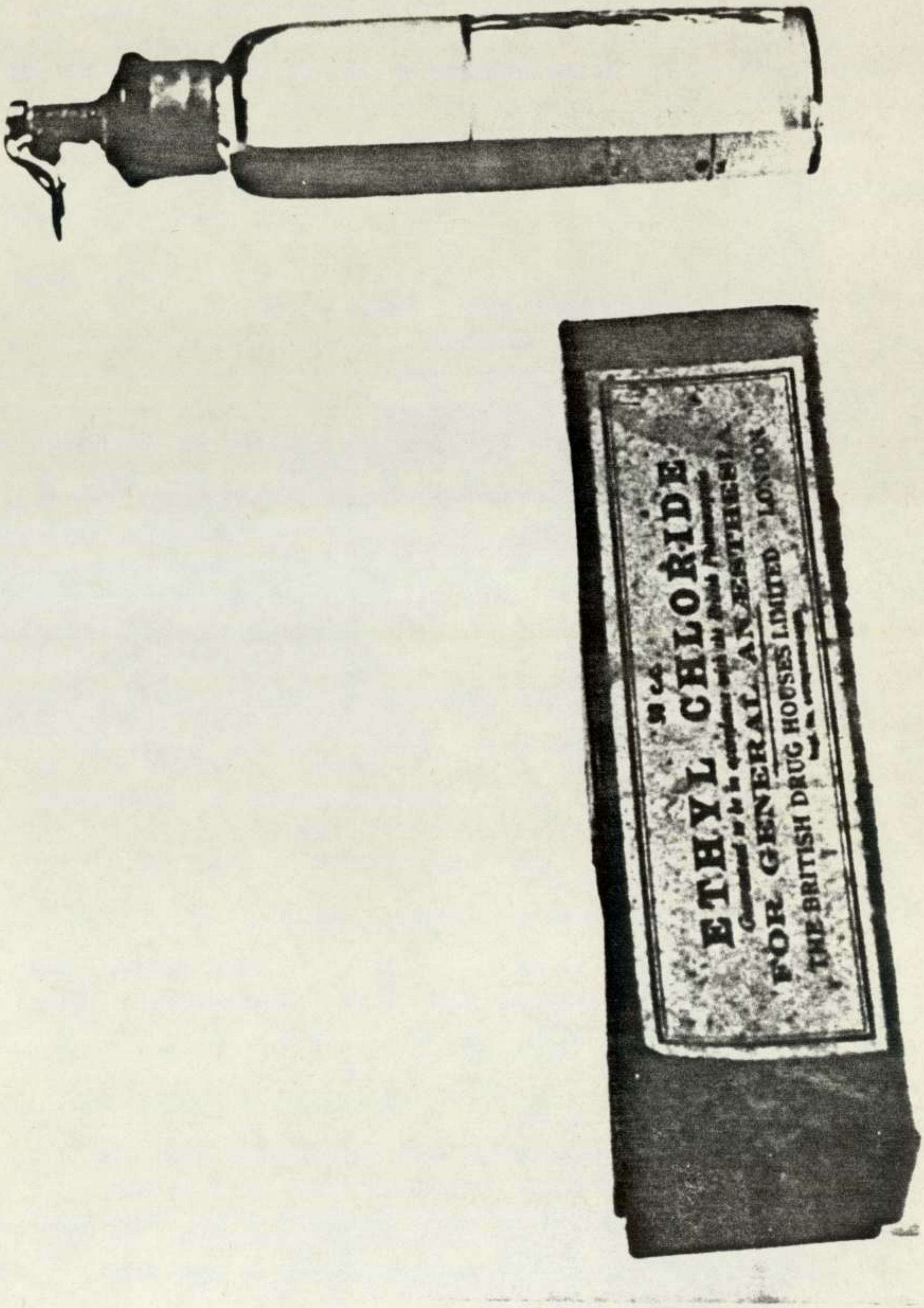


PLATE 2.4 EARLY AEROSOL ANAESTHETIC PHIAL

The aerosol insecticides used by the military during World War II were dispensed from heavy steel containers operating at 70 p.s.i.g. They had the capacity of 16oz and were filled with 90% chlorofluorocarbon and 10% concentrate made of pyrethrum and sesame oil. The valve entered the container by way of a four inch metal diptube with a 0.017 inch internal diameter. By July 1942, 10,000 containers per day were being manufactured and by the end of the war the Westinghouse Corporation had supplied over 30,000,000 containers to the US Armed Forces. In addition to Westinghouse four other companies were involved in producing aerosols and this whole development resulted from a US Department of Agriculture investigation aimed at combatting insects which caused disease among overseas troops. The invention of the above portable dispenser is accredited to Goodhue and Sullivan (46).

The first domestic aerosols appeared on the consumer market in 1947 in the United States and production during that year was estimated at 4.3 million units which were all insecticide products. The early containers were still the heavy military type and they were expensive with little sales appeal in a consumer sense. However the can companies were quick to foresee the potential of this product and by 1950 had developed suitable tin plate containers similar to those used in food packaging for the aerosol product. By 1950 aerosols were being produced in the USA and the UK and production statistics are available from about that time. Initially the products were mostly of the insecticidal type but by 1960 there developed a full range of aerosol products that are available today. Thus it might be concluded that most 'hardware' developments occured during the years 1930 to 1950 and the 'software' for product formulation development occured in the ten year period 1950 to 1960.

PLATE 2.5 ROTHEIM AEROSOL

PLATE 2.6 MORTENSEN AEROSOL

PLATE 2.7 SULLIVAN/GOODHUE AEROSOL

PLATE 2.8 SECOND WORLD WAR BUG BOMB

Though product formulations are still evolving, this ten year period saw the introduction of the first insecticide products followed by air fresheners in 1952 and then aerosol polishes in 1954 and a range of cleaning and hygiene products in 1955 onward. These events are summarised in Table 2.16 together with the appropriate references.

During the period 1960 to date, formulation refinements have continued to occur and there have been some fairly major hardware changes also, as shown in Table 2.16. Attempts to introduce aluminium containers commenced in 1962 with varying degrees of success around the world. Glass containers were also introduced about this time mostly for cosmetic products. The transition from soldered cans to welded tin plate containers commenced in the early 1970′s and is now largely complete in many parts of the world.

The mounting concern regarding the environment and the earths resources caused a series of "aerosol alternatives" to appear in the mid seventies ranging from aerosols that worked with compressed air and were rechargeable to various energy saving valving systems such as the Sepro system and Bellows system (7), (35). Though most of these are technically innovative, few have made any commercial impact to date. They are however discussed in more detail in Chapter 8.

In conclusion it may be said that there have been few technical developments during the last ten years that have achieved any real commercial success. In essence the aerosol product consists of the same basic package that was introduced in the 1960′s consisting of a three piece tin plate container, a valve largely constructed of moulded plastic parts with elastomer seals and metal springs and utilising either chlorofluorocarbons or hydrocarbon propellant systems. With the present concern regarding the suitability of aerosol product package for largely domestic use, future developments appear less likely.

TABLE 2.16 SUMMARY OF AEROSOL TECHNICAL DEVELOPMENTS

YEAR	INVENTOR	DETAILS
1825	C.Plinth (UK)	Soda Siphon "Regency Portable" with stopcock (35)
1837	Perpigna	Invention of "Vase Siphoide" - incorporating a spring loaded valve (35)
1862	Lynde	Bottle and valve withdip tube for discharge of aerated liquid (35), (48).
1899	Helbing H. and Pertsch	Medical spray for coating skin - USPat 628,463 (36).
1901	Gebauer C.L.	Valve/diptube/container - discharging volatile liquids - USPat 668,815 (37).
1903	Moore R.W.	Carbon dioxide fragrance atomiser USPat 746,866 (38).
1921	Mobley L.K.	Liquid antisceptic dispenser - carbon dioxide propelled USPat 378,481 (39).
1926	Lemoine D.R.	As above by Mobley (40)
1929	Rotheim E.	DME propelled aerosols Norwegian Pat 46613 (41).
1931	Rotheim E.	Method and Means for atomising liquid materials using DME, Methyl Chloride a propellants - USPat 1,800,156, 1,892,750 (35)
1933	Rotheim E.	H-C propelled aerosols Norwegian Pat 46613 (42).
1938	Frode Mortensen	Initial Designs on aerosol valves Norwegian Pat 60080 (47)
1939	Frode Mortensen	Further designs on aerosol valves Norwegian Pat 60842 (47).
1933	Midgley etal	Use of CFC as aerosol propellants USPat 1,926,396 (48).

TABLE 2.16 CONTINUED

YEAR	INVENTOR	DETAILS
1935	Bichowsky	Use of CFC in fire extinguishers USPat 2,021,981 (35), (49).
1938	Rotheim E.	Use of low boiling propellants for insecticides - USPat 2,128,433 (35), Norwegian Pat 56490.
1942	Goodhue L.D. Sullivan W.N.	Use of Rotheim concept to produce "Bug Bomb" insecticide - USPat 2,321,023 (35).
1943	Goodhue L.D. Sullivan W.N.	Container for aerosol insecticide USPat 2,331,117 (48).
1943	Tetco Manufacturing Company USA	Lightweight containers used for aerosols pressurised to 70 p.s.i.g. (48)
1943	Crown Cork Co	Use of beer can for aerosol using valve soldered in place
1946	Lyle and Sullivan	War surplus "Bug Bomb" stocks of insecticide put on American market (48).
1947	Greenwood	Invention of low cost aerosol valve for use with crown containers (50).
1949	Various	First aerosol hair sprays on USA market (50).
1950	Crown Can and Others	Development of the "Spratainer" with 1 inch aperture and soldered top type side seam can (50).
1950	Precision Valve; Newman-Green; Aerosol/Research Ltd.	Invention of aerosol valves with moulded plastic parts. Basic patents 1950 - 1955 and 1967. Minor patents (improvements) 1967 - 1980 e.g. Tilt Action Valve (48).
1948 to mid 1950	Crown Can; Metal Box Ltd. Continental Can	Improvements to can production. Thinner tin plate, modified temper. Test pressure up to 220 p.s.i.g. (48)
1950's	S.C.Johnson and Others	Patented use of Hydrocarbon propellants in Polishes, Air Fresheners and other Household products (50).
1953	Splitzer G.	Patented special valve for Aerosol Shave Foam (50).
1955	Various	Aerosol Perfumes and Colognes introduced with special metering valves (50).
1960	Various	Introduction of Deodorant and Antiperspirant sprays (50).

TABLE 2.16 CONTINUED

YEAR	INVENTOR	DETAILS
1970	Crown Can; Metal Box; Continental Can	Welded cans introduced first in Europe (50).
1976 - 1980	Various	Re-introduction of Carbon Dioxide and Nitrous Oxide propellants. Also mixed CFC/HC propellant systems (35), (50).

2.4 COMMERCIAL DEVELOPMENTS

2.4.1 USA

As discussed above in 'Technical Developments', the engineering aspects of the aerosol industry have been evolving for approximately 120 years. However, its commercial development is more recent and although various dispensing devices were patented in the 1800's,the first commercial production took place in Norway in 1939. This relatively small scale venture was a collaborative effort on behalf of the inventor of the aerosol, Eric Rotheim (50), a paint manufacturer from Oslo, Alf Bjerks, and an instrument maker, Frode Mortensen (51). Mortensen manufactured the containers and valves and went on to start his own filling company known as Morton Systems A.S. producing insecticides. Unfortunately this venture failed to succeed and the first successful mass production of aerosols took place during the second World War in the USA. This occured between July 1942 and 1945. During this time some 50 million "bug bombs", as they were called, were manufactured in the USA for the armed forces. It is this development that is considered to be the first stage of the commercialisation of the aerosol package.

After the war some of the "bug bombs" found their way on to the American market via war surplus stores and from the sales of this redundant military material, it became clear that the aerosol insecticide sprays had a worthwhile future in a commercial sense and several industrial companies began to seek ways to exploit this innovation. The container of the "bug bomb" was too heavy and costly and the valve too expensive for a mass produced consumer product. Therefore, to overcome this difficulty, beer cans were modified and fitted with mass produced plastic valves and because these new containers were of lighter construction, propellant changes were made to reduce the in can pressure.

On the 21st November 1946, an initial consignment of 105,000 of these early aerosols were made up from Aerosol Inc., a small company in Kansas, and distributed to the American market. This initial production of insecticides from this relatively small company was followed by the distribution of other aerosol fly spray products from companies who had also been engaged in supplying aerosols to the military such as the Regal Chemical Company, Bridgeport, Connecticut.

By 1950, the aerosol fly spray products had been supplemented with aerosol air fresheners and spray paints and the annual production had reached 42 million units. By 1956 it had risen to 325 million units and there was vertually a full range of products on the American supermarkets that we are familiar with today. As might be expected, the initial products marketed were mostly Insecticides but this changed from a 100% of production in 1946 down to 19% of the total of aerosols produced in 1956.

It was in 1956 that Hair Sprays (introduced in 1948) actually overtook insecticides, gaining 25% of total aerosols. The other major growth category was that of Personal Care products and the aerosol statistics of the time tended to include pharmaceuticals in this category raising it to 22% of the total. Table 2.17 shows how the product changed over the first twenty years of aerosol production in the United States (16).

It can be seen from Table 2.17, Insecticides declined rapidly from their prime position in 1946 being displaced by Air Fresheners and Hair Sprays. This decline in percentage terms (but not volume) continued until 1964 when it stabilised around a 5% share. Air Fresheners have vertually retained their share of the total market and have shown gains in volume terms.

Hair sprays and Personal Care products made significant advances in the early 1950's and have largely maintained a major share of the aerosol market. However a reduction in percentage and volume has been noticeable since 1976 following the concerns regarding CFC's and the environment. This reduction in share and consumption is mostly related to anti-perspirants and deodorant sprays.

The Household category seems to have stabilised around a 20% share although it continues to grow in volume terms. Aerosol paint is another growth area in the USA although as will be discussed in Chapter 3, there is little evidence of its acceptance elsewhere.

The "Others" or "Miscellaneous" category which mostly includes automotive products also shows good growth in share and consumption terms and this situation is reflected in other countries which will be discussed further in Chapter 3.

TABLE 2.17 AEROSOLS USA CHANGE IN PRODUCT MIX (6), (14), (54)
% Total Market in Year of Manufacture

Business Category	1946	1956	1962	1964	1970	1976	1980
Insecticides	100	19	10	6	4	5	6
Air Fresheners		12	9	7	8	7	10
Hair Sprays		25	22	21	23	22	18
Personal Care & Pharmaceuticals		22	22	24	25	20	15
Paint		7	9	11	10	12	11
Household		)	17	21	19	16	18
Food		) 15	6	5	5	4	5
Others		)	5	5	6	14	17
TOTAL	100	100	100	100	100	100	100

The relatively rapid acceptance of the aerosol package has been summarised as being due to its merit as a packaging medium (22). This summary made the claims that the aerosol is:-

Versatile - i.e. the product can be dispensed in a jet form, a gel or a fine spray.

Convenient - i.e. the product is ready for use, no mixing, no applicators are necessary.

Spillproof - i.e. there are no leaks, no mess, no wasteage.

Airtight - i.e. the product will not oxidise or deteriorate.

Hygenic - i.e. the aerosol is ideal for family use as there is no contact with the skin.

Easy to use - i.e. the product is quick to use and accurate as it is dispensed directly.

Childproof - i.e. the pack is robust and there is little likelihood of a child being able to use it especially as the actuator spring mechanism tends to be stronger than a child can operate.

Further understanding on the rapid success of the aerosol package may be gained from a study of four of the major product categories. The success of the aerosol insecticide spray has already been discussed under 'Technical Developments'. In brief, it represents a rapid and efficient way to deal with flying and crawling insects and even to this day, alternative biocides represent a much lower order of efficiency in terms of controlling insects.

Before aerosol Hair Sprays were marketed in the late 1940's, the squeeze pack was the traditional product. Now more than twenty years later, their contribution to this market is vertually negligeable and the reasons are to do with the factors of cost and ease of application. The initial pump pack was difficult to use, often producing very coarse particles and tended to be relatively expensive even though refill packs were available. The aerosol produces a fine, even spray giving ease of application particularly behind the head. The absence of evaporation when not in use and the impossibility of spillage combined with relatively low cost made the hair spray the leading aerosol product category.

Aerosol anti-perspirants and deodorants largely owe their success to the fact that the aerosol is preferable as a dispenser as there is no contact with the skin and it is therefore hygenic and can by used by the whole family. The aerosol deodorant is pleasant to use especially as there is no build up of stale product around the applicator. Consumer useage and attitude research (22) has shown that additional product benefits are perceived due to the cooling effect of the propellant.

The aerosol cologne and perfume segment is an example where the aerosol package has many advantages. First the aerosol is sealed so no deterioration by contact with air can occur. Second the aerosol cannot be spilt whether the protective cap is on or not and third the product can be applied exactly where required without coming into contact with the fingers or other applicators thus avoiding waste. A metering valve completes the fourth advantage which allows the dipensation of just the right amount of product. The fifth advantage is clearly cost for many of the traditionally expensive French fragrances are now available in a cologne form which can be just as effective as the concentrated fragrance but available at a price which can be within the reach of many consumers.

2.4.2 Commercial Development in UK

In the UK aerosol technology was introduced during 1949 by Cooper, McDougall and Robertson Ltd., who commissioned the first automated aerosol filling line at their Berkhamstead factory. At the same time Walter Gregory and Company, of Wellington, Somerset, were setting up a simpler line for a British made aerosol insecticide that was exhibited at the May 1950's British Industry's Fair in Birmingham by Walter Gregory. During this month Cooper, McDougall and Robertson started to market their aerosol fly killers and Metal Box Company, supplied both fillers with continental valves of USA origin and British extruded aluminium containers. Initial orders were for 50,000 units of which 80% went to Cooper, McDougall and

Robertson and the remainder to Walter Gregory. Within one year, one and a quarter million aerosols had been manufactured in the UK and within ten years fourty seven million. Table 2.18 shows the development of the aerosol in the UK and the change in product mix from the introduction of aerosol Insecticides in 1950 with two companies manufacturing, then the start of Air Fresheners and Hair Sprays as other companies like Reckitt and Coleman; Aerosol Packaging and Midland Aerosols came into the business. (See Plates 2.9 and 2.10). The importance of aerosol Insecticides reached its peak very quickly in the UK and from this point its percentage share of the total aerosols filled became less.

Room deodorants, or Air Fresheners, as they are now called, continued to grow to about the 15% level and then declined slightly, levelling off at 12% share.

Hair sprays were introduced in 1954 and within three years had achieved nearly one third of the aerosol market. As in the USA however, the advent of the Molina-Rowland hypothesis (1) appears to have caused their decline in more recent years. Similar trends are observeable for other Personal Care products (mainly anti-perspirants and deodorants) although the aerosol colognes continue to do well.

Aerosol Paints mostly for car maintenance made their appearance in the early 1960's achieving a 1% share of all aerosols in 1965. This category has shown a growth to a 5% share in recent years as well as some increase in volume terms.

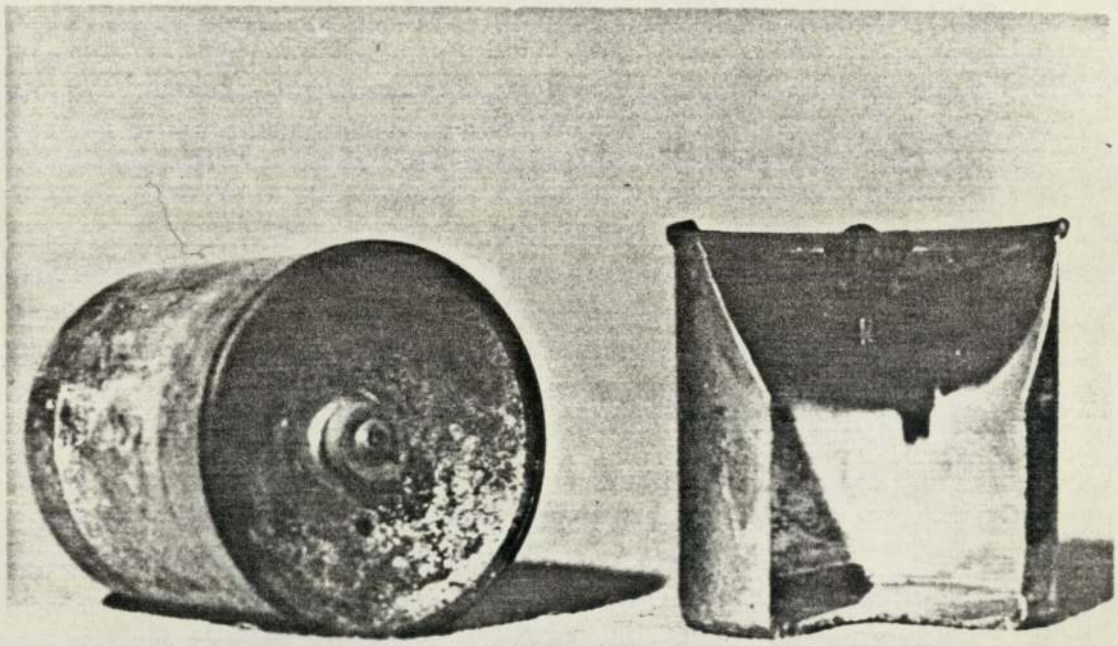


PLATE 2.9 SECTION THROUGH ONE OF THE FIRST UK AEROSOLS

PLATE 2.10 EARLY UK AEROSOLS

Household products (polish/oven cleaners/ironing aids) have shown continued growth since their introduction in 1955 increasing their market share and volume. Food products have remained small however and there is evidence (52) that their volume is declining in the UK.

A further growth category is the Miscellaneous sector which includes industrial and auto sprays. Further growth is anticipated for this group of products (53) which comprises approximately ten items. (See Tables 2.15 and 2.18).

2.4.3 Commercial Development in European Countries and Rest of World

Although statistics are less readily available for other European countries, the picture is broadly similar to the UK and the USA although displaced in time by about five years. Minor differences exist regarding the commercial development of aerosols, some products achieving greater popularity in certain countries e.g. aerosol paint. However the Personal Care products are collectively the largest segment of all aerosols in all countries and the one which shows decline almost everywhere. Air Fresheners appear to have stabilised in most areas although the Household category continues to grow.

Large differences exist on Insecticide product growth between the USA and the rest of the world in that most other countries benefited from the Anglo/American developments and introduced a range of aerosols rather than Insecticides only. Differences are further explained by climatic conditions, consumption being higher where mosquitoes and flies rate a heavy nuisance.

In all areas the Miscellaneous category appears to show good growth. (54).

TABLE 2.18 AEROSOLS UK - CHANGE IN PRODUCT MIX (6),(14),(59)
% of Total Market in Year of Manufacture

Business Category	1950	1952	1954	1955	1960	1965	1970	1975	1979
Insecticides	100	85	75	64	36	16	9	10	8
Air Fresheners		15	15	16	15	12	8	11	12
Hair Sprays			10	12	13	28	34	24	22
Personal & Pharmaceutical				6	9	8	17	16	14
Paint				-	-	1	3	5	5
Household				2	16	26	21	23	26
Food					2	4	1	2	2
Others (Miscellaneous)					9	5	7	8	11
TOTALS	100	100	100	100	100	100	100	100	100

2.5 SUMMARY OF CHAPTER 2

During this Chapter the aerosol product, its technical and commercial development and the present day industry have been described and illustrated.

The wide range of applications have been surveyed and a convenient form of classification devised for the compilation and subsequent processing of commercial information in later chapters.

CHAPTER 3: WORLDWIDE ANALYSIS OF AEROSOL MARKETS

3.1 INTRODUCTION

The purpose of this Chapter is to collect and analyse historical data on aerosol production and consumption on a country by country basis, in order to understand how the various aerosol markets have developed and are changing. This analysis provides the basis for forecasting studies in Chapter 6. In this chapter, analysis means collecting and collating aerosol data, verifying that the various figures tie up and endeavouring to understand them by examining correlations with national, regional or world events. Stemming from this analysis of the data should be an understanding of the trends present in the various markets.

The market which has shown the greatest development and change is that of the United States (34). In fact, the United States aerosol consumption became the highest in the world from the point of introduction of the aerosol package on a commercial basis (See Section 2.2) and maintained this position until 1978. This high consumption was true in an overall sense and of the individual product categories (See Section 2.2.4) and thus it may be hypothesised that the USA aerosol market is likely to represent the epitome aerosol development. As such it will be used as a source of comparison in this chapter while other comparisons will be made with similar countries within an area e.g. "Scandinavia" or "Eastern Europe", especially where some of the same trends are observed.

3.1.1 Sources of Data

Aerosol products are not included in any Government trade statistics and the bulk of the published information on aerosols comes from the aerosol trade associations in the various countries and to a lesser extent from data collected and published by major aerosol component suppliers such as Metal Box (34) and the Continental Can Company (4).

Regrettably, much of the published information is reported in varying formats and while Section 2.2.4 has already endeavoured to devise a system that caters for most data sources, there are still some discrepancies between the various world countries. Further, because many countries export or import aerosol products, production statistics may be of limited value in establishing trends which may be used to forecast the future. Unfortunately the bulk of published statistics are based on production data. To assist with this difficulty, and to supplement published sources, estimates from Johnson Wax Ltd (55) were used especially and where trade association or supplier data was found to be unavailable, and where lack of import/export information made the calculation of aerosol consumption impossible.

3.1.2 Types of Data

Essentially two types of published aerosol data are available, namely production statistics for the country concerned, sometimes broken down by product category, and consumption data, usually reported on a consumption per capita basis. As stated earlier, production statistics are in the majority. It seemed reasonable to expect a relationship between production (reported as 'aerosol fillings') and consumption and B.A.M.A. (7) and Metal Box (34) defined the relationship as follows:-

Aerosol Consumption = (Production + Imports) - Exports

This study highlighted that considerably more data exists on aerosol production than on consumption and frequently figures on imports and exports from and to a particular country are absent entirely. It was therefore necessary to make estimates and then refine these by attempting to conduct an accounting exercise on aerosols on a worldwide basis. This exercise was called the "Aerosol Balance" - using the analogy with the Chemical Engineering "Mass Balance" procedure of accounting.

3.1.3 Analysis Format

A review of available and collected data indicated that the best route to a worldwide survey of aerosol markets would be via a country by country analysis - leading to the accounting exercise named the "Aerosol Balance". For convenience a common reporting format was chosen again largely based on available data (worldwide) such that reporting consistency would allow direct and like comparisons between countries. This format was built up as follows:-

Analysis Period

Although data was found to be available for some countries which spanned twenty years (i.e. back to 1960), the period 1970 to 1980 appeared to be the consistent one for all countries. In an attempt to highlight change, it was decided to compare the 1970 to 1975 period with the 1975 to 1980 period although other data was included when found to be available.

Consumption Data:

Although this was frequently absent from the literature for many countries, this was estimated first on a per capita basis and subsequently in terms of millions of units consumed per year. To assist these estimates the following definition was used:-

C.P.P.Y. = Consumption per capita per year

$$\text{C.P.P.Y.} = \frac{(\text{Total Production + Imports}) - \text{Exports}}{\text{Total Population for the Year}}$$

Production Data:

This was also reviewed over the 1970 to 1980 period as a measure of a country's commitment to the aerosol industry rather than its position as a consumer.

3.1.4 Aerosol Balance

A comparison of aerosol consumption versus production and hence the "Balance" of aerosols imported or exported was prepared for each country and presented by world areas e.g. Western Europe. This was done to verify the aerosol consumption data presented in this Chapter and refine it as necessary. It was also intended to show where aerosol goods were transported across frontiers.

3.1.5 Country by Country Analysis of Aerosol Markets

For convenience the data and discussion that follows have been presented for specific world areas arranged in descending order of total consumption and production namely:-
Europe (West and East); North America (United States and Canada); Asia (including Japan); Central and South America; Oceania (Australia and New Zealand); and Africa. The majority of graphical and tabulated data is presented in Appendix I, and all references to this appended data in the text will be preceeded by the letter 'A' e.g. Figure A 3.1. Countries within an area are described in alphabetical order. The overall production picture is shown in Plate 3.1.

3.2 EUROPE

3.2.1 Western Europe

The comparative consumption and production picture for this region is shown in Figures 3.1 and 3.2 and the individual countries will now be discussed in more detail.

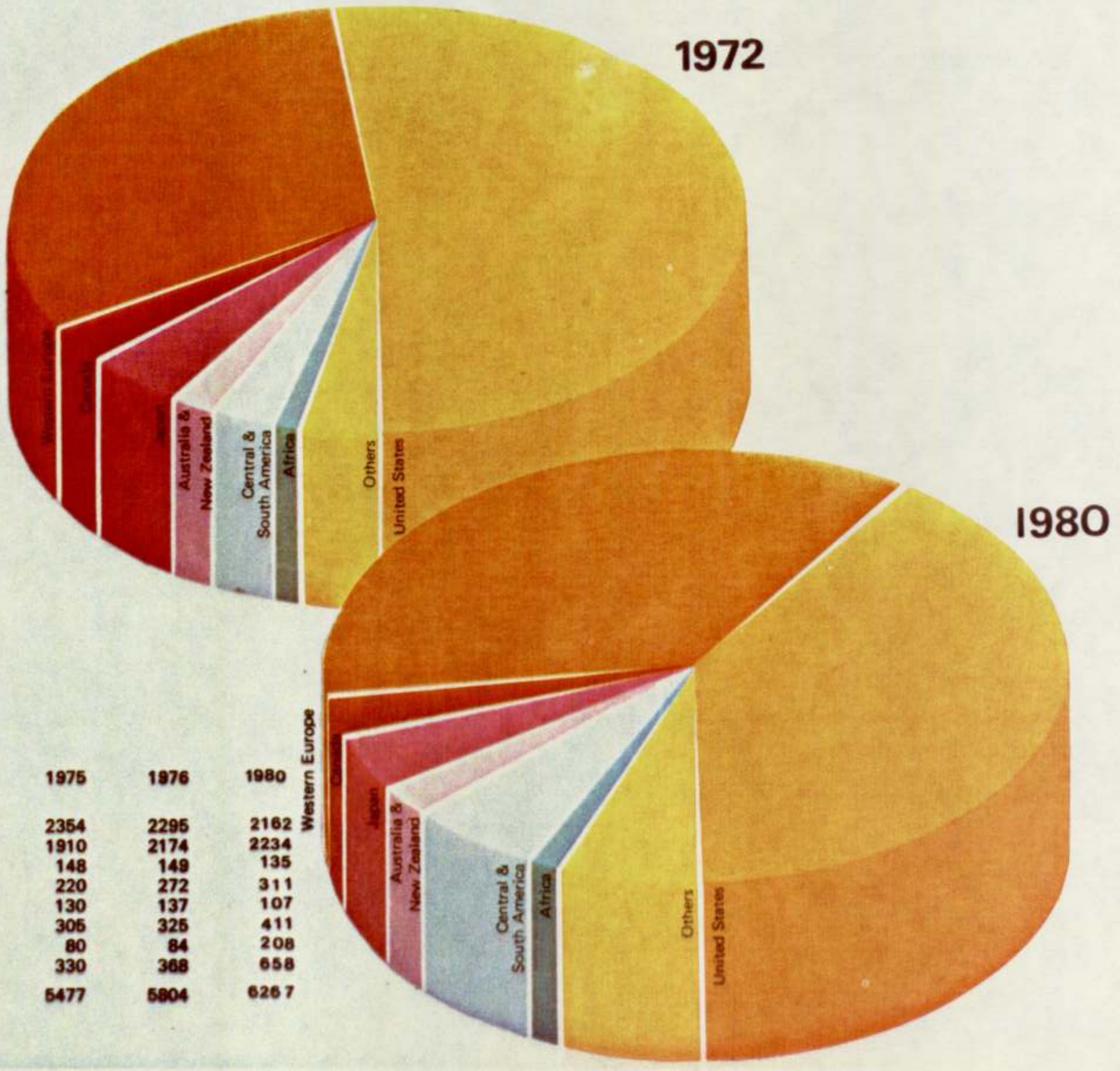
As shown in Figure A 3.1 AUSTRIAN consumption per capita per year (C.P.P.Y.) figures show growth to 1970 then maintain static trends over the ten year period with the exception of Hair Sprays and Personal Care products which show slow growth. Overall consumption for Austria is low and comparable with Scandinavian countries rather than its neighbour Germany. Overall consumption was 3.6 per capita per year for 1970 to 1975 rising to 4.5 for the period 1975 to 1980. Comparisons within Europe are presented in Figure 3.1.

World Aerosol Fillings

Because the United States markets have suffered a sharp decline, their contribution to the Annual World Aerosol Fillings has changed significantly since 1972, as the table and pie chart indicate.

Proportion of Fillings

	1972	*1976*	1980
United States of America	52%	38%	35%
Europe	31%	40%	36%
Rest of the World	17%	22%	29%



(in million units)	1972	1973	1974	1975	1976	1980
United States	2823	2902	2722	2354	2295	2162
Western Europe	1720	1930	2078	1910	2174	2234
Canada	163	168	182	148	149	135
Japan	237	264	252	220	272	311
Australia and New Zealand	106	127	152	130	137	107
Central and South America	149	176	232	305	325	411
Africa	55	73	91	80	84	208
Others	212	270	300	330	368	658
TOTAL	5465	5910	6009	5477	5804	6267

PLATE 3.1 OVERALL WORLD PICTURE ON AEROSOL PRODUCTION

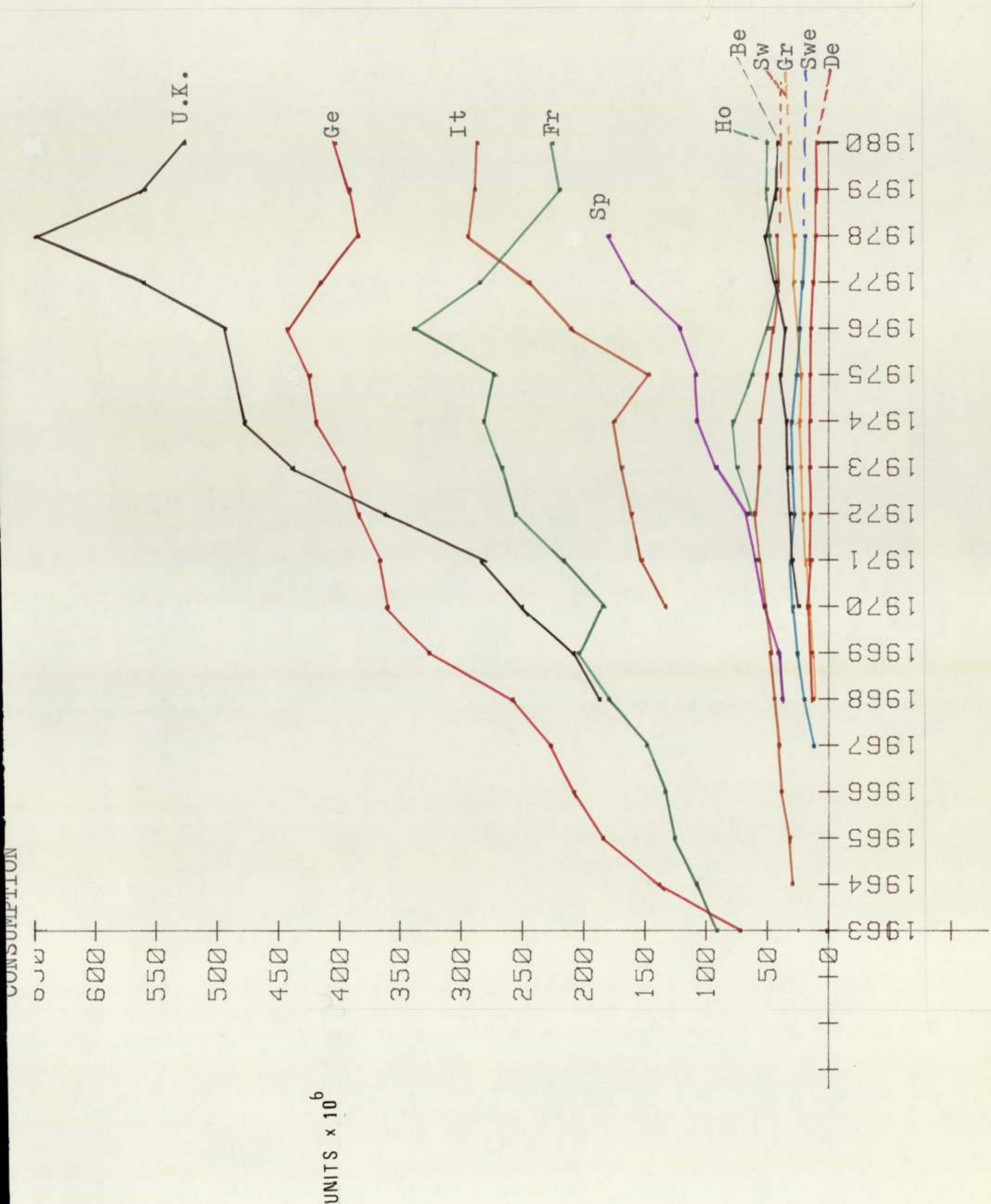


FIGURE 3.1 AEROSOL CONSUMPTION BY COUNTRY

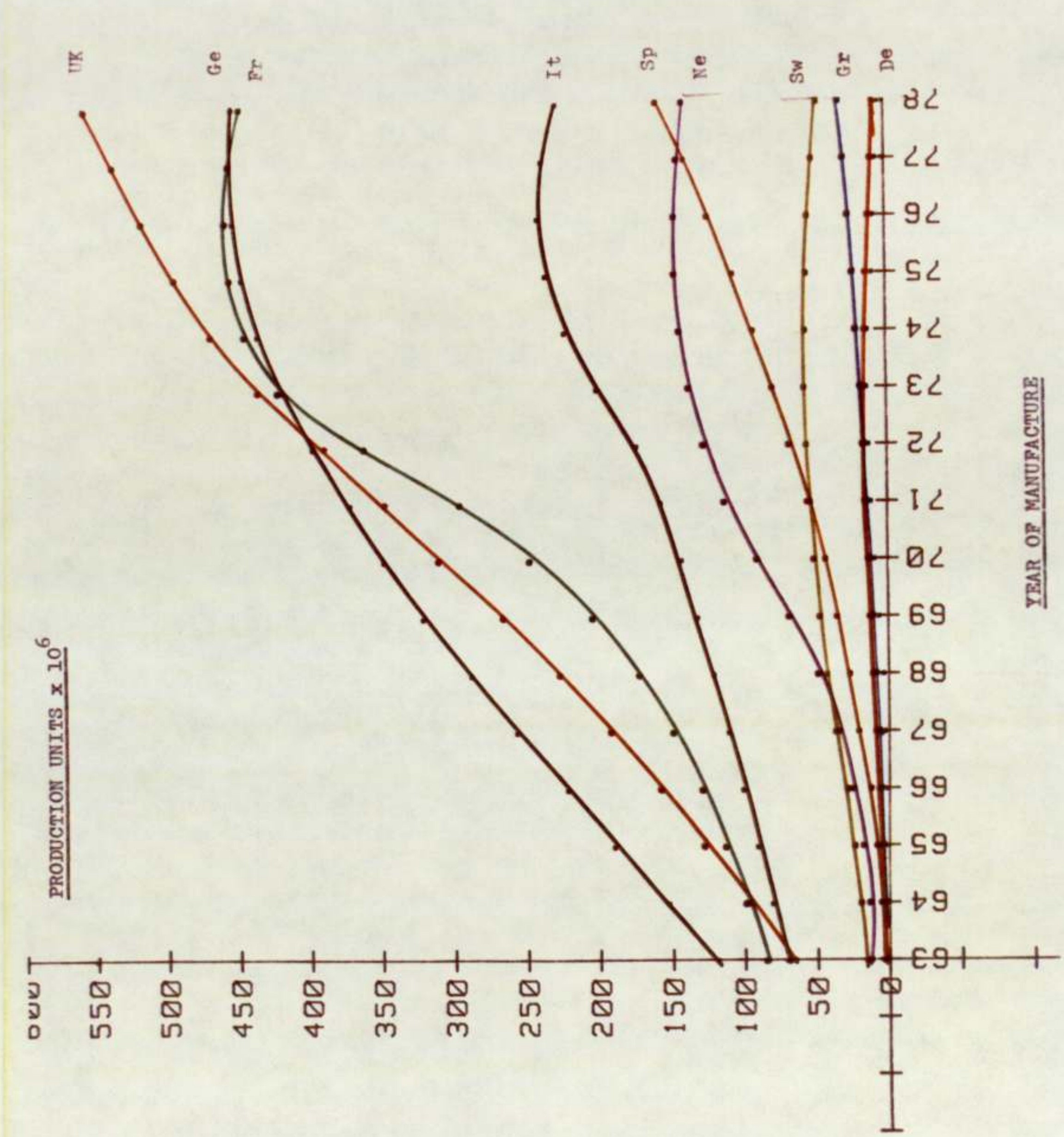


FIGURE 3.2 EUROPE AEROSOL PRODUCTION BY COUNTRY

Aerosol production has remained largely static since 1970 with Hair Sprays being the largest single category followed by Personal Care aerosols, Household products, Insecticides and then Miscellaneous products. Comparisons within Europe are presented in Figure 3.2 and graphical and tabulated data in Figure A 3.1 and Table A 3.1.

BELGIAN per capita per year consumption is similar to Austria (See Figure A 3.2) although the consumption for the individual categories shows greater variability.

Hair spray aerosols seem to be in decline whereas Household aerosols have shown quite considerable increase in consumption especially over the period 1976 to 1980. The next highest category from a consumption viewpoint is Insecticides followed by Personal Care products and lastly Miscellaneous products. Of these latter categories Insecticides have shown the greatest growth and are currently higher than Austria or Scandinavian countries.

Overall consumption per capita has risen over the ten years 1970 to 1980 averaging at 3.2 units per capita per year for the period 1970 to 1975 and 4.2 units per capita per year for the period 1975 to 1980. This is moderate to low for the region as shown in Figure 3.1.

Aerosol production has been somewhat static over the ten year period 1970 to 1980 but at a higher level than in Austria. The production of Personal Care and Hair spray aerosols were highest and similar followed by Household products, Miscellaneous products and Insecticide aerosols. Graphical and tabulated data are presented in Figure A 3.2 and Table A 3.2.

<u>DENMARK'S</u> aerosol consumption shows a consistent decline from 1970 to date. In more latter years, Personal Care aerosols show the highest consumption followed by Hair sprays; Miscellaneous products; Household products and lastly Insecticides. Only Miscellaneous products show any growth.

Overall aerosol consumption for the period 1970 to 1975 was 2.8 units per capita per year and this dropped to 2.1 units per capita per year for the period 1975 to 1980.

Aerosol production is extremely low compared to the rest of Europe, and although static during the years 1970 to 1975 appears to have declined in the years 1975 to 1980. Hair spray and Personal Care aerosols tie for the highest production level in Denmark with Miscellaneous aerosols, Household aerosols and Insecticides being almost equal. Graphical and tabulated data are presented in Figure A 3.3 and Table A 3.3.

<u>FINNISH</u> aerosol consumption divides into two groups, namely Personal Care and Hair spray aerosols and the rest. The former group are widely separated from the others (comprising Household, Insecticides and Miscellaneous) in terms of quantities consumed. Both Hair spray aerosols and Personal Care aerosols show a period of relatively rapid growth between 1966 and 1974 and a period of even more rapid decline from that period to date. (See Figure A 3.4). The remaining categories in Finland show a similar trend but at a much lower level, Miscellaneous aerosols being the highest followed by Insecticides and then Household products. These latter products are well below normal consumption for Scandinavian countries. (See Figure A 3.4 and Tables A 3.4, A 3.10, A 3.13).

Overall consumption for the years 1970 to 1975 was 4.4 units per capita per year falling to 3.1 units per capita per year for the years 1975 to 1980.

Aerosol production for all categories other than Personal Care aerosols has been static for a large number of years. (See Figure A 3.4). Personal Care aerosols have shown a period of increased production during the years 1966 through to 1973 and a decline from that point onwards up to the present time. Production levels for Household, Hair sprays, Miscellaneous and Insecticides are comparable with the figures for Austria.

FRENCH aerosol consumption levels reflect a somewhat declining picture. Hair sprays represent the highest category consumed which showed some growth in the years preceeding 1970 but stabilised and to some extent declined since that time. The second major category is Personal Care aerosols which has shown extremely rapid decline since 1977 and currently falls well below the third category which is Miscellaneous aerosols. Household aerosols and Insecticide aerosols are consumed at a similar rate in France and both of them appear to have stabilised at 0.5 units per capita per year.

Overall consumption for the years 1970 to 1975 was 4.6 units per capita per year falling to 3.8 units per capita per year for the years 1975 to 1980. More detailed statistics are presented in Figure A 3.5 and Table A 3.5.

Aerosol production reflects a more dynamic picture than the countries discussed so far,(See Figure 3.2). Once more there are basically two groups namely Personal Care aerosols with Hair sprays, and a second group comprising Miscellaneous products, Household aerosols and Insecticides.

Personal Care aerosols have shown the greatest growth in production, the major portion occuring between the years 1969 and 1976 with some decline thereafter. Hair sprays are the second largest category produced in France and a period of rapid growth occurred between 1964 and 1969 with some stabilisation following that time. This category currently shows slight decline. The next largest category currently maintaining slow growth is Miscellaneous aerosols followed by Household aerosols which have stabilised and Insecticides which are showing some decline. France is a major European producer of aerosols, the production levels are more comparable to the UK and Germany and about a one third of those in the United States.

GERMAN aerosol consumption is similar to production in that Personal Care aerosols show the highest per capita per year useage followed by Hair sprays, both showing decline since 1976. Next comes Miscellaneous aerosols which are still showing some growth and then Household and Insecticides. These latter two categories seem to have stabilised in useage, Household aerosols being higher than France and Insecticides lower.

Overall useage for the 1970 to 1975 period was 6.4 units per capita per year which increased to 6.6 units per capita per year during the 1975 to 1980 period.

Aerosol production shows a similar picture to France. Once again Hair sprays and Personal Care aerosols show rapid growth particularly between the years 1963 and 1971 with Personal Care aerosols being the highest category in 1980. Hair sprays have shown moderate decline since 1971 although other categories show slight growth or stability. Relatively high production increases are apparent in the Miscellaneous category and the ranking in more recent times (c 1980) is Personal Care >Hair sprays >Miscellaneous > Household >Insecticides. Detailed data is presented as Figure A 3.6 and Table A 3.6.

GREEK aerosol consumption reflects a picture more like Northern Europe e.g. Scandinavia than that of Southern Europe e.g. Italy/Spain. However relatively good growth has been shown by the Insecticide category continuing on through the 1980's. Personal Care aerosols, Hair sprays and Household products are consumed at similar levels, namely around 0.4 units per capita per year. Miscellaneous aerosols are static at a low level of 0.1 units per capita per year.

Overall consumption for the period 1970 to 1975 was 2.1 units per capita per year rising to 2.8 units per capita for the period 1975 to 1980.

Aerosol production has been at an extremely low level for Western Europe (See Figure 3.2). More recently it has shown a slight upward trend, and it is more comparable with Austria and Denmark. Insecticides show the highest level of production although the category has remained static since the early seventies at ten million units per annum. The next category is Personal Care aerosols, followed by Hair spray aerosols and the Miscellaneous category is virtually non existant. Detailed statistics are presented in Figure A 3.7 and Table A 3.7.

DUTCH aerosol consumption reflects a growth picture from 1963 to 1974 with a slight decline to 1980. Household aerosols show good growth from 1966 to 1980 although all other categories indicate decline from 1973. The

descending order of consumption is:-
Household aerosols >Hair sprays >Personal Care aerosols >Miscellaneous aerosols >Insecticides.

Overall consumption for the period 1970 to 1975 was 5.8 units per capita per year falling to 5.2 units per capita per year for the 1975 to 1980 period.

Aerosol production reflects a similar picture to consumption. Particular strong growth has been shown by Household aerosols, this growth having been maintained through 1980. The next largest category is Insecticides which appeared to stabilise in the early 1970's and continues to 1980. Both Hair sprays and Personal Care aerosols appear to be in decline while Miscellaneous aerosols have stabilised. (See Figure A 3.8 and Table A 3.8).

ITALIAN aerosol consumption shows an upward trend for most categories with the exception of Miscellaneous products. The strongest growth in consumption is shown by Insecticides and by Household products followed by Hair sprays and Personal care products.

Overall consumption for the period 1970 to 1975 was 2.9 units per capita per year showing a marked increase to 4.3 units per capita per year for the period 1975 to 1980.

Aerosol production has shown good growth since 1963, and although this growth has been somewhat erratic during the middle seventies it has continued to 1980. Hair sprays are still the largest category to be produced in Italy followed by Personal Care aerosols, Insecticides, Miscellaneous aerosols and finally Household aerosols. All categories maintain a slight upward trend in production levels approaching that of major European producers like the UK and Germany. (See Figure 3.2). Detailed statistics are presented in Figure A 3.9 and Table A 3.9.

NORWEGIAN consumption levels, are by comparison with other Scandinavian countries, quite high with all categories showing growth up to 1974. The strongest growth was shown by Personal Care aerosols and Hair sprays, although the strongest decline is also shown in these categories from 1974 to 1980. Miscellaneous aerosols, Household and Insecticides also show slight growth which appears to have levelled off by 1975 and has been stable since that time.

Overall consumption for the period 1970 to 1975 was 4.6 units per capita per year, comparable with countries like France and which has fallen to 3.6 units per capita per year for the period 1975 to 1980.

Aerosol production like many Scandinavian countries is at a very low level although stable since 1971. Only the Personal Care and Hair spray aerosols are noteworthy and these have both shown a decline in production levels since 1972. Detailed statistics are presented in Figure A 3.10 and Table A 3.10.

PORTUGESE consumption data describes slow growth for all categories with Insecticides being the largest followed by Personal Care, Household aerosols, Hair sprays and finally Miscellaneous. These growth trends appear to be being maintained through the period 1970 to 1980.

Overall consumption expressed as C.P.P.Y. during the period 1970 to 1975 was 0.9 rising quite dramatically to 2.4 during the period 1975 to 1980. It is however still low for Western Europe. (See Figure 3.1).

Aerosol production has been at a low level being less than five million units per year until 1971. Some increase was shown during the period 1974 to 1978 at which point it may have stabilised around twenty five million units per annum. Detailed analysis are shown in Figure A 3.11 and Table A 3.11.

SPANISH aerosol consumption data reflects good growth from 1963 with some levelling during the period 1978 to 1980. Household aerosols are the highest on a per capita per year basis followed by Insecticides, Personal Care aerosols, Miscellaneous aerosols and Hair sprays. Consumption levels of many of these latter categories are approaching those of Germany and France. (See Figure 3.1).

Overall consumption of the period 1970 to 1975 was 2.3 units per capita per year almost doubling during the 1975 to 1980 period to 4.1 units per capita per year.

Aerosol production has shown good growth since its initiation in 1963, although there has been some levelling during the period 1978 to 1980. Personal Care aerosols are the category showing highest production levels followed by Household aerosols, Insecticides, Miscellaneous and Hair sprays. All categories show an overall growth trend in production levels and further data is presented in Figure A 3.12 and Table A 3.12.

The SWEDISH consumption picture is typical of Scandinavia i.e. low compared with the rest of Western Europe. Personal Care aerosols are consumed the highest but the category has been in decline since 1974 at about 0.6 units per capita per year. The next category are Hair sprays (also showing decline), followed by Miscellaneous aerosols, Household and Insecticide aerosols, all of which are static and at low levels.

Overall consumption for the period 1970 to 1975 was 3.5 units per capita per year falling to 2.4 units per capita per year for the period 1975 to 1980.

Aerosol production is typical of many of its Scandinavian sister countries, the peak year being 1971 with less than thirty million units per year. Some decline has occured since that date to about ten million units per year. Only Hair sprays are noteworthy, all other categories being produced at extremely low levels. (See Figure 3.2). Detailed data are presented in Figure A 3.13 and Table A 3.13.

SWITZERLAND'S aerosol consumption is quite dynamic with Personal Care aerosols, Hair sprays and Household products showing good growth until 1972 when they proceeded to undergo varying degrees of decline. In 1980 Hair sprays were consumed the most followed by Personal Care, Household, Miscellaneous and Insecticides. The Insecticides and Miscellaneous categories appear to be still showing slight growth.

Overall consumption for the period 1970 to 1975 was 8.6 units per capita per year which is very high and comparable with the United States. This record level for Europe fell to 6.9 units per capita per year for the period 1975 to 1980. (See also Figure A 3.14 and Table A 3.14).

Aerosol production is reminiscent of Scandinavian levels showing a downward trend around fo rty five million units per annum in 1980. Hair sprays and Personal Care aerosols have been produced in roughly equal quantities and the ranking for the rest is:-
Household aerosols >Miscellaneous aerosols >Insecticides.

UK consumption data indicates that most categories have shown growth at varying rates for the period 1970 to 1980. The significant factor here is the almost vertical growth of Household aerosols for the period 1976 to 1980 and in complete contrast, the rapid decline of Personal Care aerosols over the same period. Hair spray aerosols appear to have stabilised at the 2.2 units per capita per year level, and Miscellaneous aerosols continue to show a slower growth. Insecticides on the other hand having shown reasonable growth between 1970 and 1978, show some decline over the latter years.

Overall consumption for the period 1970 to 1975 was 6.7 units per capita per year rising to 9.6 units per capita per year, a European high for the period 1975 to 1980.

UK aerosol production has shown an upward trend since 1970 with a slight turn down in 1978. For most of the period 1970 to 1980 Hair sprays remained the dominant category overtaken by Miscellaneous products in 1978. The Miscellaneous category continues to be at the highest production level in the UK having shown major growth since 1977. At the present time the production ranking by category is:
Miscellaneous >Household products >Hair sprays >Personal Care products which have been in strong decline since 1978. Insecticides are the least

produced category but continue to show a slow growth. More detailed statistics are presented in Figure A 3.15 and Table A 3.15.

3.2.2 Eastern Europe

In the previous section, aerosol consumption and production statistics were presented and discussed for the various Western European countries on the basis of the five product categories defined in Chapter 2. Growth or decline trends were also highlighted over the period 1970 to 1980. As might be expected such detailed aerosol statistics are not available for Eastern Europe and only production data for each country appears to have been published (57), (58). This data reports on the total aerosols filled with no breakdown by product category or any indication of import or export activity. Therefore a decision was made to estimate the needed aerosol statistics for Eastern Europe using available data.

Available data was found to consist of the production statistics mentioned earlier and information on the population of each country and some details of its economic affairs (60), (61). Two different methods of estimation of aerosol production and consumption for Eastern European countries were devised in order that a degree of cross checking could be applied and these will now be described in some detail.

3.2.2.1 Method A - The Use of the "Apparent Consumption" Hypothesis

The "apparent consumption" was calculated for each country by ratioing the available production figures to the country's total population for that year. This data is presented in Table 3.1 together with some actual C.P.P.Y. figures for other Western European countries by way of comparison.

Assuming that these Eastern European countries have no imports or exports then the apparent consumption figure becomes the actual consumption figure and can be examined in relation to the C.P.P.Y. figures for Western Europe. By reference to Table 3.1 it can be seen that with the exception of Czechoslovakia, East Germany and possibly Yugoslavia, the consumption data for Eastern European countries is very low. This conclusion coupled with information from SC Johnson (62) confirms that exports to Eastern European countries have been occuring for some years. It also suggests that the apparent consumption figures are in error. A comparison of the economic data for the various countries (60) further indicates that aerosol consumption should be of the following order:-
USSR >East Germany >Yugoslavia >Czechoslovakia >Turkey >Hungary >Bulgaria >Poland >Romania.

The apparent consumption figures in Table 3.1 do not entirely bear this out although the figures for East Germany and Czechoslovakia seem more reasonable. The USSR figure could also be feasible in view of the large areas of the country devoted to farming and where there is unlikely to be either consumption or distribution of aerosols due to lack of disposable income, poverty in general and life style.

Therefore in the absence of further information, a decision was made to estimate past and present consumption using the mean apparent consumption per capita per year figure for 1975 for all countries and projecting growth from that point at 5% per annum (a figure obtained from within Johnson Wax Ltd Export Department). In preparing this estimate, a further assumption was made namely that there would be no increase in domestic production capacity during the period 1975 to 1980. This data is presented in Table 3.2 which gives the estimated consumption in 1975 and 1980 together with the necessary imports to balance local production.

TABLE 3.1 AEROSOL PRODUCTION DATA FOR EASTERN EUROPE - 1975 (58)

Country	Production Units x 10^6	Country Population x 10^6	Apparent Consumption/Capita/Year
1. Bulgaria	0.5	8.6	0.06
2. Czechoslovakia	22.0	14.6	1.51
3. East Germany	33.0	17.0	1.94
4. Hungary	5.5	10.4	0.53
5. Poland	22.0	33.4	0.66
6. Romania	4.0	20.8	0.19
7. USSR	130.0	249.8	0.52
8. Yugoslavia	20.0	21.5	0.93
9. Turkey	6.5	37.9	0.17
TOTALS	243.5	414.0	Mean = 0.72
			Total Cons'n @ 0.72 = 298×10^6

COMPARATIVE DATA - WESTERN EUROPE

Austria	33.0	7.5	4.5
Denmark	14.0	5.1	2.8
Finland	22.0	4.7	4.4

TABLE 3.2 ESTIMATED AEROSOL CONSUMPTION IN EASTERN EUROPE

Country	Estimated Consumption in 1975 Units x 10^6	Estimated Consumption in 1980 Units x 10^6	Estimated Imports WRT 1975 Production (Table 3.1)	
			1975	1980
1. Bulgaria	6.2	7.8	5.7	7.3
2. Czechoslovakia	10.5	13.1	11.5	- 8.9
3. East Germany	12.2	15.3	- 20.8	- 17.7
4. Hungary	7.5	9.4	2.0	3.9
5. Poland	24.1	30.1	2.1	8.1
6. Romania	15.0	18.8	11.0	14.8
7. USSR	179.9	224.9	49.9	94.9
8. Yugoslavia	15.5	19.4	- 4.5	- 0.6
9. Turkey	22.3	34.1	15.8	27.6
TOTALS	243.5	414.7	49.7	129.4

NOTES (a) C.P.P.Y. for all countries = 0.72

(b) All countries shown 5% per annum growth from 1975 to 1980.

(c) No increase in home production from 1975

3.2.2.2 Method B - The Use of Economic Factors

The aerosol product is essentially one of convenience and for most end uses there are alternatives. These may be less sophisticated but are usually lower in cost, e.g. paste wax polishes as opposed to the aerosol type. In countries where disposable income is low or where there is a lack of general wealth, it is likely that the simpler, cheaper products are preferred. In addition, if large areas of the country are devoted to farming and there is a complete absence of industry and commerce, the likelihood of selling any aerosols could be small. The Economist diary presents data that shows that this situation is generally true around the world, (60) and it was reasoned that it ought to be possible to correlate some form of wealth index with aerosol consumption. The data selected is presented in Table 3.3.

Figures 3.3; 3.4; 3.5; 3.6; and 3.7 are attempts at correlations between aerosol consumption per capita per year by country and the following:-

* Weekly earnings in the manufacturing industry of the country concerned (61); (Appendix I).
* Gross National Product (60); (Appendix I).
* Number of households having a car. (60); (Appendix I).
* Number of households having a television (60); (Appendix I).
* Number of households having a telephone (60); (Appendix I).

Using a standard software package (63) based on the method of least squares for curve fitting, Figure 3.3 was selected as being best. It was thus used to estimate aerosol C.P.P.Y. for Eastern Europe, which is presented as Table 3.4.

TABLE 3.3 1979 - WORLD WEALTH INDICATORS (60)

Country	C.P.P.Y. 1975-80	G.N.P. Income $ per head	Weekly Earnings $ USA	% 1975 Households with ownership of: Cars	T.V.	Phones
Australia	8.7	7,714	300.5	39.6	35.7	46.3
Austria	4.5	7,995	137.5	28.5	28.2	34.9
Belgium	4.2	10,271	152.3	31.2	29.7	33.2
Canada	5.9	8,376	203.4	41.3	42.7	63.5
Denmark	2.1	11,587	186.7	27.8	35.4	56.5
Finland	3.1	7,393	117.5	24.5	40.0	47.0
France	3.8	9,543	126.0	34.4	28.0	37.2
Germany (W)	6.6	11,080	186.6	36.9	31.6	42.0
Greece	2.8	3,876	86.0	8.9	16.0	27.9
Ireland	5.0	4,152	170.0	20.1	17.5	17.3
Italy	4.3	5,135	141.6	30.9	22.7	30.1
Japan	2.0	7,366	83.6	19.5	24.6	45.8
Netherlands	5.2	9,568	151.4	29.3	33.0	45.3
N.Zealand	5.0	6,048	109.3	39.8	27.3	56.8
Norway	3.6	9,071	124.0	29.2	28.7	42.3
Portugal	2.4	1,693	75.0	12.2	12.0	12.8
Spain	4.1	4,795	143.0	18.9	20.6	29.8
Sweden	2.4	10,749	211.0	34.5	37.4	77.2
Switzerland	6.9	13,987	230.0	33.8	30.6	70.2
UK	9.6	6,372	250.0	26.7	32.7	44.2
USA	9.7	9,637	302.0	53.2	68.0	76.9

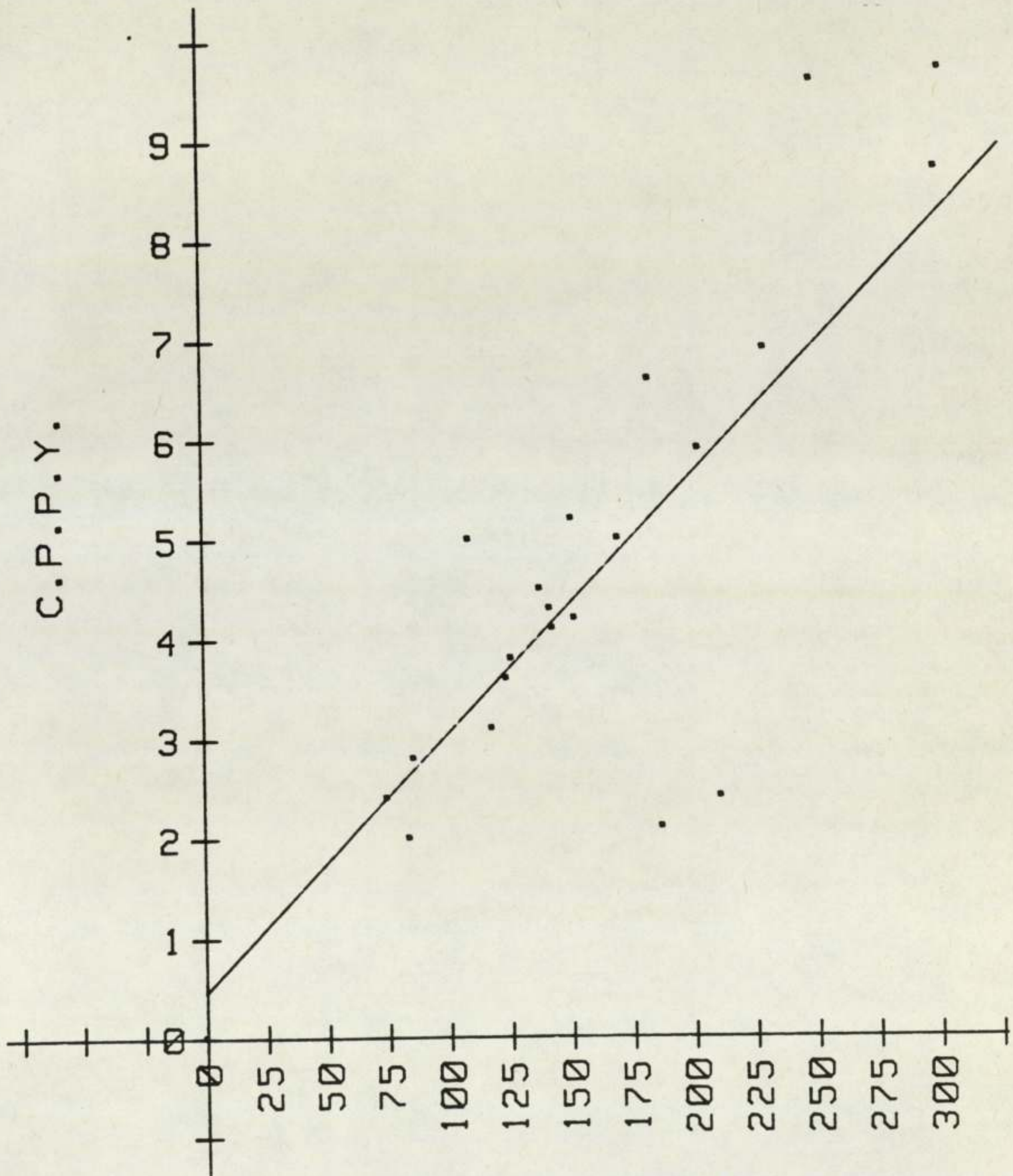


FIGURE 3.3 C.P.P.Y. VERSUS WEEKLY EARNINGS

IN MANUFACTURING INDUSTRIES (USA $)

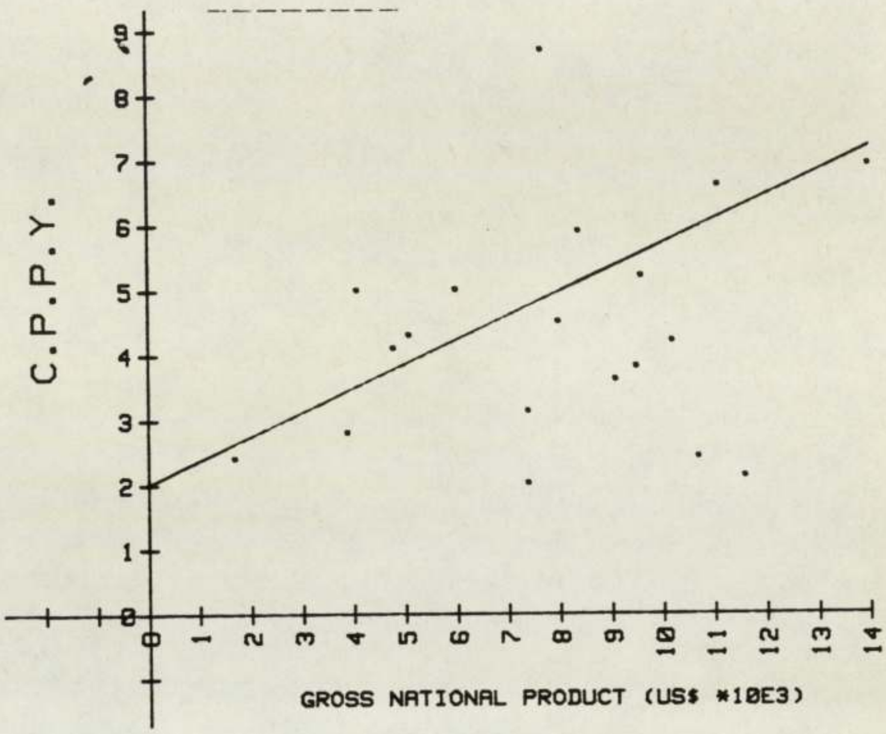


FIGURE 3.4 C.P.P.Y. VERSUS GROSS NATIONAL PRODUCT (USA $ - 1983)

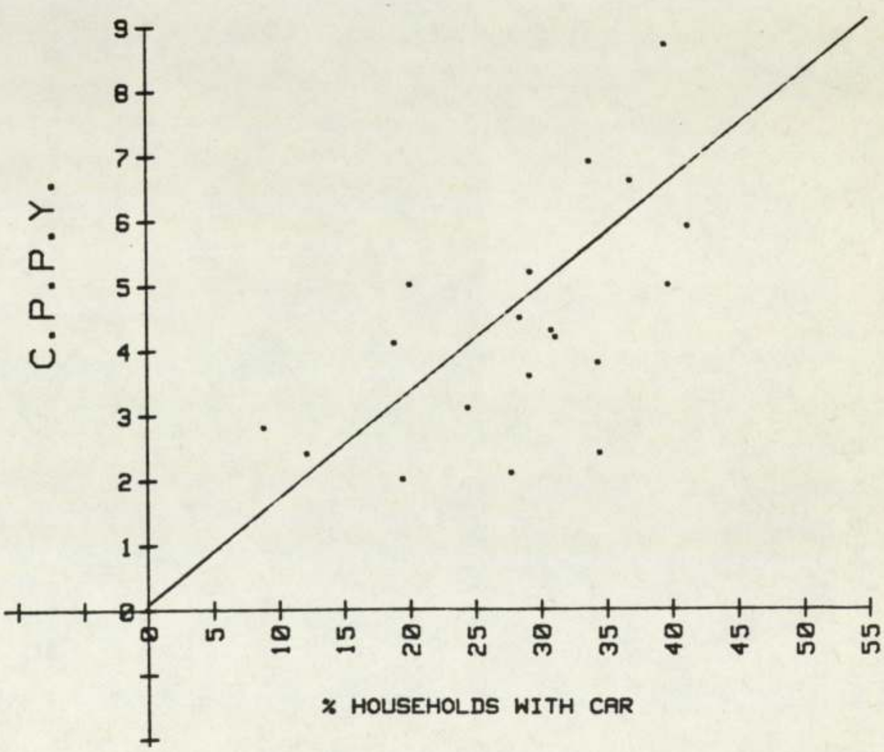


FIGURE 3.5 C.P.P.Y. VERSUS % HOUSEHOLDS WITH CAR

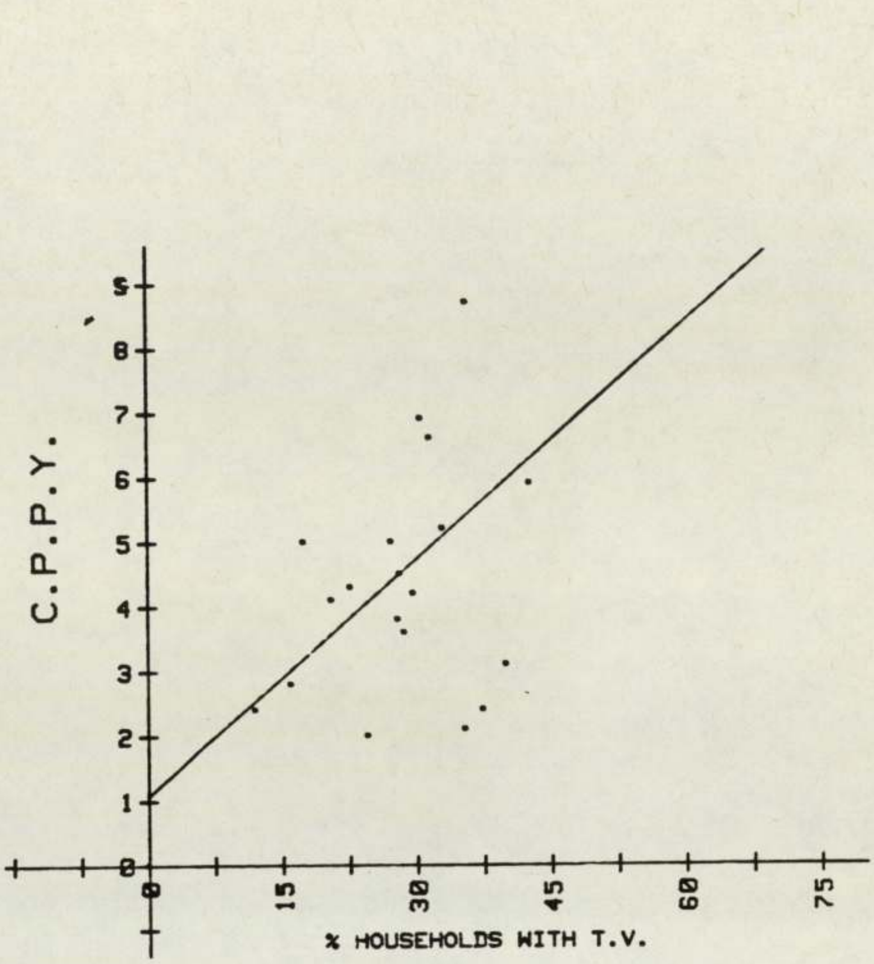


FIGURE 3.6 C.P.P.Y. VERSUS % HOUSEHOLDS WITH TELEVISION

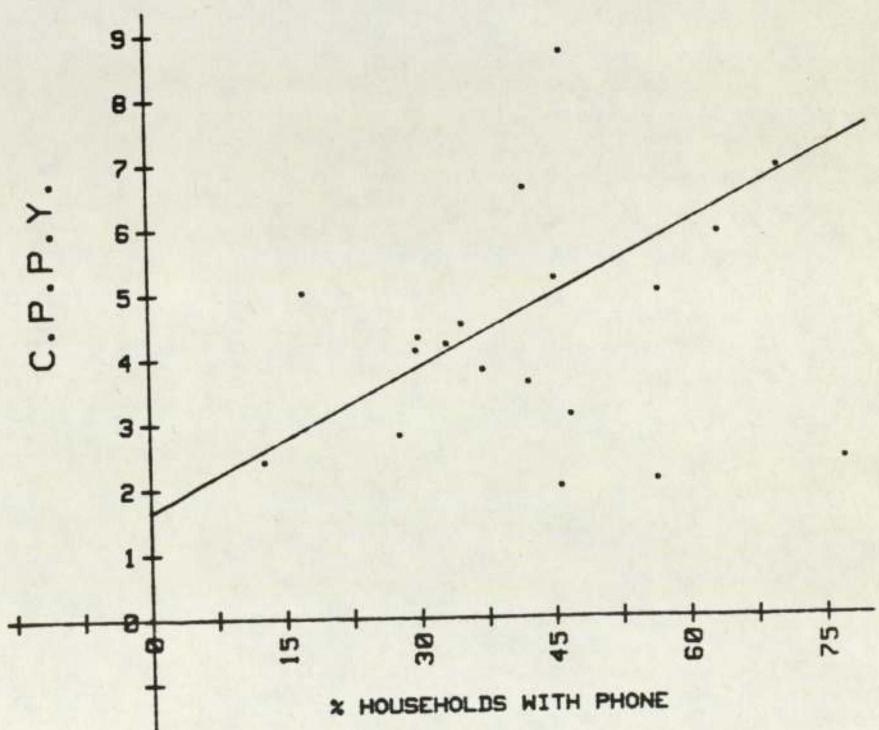


FIGURE 3.7 % HOUSEHOLDS WITH TELEPHONE

3.2.2.3 Conclusions

Comparison of Table 3.2 and 3.4 show quite similar predictions for aerosol consumption in all countries except the USSR where method B yields a higher estimate. However, it should be stressed that all that is sought from the above exercise is an order of magnitude of Eastern European aerosol consumption, such that it may be later compared with Western European data during the "aerosol balance". It is realised that the average approach of method A assumes a similar consumption and growth rate for all Eastern countries over a five year period, both of which may be an error. Similarly, method B utilises a world correlation and applies it to Eastern Europe without knowing the accuracy of fit. Nevertheless, the similarity of result is encouraging and bearing in mind the limitations of the data, should suffice for the present exercise. The largest estimates were used for the aerosol balance i.e. as in Table 3.4.

TABLE 3.4 ESTIMATE OF AEROSOL CONSUMPTION FOR EASTERN EUROPE (METHOD (B))

Country	Population $\times 10^6$ (1980) (60)	Average Weekly Earnings US \$ (1975-80)(61)	C.P.P.Y. (From Fig. 3.3)	Estimated Average Consumption (1975-80 Units $\times 10^6$
1. Bulgaria	8.9	31.0	0.93	8.3
2. Czechoslovakia	15.3	34.3	1.03	15.0
3. East Germany	16.8	40.0	1.20	20.2
4. Hungary	10.7	19.3	0.58	6.2
5. Poland	35.2	23.3	0.7	24.6
6. Romania	22.1	36.7	1.3	24.3
7. USSR	250.1	40.0	1.2	300.11
8. Yugoslavia	22.2	43.3	1.3	28.9
9. Turkey	44.3	16.7	0.8	22.2
TOTALS	425.6	$\bar{x}$ = 31.6	$\bar{x}$ = 0.94	450.6

NOTE $\bar{x}$ = arithmetical mean

3.2.3 Summary of European Aerosol Statistics

In order to conduct the "aerosol balance" described in Section 3.1.4, the period 1975 - 1980 was chosen as a convenient window in time with respect to available data. This data (presented in Appendix I and in this Chapter) was then summarised for the European region in order to highlight imports and/or export activity. Table 3.5 represents this summary.

TABLE 3.5 SUMMARY OF EAST AND WEST EUROPE STATISTICS 1975 - 1980

Country	Averaged Data for 1975-80 (Units x 10^6)			Balance for Import(-)or Export(+)	Source or Destination
	Consumption	C.P.P.Y.	Production		
WEST					
Austria	33.5	4.5	33.3	- 0.2	Self Sufficient
Belgium	41.0	4.5	49.8	+ 8.8	To Western Europe
Denmark	10.7	2.1	10.3	- 0.4	Self Sufficient
France	204.0	3.8	426.2	+ 222.2	E.Europe, Asia & Africa
Finland	15.0	3.1	18.0	+ 3.0	Eastern Europe?
Germany	409.2	6.6	453.5	+ 44.3	To E.Europe, Apain and Italy
Greece	25.9	2.8	28.8	+ 2.9	To Africa
S.Ireland	20.0	5.9	2.0	- 18.0	From UK
Italy	242.1	4.3	219.9	- 29.2	From Switzerland and Germany
Netherlands	71.9	5.2	141.2	+ 69.3	To Italy, Spain, Scandinavia
Norway	14.6	3.6	13.8	- 0.8	From Holland?
Portugal	23.5	2.4	23.7	- 0.2	To Spain
Spain	151.4	4.1	128.8	- 22.6	From Netherlands, Germany & France
Sweden	19.8	2.4	14.1	- 5.7	?From Holland
Switzerland	43.7	6.9	47.5	+ 3.8	To Italy
UK	536.4	9.6	508.0	- 28.4	From France, Netherlands & Germany
TOTALS	1862.7		2111.9	+ 249.4	Exports to E.Europe (206.3) and Africa (42.9)
EAST					
Bulgaria	8.3	0.93	0.5	- 7.8	From W.Europe
Czechoslovakia	15.0	0.98	0.5	+ 7.0	to USSR
East Germany	20.2	1.20	33.0	+ 12.8	To Poland/USSR
Hungary	6.2	0.58	5.5	- 0.7	)
Poland	24.6	0.70	22.0	- 2.6	)
Romania	24.3	1.10	4.0	- 20.3	)From Western Europe
USSR	300.1	1.20	130.0	- 170.1	)
Yugoslavia	28.9	1.30	20.0	- 8.9	)
Turkey	22.2	0.50	6.5	- 15.7	)
TOTALS	449.8		243.5	- 206.3	Imports from W. Europe (206.3)

3.3 NORTH AMERICA

3.3.1 The United States

The UNITED STATES aerosol consumption picture viewed over the period 1970 to 1980 represents one of decline. The only categories showing growth or stabilisation are Miscellaneous and Household aerosols. Personal Care aerosols have been in strong decline since 1973, as have Hair sprays and Insecticides. Some stabilisation, however, appears to have occured since 1977 for all categories. Consumption levels are however still high on a per capita per year basis compared with other parts of the world. For example, Miscellaneous aerosols appear to be stabilising at 4.1 units per capita per year, Household aerosols at 2.9 units per capita per year, Insecticides at 0.5 units per capita per year.

Overall consumption for the period 1970 to 1975 was 12.6 units per capita per year falling to 9.7 units per capita per year for the period 1975 to 1980. It is interesting to note that this now compares with the UK figure.

Production levels in the United States continue to be the highest in all of the world. In fact production levels are so high that until very recent times, they equated with the whole of the production out of Europe. These levels reached their peak in 1972 and have been in overall decline since that time. In more recent years this decline appears to have been halted, although all of the industry in the USA hope that some stabilisation is now occuring. Hair sprays and Personal Care aerosols held the largest production levels until 1975 when the Miscellaneous category moved into this position.

Miscellaneous aerosols, together with Household aerosols are the onlycategories still showing some growth in production level, Insecticides having remained static for some years. The general picture is shown in Figure 3.8 and 3.9 and more detailed data is available via Figure A 3.16 and Table A 3.16.

CANADIAN aerosol consumption over the period 1970 to 1980 shows growth across all categories to 1974 then fairly rapid decline to 1977 with some stabilisation thereafter. Exceptions are Hair sprays and Insecticides showing continued decline and slow growth respectively.

Overall consumption for the period 1970 to 1975 was 7.3 units per capita per year falling to 5.9 units per capita per year for the period 1975 to 1980. More detailed statistics are presented in Figure A 3.17 and Table A 3.17.

Aerosol production over the period 1970 to 1980 shows a rapid increase up to 1974 followed by a period of equally rapid decline between 1974 and 1977 and some stabilisation after that time. Throughout this period the production ranking was Personal Care aerosols >Household products >Miscellaneous products >Hair sprays >Insecticides. Insecticides and Personal Care aerosols are still showing slow growth in production levels.

3.3.2 Summary of Aerosol Statistics for North America (1975 - 1980)

Production and consumption data for the period 1975 - 1980 for total North America are presented in Table 3.6. Overall North America is an exporter of aerosol products.

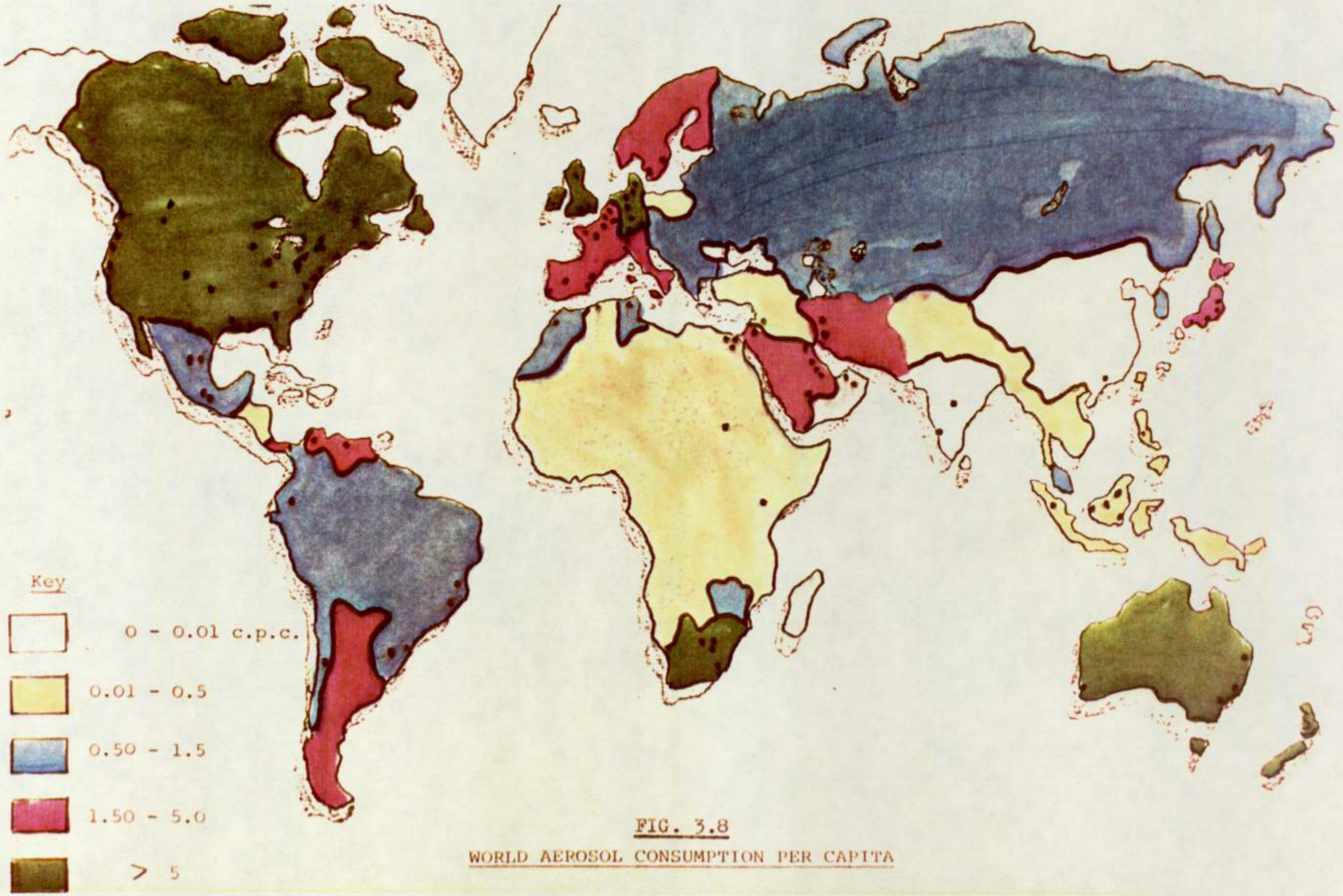


FIG. 3.8

WORLD AEROSOL CONSUMPTION PER CAPITA

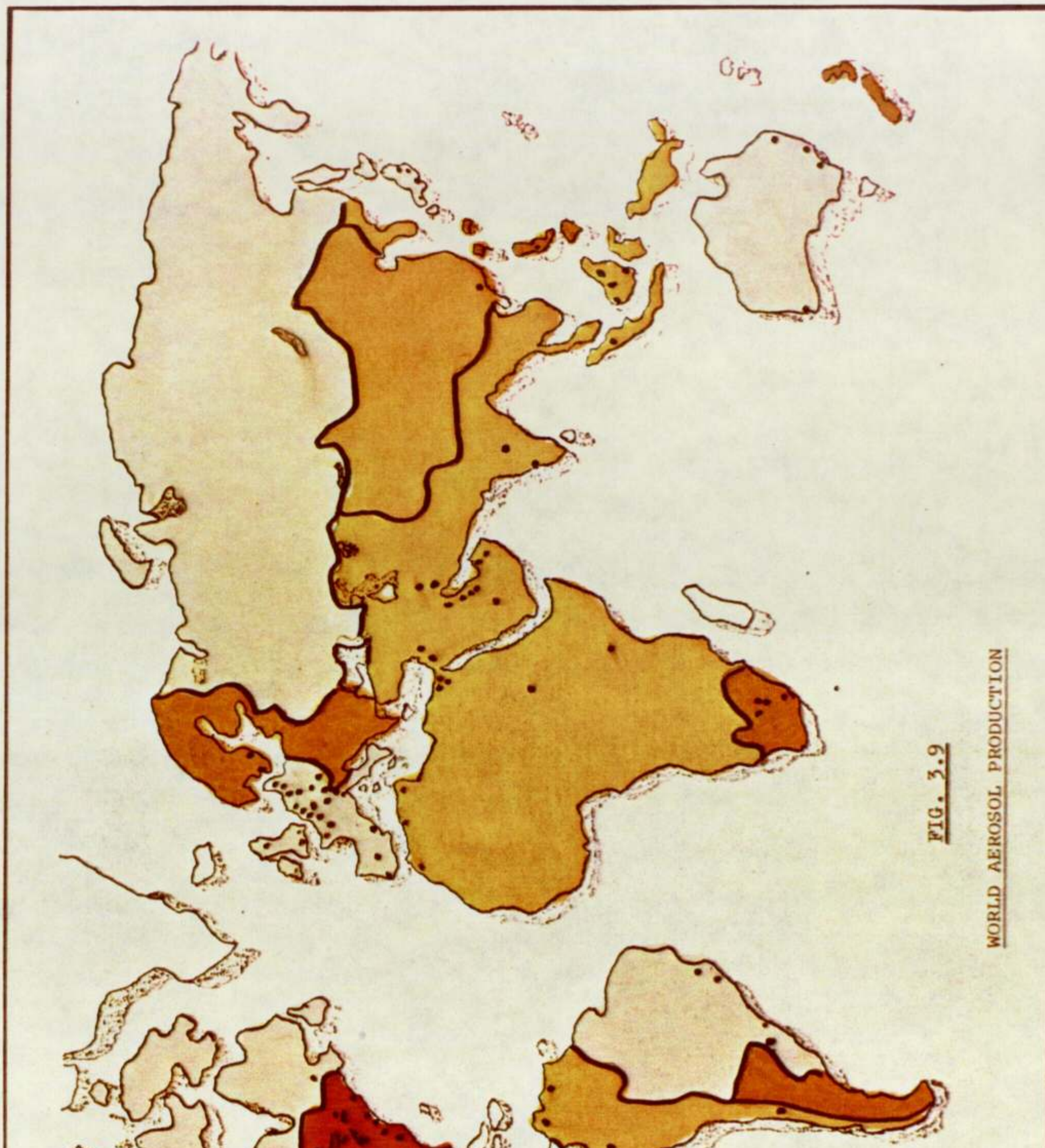


FIG. 3.9

WORLD AEROSOL PRODUCTION

TABLE 3.6 NORTH AMERICAN AEROSOL STATISTICS

Country	Population $\times 10^6$	Averaged Data for 1975 - 1980 (Units $\times 10^6$)			Balance for Import(-)or Export (+)	Source or Destination
		Consumption	C.P.P.Y.	Production		
Canada	23.9	139.9	5.9	140.8	+ 0.9	To USA
USA	227.6	2144.9	9.4	2265.0	- 120.1	To Asia; South America
TOTALS	251.5	228.4	$\bar{x}$ = 7.7	2405.8	+ 121.0	To Asia (56.9) To America (64.1)

NOTES

1. Arithmetic Mean C.P.P.Y.($\bar{x}$) = 7.7

2. Weighted Mean C.P.P.Y. based on population = 9.1

3.4 ASIA

3.4.1 Definition of the Asian Region

The countries usually described (61) as being part of Asia are:-

Bangladesh	Japan
China	Kuwait
Taiwan or Formosa	Lebanon
Hong Kong	Pakistan
India	Singapore
Indonesia	South Korea
Iraq	Syria
Iran	Thailand
Israel	Vietnam

3.4.2 Availability of Data

This is another world area where the state of industrial development in many of the countries prevents the procurement of reliable aerosol statistics. Detailed aerosol statistics i.e. breakdown by product category, have only been published so far for Japan (64), which is the only sizeable producer for this continent. Overall production data have however been obtained from published sources such as Metal Box and others (34), (57), (58), (65), for 1974 to 1975 and from S.C. Johnson data sources (66). These are presented together with consumption estimates made using Figure 3.3 of Section 3.2.3 and available data (60), (61) as Table 3.7.

3.4.3 Discussion

From the aerosol consumption viewpoint, Asian countries show low consumption on a per capita per year basis comparable with parts of Eastern Europe and Africa. Further, as many of the Asian countries have controlled economies like Eastern Europe, it is difficult to foresee ways in which this consumption can be increased. In terms of potential users, China, India, Indonesia and Pakistan all represent countries with very low current consumption yet with high numbers of potential users. The average C.P.P.Y. for this Continent is 0.75 with a weighted average based on population of 0.26 cans per capita per year. The lack of reliable data makes further comment impossible.

In production terms, the only country manufacturing on a scale comparable with Western Europe is Japan. Japan is also the only country with any sizeable export capability. The major countries importing aerosols are India; Iran; South Korea; Saudi Arabia. Once again lack of data makes comment on the increase or decrease of production capacity by products or country impossible.

3.4.4 Asia Summary

The summarised consumption/production picture for this region for the period 1975 to 1980 is presented in Table 3.7. Overall Asia is an importer of aerosols.

TABLE 3.7 ASIAN AEROSOL STATISTICS 1975 - 1980

Country	Popl'n x 10^6	Actual 1975 Prod'n Units x 10^6	%Total Prod'n	Averaged Data for 1975-80 Consumption Units x10^6	C.P.P.Y.	Prod'n Units x 10^6	Balance for -1975-80 Imports(-) or Exports(+)	Source or Destination
Bangladesh	86.6	1.0	0.4	8.7	0.10	2.3	- 6.4	From Pakistan; Israel;China
China	964.5	9.0	3.1	16.5	0.02	18.1	+ 1.6	To Bangladesh
Taiwan/Formosa	17.6	7.5	2.6	14.8	0.84	15.2	+ 0.4	To South Korea
Hong Kong	5.1	8.0	2.8	6.1	1.20	16.4	+ 10.3	To South Korea
India	663.6	7.0	2.4	159.3	0.24	14.0	- 145.3	From Japan; Israel Indonesia
Indonesia	148.5	4.5	1.6	5.9	0.04	9.4	+ 3.5	To India
Iraq	12.8	1.2	0.4	2.6	0.20	2.3	- 0.3	To Kuwait
Iran	36.9	2.0	0.7	55.4	1.50	4.1	- 51.3	From USA; Syria; Lebanon; Kuwait
Israel	3.9	8.5	3.0	10.6	2.72	17.6	+ 7.0	To India; Bangladesh
Japan	116.8	220.0	76.7	282.2	2.45	448.7	+ 162.5	To India Middle East South Korea
Kuwait	1.3	0.8	0.3	1.2	0.92	1.8	+ 0.6	To Middle East
Lebanon	3.1	0.5	0.2	0.5	0.16	1.2	+ 0.7	To Middle East
Pakistan	79.8	3.5	1.2	4.0	0.05	7.0	+ 3.0	To Bangladesh
Saudi Arabia	8.1	NIL	NIL	20.3	2.51	NIL	- 20.3	From USA
Singapore	2.4	1.5	0.5	2.5	1.04	2.9	+ 0.4	To South Korea
South Korea	37.6	1.5	0.5	35.7	0.95	2.9	- 32.8	From Singapore; China;Hong Kong;
Syria	9.0	0.8	0.3	1.0	0.11	1.8	+ 0.8	Japan
Thailand	46.5	5.0	1.7	6.2	0.13	10.1	+ 3.8	To Middle East
Thailand	46.5	5.0	1.7	6.2	0.13	10.0	+ 3.8	)
Vietnam	51.1	2.0	0.7	2.5	0.05	4.1	+ 1.6	)To South Korea
"Others"	190.0	2.5	0.9	1.9	0.01	5.3	+ 3.4	)
TOTALS	2485.2	286.8	100.0	641.9	$\bar{x}$= 0.76	585.0	- 56.9	Imports from USA (56.9)

NOTES

1. Arithmetical Average C.P.P.Y. for Asia ($\bar{x}$) = 0.76

2. Weighted Average C.P.P.Y. on population = 0.30

3.5 SOUTH AMERICA

3.5.1 Definition of the South American Region

The countries usually described (61) as comprising South America are:-

Argentina	Equador
Brazil	Mexico
Chile	Peru
Columbia	Uruguay
Costa Rica	Venezuela

3.5.2 Availability of Data

The availability of aerosol consumption and production data is similar to the situation for Asia described in 3.4. Consequently estimates of consumption and production by country were made as for Asia (See section 3.4.2 and Table 3.7). They are presented as Table 3.8.

3.5.3 Discussion

South American consumption of aerosols is higher than Asia and Africa, giving an average C.P.P.Y. of 0.97 and a weighted average C.P.P.Y. based on population of 1.33.

Production data for the period 1975 to 1980 with consumption estimates using Figure 3.3 are presented as Table 3.8. It can be seen that the two most important producers are Argentina and Brazil. Most countries are close to being in balance such that their production almost equals their consumption. The major importers are Mexico, Venezuela and Brazil. Mexico imports from the United States.

3.5.4 South America Summary

The summarised consumption/production picture for this region for the period 1975 to 1980 is presented in Table 3.8. Overall South America is an importer of aerosols.

TABLE 3.8 SOUTH AMERICAN AEROSOL STATISTICS 1975 - 1980

Country	Popl'n x 10^6	Actual 1975 Prod'n Units x 10^6	%Total Prod'n	Averaged Data for 1975-80			Balance for 1975-1980 Imports (-) Exports (+)	Source or Destination
				Consumption		Prod'n		
				Units x 10^6	C.P.P.Y.	Units x 10^6		
Argentina	26.7	105.2	39.3	75.7	2.8	135.6	+ 59.9	To Brazil; Peru; Venezuela; Columbia; Equador; Mexico
Brazil	118.7	90.0	33.6	140.7	1.2	115.9	- 24.8	From Argentina
Chile	10.9	4.5	1.7	4.7	0.4	5.9	+ 1.2	From Brazil
Columbia	26.4	2.8	1.1	12.8	0.5	3.8	- 9.0	From Argentina
Costa Rica	2.2	0.6	0.2	0.7	0.3	0.7	NIL	
Equador	8.2	1.1	0.4	1.6	0.2	1.4	- 0.2	From Argentina
Mexico	69.4	48.0	17.9	128.8	1.9	61.8	- 67.0	From USA & Argentina
Peru	17.3	2.2	0.8	3.5	0.2	2.8	- 0.7	From Argentina
Uruguay	2.9	3.0	1.1	0.9	0.3	3.8	+ 2.9	To Brazil
Venezuela	13.5	5.8	2.2	34.0	2.5	7.6	- 26.4	From Argentina
"Others"	14.3	4.5	1.7	5.7	0.4	5.9	+ 0.2	To Brazil
TOTALS	310.5	267.7	100.0	409.1	$\bar{x}$= 0.97	345.0	- 64.1	Imports from USA (64.1)

NOTES

1. Arithmetic C.P.P.Y. ($\bar{x}$) = 0.97

2. Weighted mean C.P.P.Y. based on population = 1.33

3.6 AFRICA

3.6.1 Definition of the African region

Africa is generally considered (61) to comprise the following countries:-

Algeria	Egypt
Kenya	Morocco
Nigeria	Rhodesia (Zimbabwe)
South Africa	Sudan
Tunisia	Uganda
Zaire	

and some of the less industrialised countries classified as "Others".

3.6.2 Availability of Data

Once again, there is a marked lack of aerosol consumption/production statistics for this continent and information has been derived and estimated from similar sources to that described under "Asia" in Section 3.4.2, and Table 3.9 presents data for 1975 to 1980.

3.6.3 Discussion

With the exception of South Africa, consumption is generally low, with an average C.P.P.Y. of 0.73 and a weighted average C.P.P.Y. based on population of 0.34. As shown in Table 3.9, South Africa is the only sizeable producer of aerosols and most countries fail to produce sufficient aerosols for home consumption. Algeria, Egypt, Morocco and Nigeria collectively import approximately 43 million units from Europe.

3.6.4 Africa Summary

The summarised consumption/production for this region for the period 1975 to 1980 is presented in Table 3.9. Overall Africa is an importer of aerosols.

TABLE 3.9 AFRICAN AEROSOL STATISTICS 1975 - 1980

Country	Popl'n $\times 10^6$	Actual 1975 Prod'n Units $\times 10^6$	%Total Prod'n	Averaged Data for 1975-80: Consumption Units $\times 10^6$	Consumption C.P.P.Y.	Prod'n Units $\times 10^6$	Balance for 1975-1980 Imports (-) Exports (+)	Source or Destination
Algeria	19.1	4.0	4.6	17.5	0.92	6.4	- 11.1	)From Western Europe
Egypt	41.0	1.5	1.7	8.2	0.20	2.4	- 5.8	)
Kenya	15.3	2.0	2.3	12.2	0.81	3.2	- 9.0	From South Africa
Morocco	19.5	6.5	7.5	11.7	0.60	10.5	- 1.2	From Western Europe
Nigeria	74.6	0.5	0.6	37.3	0.51	0.8	- 36.5	From South Africa (15.6) Western Europe (20.9)
Rhodesia) Zimbabwe)	7.1	3.0	3.4	7.3	1.03	4.8	- 2.5	From South Africa
S. Africa	28.5	60.0	69.0	68.9	2.41	96.6	+ 27.7	To Uganda; Zaire; Zimbabwe; Nigeria; Kenya
Sudan	17.9	1.0	1.2	1.8	0.12	1.7	- 0.1	From South Africa
Tunisia	6.4	4.0	4.6	8.3	1.31	6.4	- 1.9	)
Uganda	13.2	1.0	1.2	2.6	0.22	1.7	- 0.9	)From "Others" and
Zaire	27.9	0.5	0.6	1.4	0.05	0.8	- 0.6	)South Africa
"Others"	185.5	3.0	3.4	5.7	0.03	4.8	+ 0.9	)
TOTALS	456.0	87.0	100.0	182.9	$\bar{x}$=0.70	140.0	- 42.9	Import 42.9 from Western Europe

NOTES

1. Arithmetical mean C.P.P.Y. ($\bar{x}$) = 0.70

2. Mean Weighted C.P.P.Y. based on population = 0.34

3.7 OCEANIA

3.7.1 Definition of Oceania

Oceania is considered (61) to comprise the following countries:-

Australia	New Zealand

which between them account for 80% of the population of Oceania. The balance is made up of a series of small islands, namely:-

American Samoa	Christmas Island
Cocos Island	Cook Islands
Fiji	French Polynesia
Guam	Johnson Island
Kiribati Island	Mariana Islands
Midway Island	Nauru
New Caledonia	Niue
Norfolk Island	Pacific Islands
Papua New Guinea	Pitcairn
Solomon Islands	Tokelau
Tonga	Tuvalu
Vanuatu	Work Island
Wallis and Fortuna Islands	Western Samoa

Apart from Australia and New Zealand, only New Caledonia and Papua New Guinea have populations in excess of three million. It is difficult to estimate to what extent aerosol products are used in any of these areas.

3.7.2 Availability of Data

Information on aerosol consumption and production available for Australia and New Zealand, gathered by their respective Aerosol Trade Associations (67), (68), and from S.C. Johnson internal sources (69). There is no available data on the small islands therefore for the purpose of the "Aerosol Balance", Oceania will be considered to comprise Australia and New Zealand. This assumption is unlikely to introduce large errors as the population and lifestyle of the populus of the Oceanic Islands (61) is inconsistent with appreciable aerosol consumption.

3.7.3 Discussion

AUSTRALIAN consumption figures show some decline for Hair sprays and Cosmetic aerosols but good growth for Household, Insecticide and Miscellaneous products. Overall C.P.P.Y. for the period 1970 to 1975 was 7.7 rising to 8.7 for the period 1975 to 1980. Further data is presented in Figure A 3.18 and Table A 3.18.

Aerosol production has shown a steady growth since 1970 with Household products being the largest category and Hair sprays, Personal Care aerosols and Insecticides at similar levels. The production levels are similar to the Netherlands and Spain. (See Section 3.2).

NEW ZEALAND aerosol consumption appears to have peaked in 1974, undergone a period of decline until 1978 and stabilised from that point. The ranking in decreasing order is:-

Household >Insecticides >Miscellaneous >Hair sprays >Personal Care.

Overall C.P.P.Y. for the 1970 to 1975 period was 6.3 falling to 4.4 for the period 1975 to 1980.

Aerosol production showed some growth from the period 1968 to 1974 and has remained static at low level since that period. Like Australia, Household aerosols are the largest single category followed by Insecticides and Miscellaneous products. Hair sprays and Personal Care products are at similar levels.

More detailed data is presented as Figure A 3.19 and Table A 3.19.

3.7.4 Oceania Summary

The summarised consumption/production for this region for the period 1975 to 1980 is presented in Table 3.10. Overall Oceania is self sufficient in aerosols.

TABLE 3.10 OCEANIA AEROSOL STATISTICS 1975 - 1980

Country	Popl'n Units $x10^6$	Averaged Data for 1975 - 80			Balance for 1975-1980 Imports(-)or Exports (+)	Source or Destination
		Consumption	C.P.P.Y.	Prod'n		
Australia	14.4	125.3	8.7	125.0	))In Balance	NIL
N.Zealand	3.1	13.6	4.4	13.5	)	NIL
TOTALS	17.5	138.9	$\bar{x}$= 6.6			No Exports or Imports

NOTES

1. Arithmetical mean C.P.P.Y. $\bar{x}$ = 6.6
2. Mean C.P.P.Y. based on population = 8.0

3.8 THE AEROSOL BALANCE

3.8.1 Introduction

Earlier in this Chapter, the production and consumption statistics for aerosols are surveyed on a world-wide basis. For the period 1975 to 1980, these data were presented as a series of tables (Tables 3.5 through to 3.10), giving side-by-side comparisons of production and consumption figures for this period together with the difference between them or 'balance' in millions of units. The sources and/or destination for these units was also identified. Using these Tables 3.5, 3.6, 3.7, 3.8, 3.9 and 3.10, a test was made of the validity of the information by conducting an accounting exercise which has been called the "Aerosol Balance".

The "Aerosol Balance" is presented as Table 3.11 and further illustrated in Figures 3.8 and 3.9. Figure 3.8 shows world aerosol consumption on a C.P.P.Y. basis by area indicating the transfer of products a cross frontiers.

3.8.2 Conclusions

(a) Aerosol consumption and production largely occur in the more wealthy and economically well developed parts of the world.

(b) Typical C.P.P.Y. figures for industrialised and relatively prosperous countries e.g. USA/UK are in the range 5 to 10 yet reduce to 0.8 for poor and developing countries.

(c) Major exporters are: Western Europe, USA.

(d) Major importers are: Eastern Europe, Asia, South America.

TABLE 3.11 AEROSOL BALANCE 1975 - 1980

Continent	Aerosols Imported x 10^6	Aerosols Exported x 10^6
Western Europe	-	249.2
Eastern Europe	206.3	-
North America	-	121.0
Asia	56.9	-
South America	64.1	-
Africa	42.9	-
Oceania	-	-
TOTALS	370.2	370.2

3.9 SUMMARY OF CHAPTER 3 WORLD-WIDE ANALYSIS OF AEROSOL MARKETS

This section has presented and analysed historical data on aerosol consumption and production on a country by country basis. In conducting this exercise, it has become apparent that aerosol statistics are lacking from many world areas and that this study probably represents the first published attempt to survey this important part of the chemical speciality business.

North America and Western Europe emerge as the major aerosol consumers, producers and exporters and it is clear that there is much potential to increase aerosol consumption in many world areas such as parts of South

America, Africa, Middle, Near and Far East plus Eastern Europe if the political/social barriers can be in some way overcome.

The aerosol balance gives credibility to the various aerosol statistics in accounting for <u>all</u> aerosols consumed, produced and transferred across frontiers on a world-wide basis.

CHAPTER 4: EXTERNAL FACTORS LIKELY TO INFLUENCE THE MARKET FOR AEROSOLS

4.1. INTRODUCTION

The external factors likely to influence the world market for aerosols were identified, examined and ranked prior to conducting the forecasting exercise aimed at predicting this market to the year 2000. A critical literature review formed the basis of this study from which three main factors emerged: "Safety", "Environmental", "Socio-economic". The safety problems identified were mainly those of flammability and inhalation. The environmental factors appeared to be primarily the ozone controversy but also concern over the use of a valuable natural resource (L.P.G.) and the problems of disposal of empty aerosol containers. Socio-economic factors were those which affected and controlled the rationale for aerosol production and consumption.

4.2 LITERATURE REVIEW

The literature review set out below comprises a section on each of the three major factors described in the introduction to this Chapter.

In reviewing the safety of aerosols, consideration was given first to the question of aerosol flammability and secondly to the possible health hazards that may be associated with the inhalation of aerosol particles. The environmental factors appear to relate mostly to the ozone controversy (1), the main points of which are reviewed in this Chapter.

Finally the literature on the socio-economic factors which effect some control over aerosol consumption has been reviewed. This literature concerning the external factors likely to influence the world market for aerosols, is made up of contributions mostly from the United States via the Chemical Speciality Manufacturers Association (C.S.M.A.), (70), and the work of the British Aerosol Manufacturers Association (B.A.M.A.) in the UK (71). Ideally a more international picture would be preferred in preparing this review, but these are two prime sources of information on this subject.

4.2.1 The Safety of Aerosol Products

4.2.1.1 Flammability Issues

(a) Manufacture:

Aerosol flammability has assumed a position of increasing importance in more recent years as a result of the ozone controversy, described later in this Chapter. The basic problem is that many aerosols are propelled by liquified petroleum gas propellent (L.P.G.) which is highly flammable. This flammability hazard can manifest at all stages of production and consumption through to disposal. C.F.C. propelled aerosols are still widely used but even these may not be completely free from the flammability hazard, for example insecticides, which can contain large quantities of flammable solvents and thus present a pressurised source of flammable material.

The accident statistics concerning fires at aerosol manufacturing installations are difficult to obtain although such data is collected by both the British Aerosol Manufacturers Association and by the Chemical

Speciality Manufacturers Association in the United States. This is done by liaison with the various aerosol trade associations throughout the world and by scanning the technical and popular press. Many of the newspaper articles are extremely emotive and have tended to give more space to this subject since the publication of the Molina Rowland hypothesis (1). There appears to be a common viewpoint in such articles namely that aerosols are not only damaging to environment but are dangerous both to manufacturer and consumer (72), (73), (74).

Information collected by B.A.M.A. (75) and C.S.M.A. (76), is issued periodically on a confidential basis to their members and at the present time describes less than half a dozen factory fires in the forty five years that aerosols have been manufactured commercially. According to the B.A.M.A. manufacturing incidents have been due to one of four factors namely:-

(i) Ruptured or leaking L.P.G. transmission lines.

(ii) Shrink wrapping machinery.

(iii) Electrostatic charging and subsequent ignition of leaking aerosols.

(iv) Problems occuring during the warehousing of aerosols.

All the above problems appear to have been experienced and therefore anticipated in the two major codes of good manufacturing practice issued by both B.A.M.A. (77) and C.S.M.A. (78). It is likely however that many of the smaller aerosol manufacturers have either not appreciated the importance of adhering to these codes or have been unable to afford the installation of the extra equipment needed for transferring from C.F.C. to L.P.G. propelled products.

The electrostatic problems which specifically relate to powder containing aerosols are a further consequence of the ozone controversy induced change from C.F.C. propellants to hydrocarbon propellants. Fortunately there has only been one serious incident which may be attributed to this phenomenon (79) although with a high level of interest in filling powder containing anti-perspirant aerosols, the industry has been forced to take the matter very seriously. The electrostatic problem and possible solutions to it have been described by Roberts and Simpson (80) and proposed safety methods by Roberts and Hughes (81) and by B.A.M.A. (82). The problems relating to the warehousing and storage of aerosols will be described in the next section.

(b) Warehousing of Aerosols:

Flammability hazards relating to the storage of aerosols in warehouses are almost absent from the literature. However the subject has received extensive attention from both the British Aerosol Manufacturers Association (83) and from the C.S.M.A.(84) via their respective Flammability and Warehouse Committees. Both committees have published confidential documents available to their members (85), (86) and are still actively working on the subject at the time of writing.

In addition to the specialised reports of the two Flammability Committees, both aerosol associations produce so-called "media" reports which essentially list adverse copy in the press relating to aerosols. (75), (76). Very few of these publications relate to warehousing problems but by using those available and the trade association reports, information has been built up which allows the discussion below.

Aerosol flammability hazards during warehousing relate to the fact that hydrocarbon pressurised aerosols can leak flammable vapours either due to faulty or damaged packaging which may be subsequently ignited by a spark from either electrical or internal combustion equipment or machinery. Once again ignition occurs, there is usually sufficient outer packaging material, such as shrink wrap film and board cartons, to sustain the fire and as the heat builds, the process is accelerated by aerosol cans becoming over pressurised, bursting, and liberating more fuel to expand the fire. In addition, it has been established (73) that aerosols can become projectiles making the process of fire fighting additionally hazardous.

The incidence of warehouse fires in the United Kingdom has been surveyed by B.A.M.A. (85) and by the Fire Protection Association (87). In summary, there have been nine incidents involving the storage of aerosols dating back to 1973 although it has not been established that aerosols are directly the cause of the fire in each case. In addition, the B.A.M.A. Warehouse Committee has compiled further confidential data by polling its various members (88). This was done by sending questionnaires to major aerosol companies who are members of the Warehouse Safety Committee and the questionnaires gathered information on the dimensions; storage capacity; method of storage and fire prevention and fire fighting facilities in each warehouse. They also gathered information on incidence of fires both minor and major. Further data gathered in this survey suggested that in addition to those incidents reported by B.A.M.A. and the Fire Protection Association, there were several other minor incidents where the fire had been contained and there was little damage to personnel or plant and equipment.

Data on fire incidents in the United States is tightly controlled within the C.S.M.A. membership and thus quantification here is impossible. The most recent fire there occured in June 1982 when 113 million USA dollars worth of damage resulted from a warehouse fire in which butane lighter fluid and aerosol based carburetor cleaners were involved. This incident received extensive coverage in the USA press which was summarised in B.A.M.A.'s media bulletin of February 1983 (89).

It has been found to be impossible to obtain data on aerosol warehouse flammability incidents elsewhere in the world. However data already presented has raised industry concern to such a level that further stringent constraints are already being considered for aerosol manufacture and storage. These will now be discussed.

Codes of practice for the safe handling and storage of aerosol products have been established for some time via the C.S.M.A. Code of Good Manufacturing Practice (78) and its B.A.M.A. counterpart (77). Fresh interest in the storage of aerosols re-emerged in 1976 via the Health and Safety Executive who were alerted by a major aerosol fire in Scotland (87). It is also probable that the concern with aerosols generally triggered by the Molina Rowland publication (1) caused regulation authorities to re-consider flammability aspects and insurance associations to re-examine conditions of acceptance. One such association which apparently gives indemnity to much of the American aerosol industry is the Factory Mutual Association (90). Prior to the K-Mart fire in 1982, (89), they were already working with the C.S.M.A. to re-draft their conditions of acceptance. The K-Mart fire had an immediate "knock-on" effect causing them to tighten their acceptance conditions via their loss prevention data sheets (90).

This action has prompted an extensive series of discussions between the C.S.M.A. and the insurance company and similar discussions and activities in the UK via the B.A.M.A. Safety Panel. Test work has been completed (85) with the aim of demonstrating that proposed and existing safety measures in the warehouse are quite capable of dealing with any flammability incident, such that risk to human life and damage to plant and equipment is minimised. This work is continuing at the present time and the general trend is towards compartmentalising warehouses and installing very extensive readily activated sprinkler systems. This is unlikely to be a problem for the major aerosol manufactures despite the high costs involved. However concern exists that insurance companies may try to insist on similar guidelines for what they call "mercantile locations" or retail stores.

Naturally aerosol associations on both sides of the Atlantic and elsewhere in the world regard these proposals with apprehension. The B.A.M.A. Warehouse Safety Committee has been active on this subject since September 1981 liaising with the Health and Safety Executive. In addition, specialist consultant organisations have been enlisted (91) to argue the case for aerosols using their specialised knowledge and the good safety record with regard to the storage of aerosols held by the supermarkets and retail outlet warehouses. A major problem source appears to be the forklift truck. Many of these machines are not fully flame-proof and often powered by internal combustion motors. The cans can be punctured by the truck forks or by a truck running over them and resulting ignition situations have been demonstrated. The subject is receiving extensive attention from the Committee.

Studies on reducing flammability of hydrocarbon propelled aerosol systems have been made by Johnson Wax Ltd by Roberts (92), Wagenaar (93), and also by Meuresch of the German aerosol Valve Company, D.V.P. (94). However while these essentially formulation changes can greatly reduce the danger from the aerosol in the home (to be discussed in the next section), they are unlikely to have any effect on the warehousing problem. In this respect work continues in the hope that both B.A.M.A. and C.S.M.A. can influence their respective government and insurance society executives to produce a set of guidelines that will not initiate a de-stocking of aerosol products.

(c) In the Home:

The main sources of information on aerosol hazards in the home are the media bulletins collected and issued by the American and British Aerosol Trade Associations and referred to in the previous section. These bulletins started to be circulated to trade association members in 1973 following the Molina Rowland publication (1).

Most of these articles are somewhat emotive and many suggest that a serious problem does exist with aerosol products. In two of these articles (95), (96), various fire officers have been misquoted as making statements about aerosols being dangerous in the home and although retractions have been printed at a later date, such statements have caused the industry some concern. Once again, quantitative data is hard to come by and is based on the media bulletins from both B.A.M.A. and C.S.M.A. From their interpretation, it apears that the number of incidents reported have been small in relation to the number of aerosols sold and successfully used. Such incidents have usually involved aerosol misuse, that is to say, the manufacturers recommendations about keeping pressurised cans away from heat sources such that the temperature is maintained at less than 50 degrees Celsius or from naked flames, have been totally or deliberately ignored, resulting in a fire situation.

In summary, therefore, it must be concluded that aerosols have satisfactory safety record for home use from the flammability viewpoint although it should be pointed out that these conclusions are based on somewhat scanty data.

4.2.1.2 Inhalation and Toxicity Hazards Associated with Aerosol Products

The investigations into the inhalation and toxicity aspects of aerosols were prompted by two separate phenomena. First the popularity of the aerosol antiperspirant/deodorant sprays in the late 1960's was associated with consumer complaints regarding the application of the product inducing coughing and sneezing.

The second phenomenon was considerably more serious and involved a new form of aerosol misuse directed at achieving partial anaesthesia by the deliberate inhalation of certain aerosol sprays. This subject has been recently reviewed by Roberts (97), and Table 4.1 shows threshold limit values for aerosol propellants. Tables 4.2, 4.3 and 4.4 give the mortality statistics due to aerosol abuse. Roberts concludes that the only dangers in respect of inhalation of aerosols are due to artificially concentrating the vapours i.e. aerosol misuse.

TABLE 4.1 PROPELLANT THRESHOLD LIMITS

Substance	Threshold Limit Value * (Time Weighted Average)
Dichlorodifluoromethane (Propellant 12)	1000 ppm
Trichlorofluoromethane (Propellant 11)	1000 ppm
Butane	600 ppm

* HSE Guidance Note EH 15/80

TABLE 4.2 ANALYSIS OF AEROSOL PRODUCT TYPES ASSOCIATED WITH NUMBER OF DEATHS (TOTAL 36)

Gas Lighter refills	14	Hair Sprays	1
Pain relief sprays	8	Spraygun cartridge	1
Deodorant/antiperspirant	3	Fire Extinguisher	1
Fly Sprays	2	Unknown	5
Industrial Solvent Cleaner	1	TOTAL	36

TABLE 4.3 ANALYSIS OF AEROSOL INGREDIENTS ASSOCIATED WITH NUMBER OF DEATHS # (TOTAL 36)

Halogenated hydrocarbons	14
Hydrocarbons	14
Solvents	1
BCF (Fire extinguishant)	1
Unknown	6
TOTAL	36

Coroners´ findings do not always implicate the particular material

TABLE 4.4 NUMBER OF DEATHS (TOTAL 36) RECORDED PER YEAR IN UK DUE TO AEROSOL ABUSE-INFORMATION RECORDED BY B.A.M.A.

1969	1	1974	1	1979	6
1970	0	1975	3	1980	10
1971	0	1976	3	1981	4
1972	0	1977	4		
1973	2	1978	2	TOTAL	36

Both of these phenomena caused aerosol producers to commission various scientific investigations into the toxicological aspects of aerosol inhalation by product type (98), (99), (100). As with much of the data highlighted and discussed in this study, most of the scientific work in this area was subsequently completed in the United Kingdom, co-ordinated by the trade association there. Although the literature on the subject is very extensive it has been conveniently summarised in a recent B.A.M.A report (101). This report, prepared by a special B.A.M.A. committee comprising scientific personnel from all major UK aerosol manufacturers reviews all published data on the subject up to 1981. Specifically the review deals with production and fate of aerosol particles; the position of inhaled particles in the respiratory tract; epidemiological studies; inhalation tests on animals and development of consumer protection to inhalation. It concludes that under likely conditions of use, inhalation of aerosol particles resulting from the current range of consumer products is unlikely to present any hazard to health. However the report also states that while there is no firm evidence to suggest a health problem, there are many topics relating to the toxicity apsect of aerosols that need further research.

More general aspects of product toxicity in the UK are monitored by the "Home Accidents Surveillance System" (102, operated by the Consumer Safety Unit of the Department of Trade. Their most recent report (102), is summarised in Table 4.5 and indicates that aerosols account for 0.04% of the total home accidents and 0.43% of accidents with packaged goods.

TABLE 4.5 ACCIDENT SURVEILLANCE SCHEME DATA ON ACCIDENTS WITH PACKAGED GOODS

Tin	1065
Bottle (Glass)	445
Box (Not tool/toy)	134
Jar (Glass) and lids	66
Tool/toy box	62
Key (to tin)	61
Polythene Bag	39
Other (specified)	36
Plastic container	30
Tube	28
AEROSOL	19
Case (of food and drink)	12
Food wrappings	12
Carton	8
Barrel/drum	6
Flask (vacuum)	6
Paper Bag	4
Other (unspecified)	4
Sachet	1
Flask (not vacuum)	1
TOTAL	2039

4.2.2 Environmental Factors

Three main environmental factors which are likely to influence aerosol sales are described in the literature. The major one is the so-called "ozone controversy" resulting from the Molina Rowland report (1), and the minor one relates to the concern over the use of valuable natural resources such as L.P.G. in 'unnecessary' products like aerosols. There are also problems associated with the disposal of empty or used aerosol containers from the safety viewpoint. These factors will now be discussed in more detail.

4.2.2.1 Ozone Controversy

The literature describing the ozone controversy originates from two sources, namely the media and the information published by the professional and scientific bodies. The publications by the press are extensive dating from the late 1973 when the hypothesis, first advanced by Molina Rowland (1), initiated concern regarding damage to the earth's environment by chlorofluorocarbons mostly stemming from aerosol use. In essence, the hypothesis of Molina Rowland (illustrated in Figure 4.1) suggested the following sequence of events:-

1. Chlorofluorocarbons (C.F.C.'s) due to their great stability, are not decomposed in the lower atmosphere but find their way into the stratosphere.

2. C.F.C molecules are broken down by sunlight to liberate chlorine atoms.

3. These chlorine atoms catalyse the decomposition of ozone present in the stratosphere.

4. Stratospheric ozone is responsible for absorbing ultra-violet radiation arriving from the sun. A reduced ozone concentration means an increase in the amount of ultra-violet radiation reaching the surface of the earth.

5. Ultra-violet radiation can be shown to cause skin cancer, whose incidents will thus increase.

The press and the media reacted as though the work by Molina Rowland was a factual report rather than a hypotheses. Most of the articles appearing from 1974 until fairly recently tended to convey the message that <u>all</u> aerosols are bad and should be avoided. Newspaper and even technical magazine articles with titles like "Spray and Disaster" (103) and "US Warns of Cancer Threat" (104) were quite common in more sensationalist newspapers, written by science correspondents who simply got the facts wrong. In addition they were also in the Pseudo-Scientific articles which assembled the known facts but also filled in the gaps with assumptions, giving the impression much more was known of the ozone depletion question than was in fact the case (105), (106).

Fortunately the main body of the scientific community took a more reasonable view. Although there are numerous publications on the subject, three scientific reports summarise what is known and what work is planned and on-going in order to clear up the uncertainties. The most comprehensive report was published by the UK department of environment and is known as Pollution Paper Number 15 (10). A similar document was

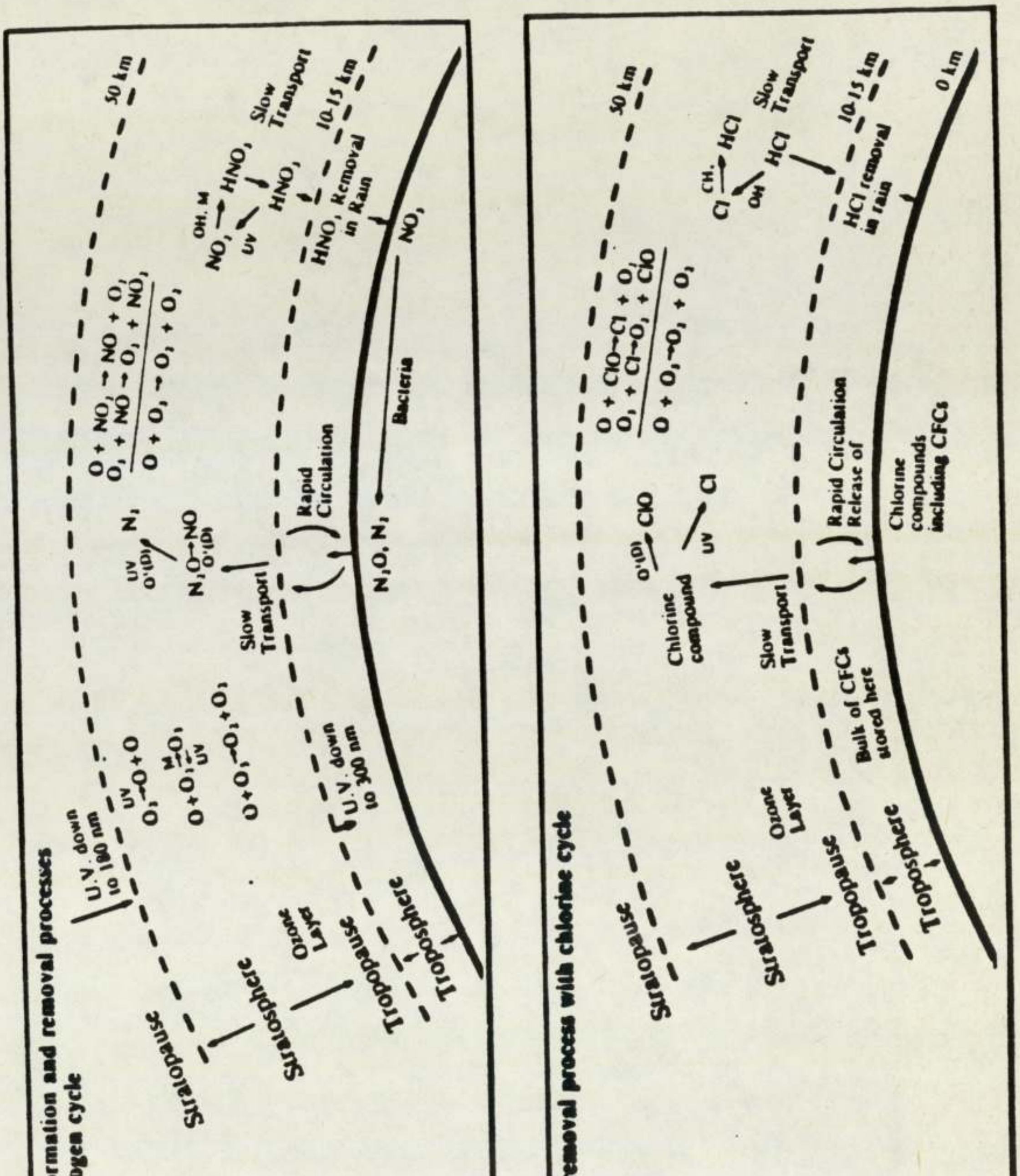


FIGURE 4.1 OZONE REMOVAL PROCESSES

published by the National Research Council in the United States and entitled "Stratospheric Ozone Depletion by Hydrocarbons, Chemistry in Transport" (9). The third report of consequence was compiled by the Metra Consulting Organisation and entitled "Social and Economic Implications of Controlling the Use of Chlorofluorocarbons in the E.E.C." (8). All three reports concluded that while the case was unproven, chlorofluorocarbons were likely to be damaging to the environment and recommended that the authorities considered carefully the implications of reducing their use and the timing of such a move.

The two former reports concentrated on the chemistry, the modelling exercises and the degree of uncertainties associated with the various measurements being made in the upper atmosphere. They are in broad agreement regarding predictions of ozone depletion and in the fact that it would be in five to fifteen years before computer modelled predictions can be confirmed by direct measurements. The Metra report concludes that the effects of an immediate ban on chlorofluorocarbons could have quite serious consequences for many people, employed directly or indirectly in the manufacture and use of chlorofluorocarbons and that a proper regulatory time scale be devised to safe-guard industry, especially in view of the time needed to establish with certainty the extent of the problem.

The conclusions therefore on the published studies to date are as follows"-

1. It appears likely that chlorofluorocarbons and other compounds (both man made and natural e.g. N_2O; CH_4; CO; NO_x; CO_2; CH_3Cl) are reaching the stratosphere.

2. It is likely that they are causing an increased breakdown of ozone but more information is needed on all species.

3. If the release of chlorofluorocarbons into the atmosphere continues at the 1973 rate, an equilibrium depletion of ozone of some 6 - 7% may be achieved in one hundred years or more.

4. Events described in (3) above may cause an increase in the average ultra-violet flux of up to 14%.

5. Although it is known that ultra-violet radiation is one of the causes of skin cancer, it is impossible to say if an increase of 14% in the U.V.B. could cause a detectable increase in its incidence.

6. There is no reliable information on concentration of unnatural contaminents in the stratosphere or the effect on each other in the natural constituents.

7. The Molina Rowland report has had a considerable effect on the aerosol industry both in terms of temporarily and permanently reduced aerosol sales (to be discussed later in Chapter 6) and in terms of the move away from C.F.C. propellants to hydrocarbon and other propellants. With hindsight this effect may be considered out of all proportion to the validity and so far proven consequences of the original hypothesis.

8. The ramifications of some of the changes currently underway in the aerosol industry are considerable, aerosols now having been put under continual scrutiny from not only the environmental aspect but in terms

of general safety, flammability and overall desirability. These aspects will be discussed later in this Chapter.

4.2.2.2 Using Valuable World Resources

The United States have always used L.P.G. as the major propellant for aerosols and as the result of the ozone controversy described earlier, this propellant is rapidly gaining ground in Europe and elsewhere. In view of this and taking into account the general concern about aerosols, commentary has been made in the literature (107) regarding the use of this valuable natural resource into what has been termed "unnecessary products".

The UK is a convenient example through which to study this question in that a substantial amount of aerosols are filled here and that many of the aerosol fillers have undergone a degree of substitution away from C.F.C. propellants.

Annual production of L.P.G. was 1,575 thousand metric tonnes in 1976 (7). During the same year 70% of the aerosols produced were C.F.C. propelled, the balance being L.P.G. propelled which is equivalent to a consumption of 12 thousand tonnes or 0.8% of the total. A further estimate shows that if all aerosols produced in 1976 had used hydrocarbons, the total L.P.G. consumption would be 40 thousand tonnes or 2.5% of the total.

Therefore although the annual consumption and use figures have changed slightly from the 1976 figures discussed above, overall proportions have not changed and the data serves to illustrate the problem is not of significant proportions.

4.2.2.3 Use of Tinplate

Continuing with the theme of questioning the use of valuable resources, further queries have been raised about tinplate for non food-stuff containers i.e. aerosols. The possibility of re-cycling such containers has also been discussed (108) and while work apparently continues on the fine tuning of the economics of such a proposal, the current facts are the quantity of tinplate used in aerosol containers is very small compared with that used in food stuffs and beverages. A recent estimate shows that the actual figure is a little over 1% (109).

4.2.2.4 Problems in Disposal of Used Aerosol Cans

It has been claimed that even used aerosol containers constitute a flammability hazard either by being thrown onto bonfires or by being disposed of through normal refuse disposal systems (110). In addition, some trade association literature (85) has indicated difficulties in can disposal at aerosol manufacturing sites.

Dealing first with the concern regarding the misuse of aerosol containers, there are cases on record of children being injured as a result of throwing used and partially used aerosols on bonfires (111). In such a situation the aerosol container will contain appreciable amounts of propellant gas to cause the can to explode or even to become a projectile as a result of over-heating. The actual number of recorded incidents appears to be small (102) and while this is one aspect of the aerosol system that lends itself more readily to abuse than for other containers, these accidents involve a total disregard for the manufacturers recommended use instructions.

There appears to be no evidence in the literature that problems exist regarding the collection and sorting and compacting of used aerosol containers by municipal authorities. The absence of the problem has been confirmed by conducting an internal survey within the S.C. Johnson manufacturing companies throughout Europe and asking and establishing that no such problems exist with their local authorities. The survey showed that where compactive residues have been used on a land fill site, some ingnitions have occured. These occurrences are however typical of flammable materials rather than of aerosols and there appear to be no special problems associated with aerosols. A day to day collection of used aerosol containers is known to occur without difficulties even when mixed with normal domestic refuse.

Finally there is the question regarding aerosol can disposal at aerosol manufacturing sites. During the manufacture of aerosol products, a certain amount of scrap ensues. This takes the form of cans of products which are defective in some way and are therefore unsuitable for retail sale. These cans have to be disposed of at the manufacturing site.

The B.A.M.A. Flammability Committee (112) has documented some of the earlier problems experienced with the ignition of aerosol cans during the disposal process. Most manufacturers dispose of their sub-standard cans by compacting them in a crusher prior to being moved from the site by a specialist waste disposal contractor or the local authority. During the site process, the cans are first de-pressurised by piercing and then crushed and compacted. Because of the flammable contents, and in some cases the lack of flame-proofing of crushing equipment, fires in can crushing machines have occured particularly where the feed stock to the crushing machine consists totally of aerosol cans.

Codes of practice for handling such scrap have been well documented by the Trade Associations such as B.A.M.A., C.S.M.A., also by the can manufacturers themselves such as Metal Box Company (113). This latter company through a subsidiary, has designed special equipment for crushing, venting and compacting aerosol packages and such specialised equipment is frequently in evidence at aerosol manufacturing sites. There is no evidence in the UK at least, that the shift from C.F.C. to hydrocarbon propellants has caused further problems in this respect.

4.2.3 Socio-Economic Factors

4.2.3.1 Introduction

In this section the aim is to investigate and discuss the sociological and economic factors which currently affect aerosol consumption and may do so in the future. At the end of this Chapter, these and other factors so far discussed, will be ranked according to their assessed importance in contributing to future aerosol demand and consumption.

The sociological factors relate to consumer behaviour and attitudes to aerosol products and these factors tend to be studied by companies marketing aerosols as a matter of normal business procedure, via their market research departments. In addition, work has been done in this area by both B.A.M.A. (21), (7), and the Metal Box Organisation (22).

The influence of economic factors is key to most business interests and aerosols are particularly sensitive in that for three decades, the industry has been one of the more profitable parts of the household products sector and expectations in this respect are high. However the conversion from C.F.C.'s to hydrocarbon propellants has so far proved to be costly in terms of capital investment, and has had adverse effects on the economics of aerosol production (114), (115). This situation coupled with other more general economic factors continues to give cause for concern. Both sociological and economic factors will be discussed in more detail in this section.

4.2.3.2 Sociological Factors

These factors may be sub-divided under two further headings, namely:-

(a) Behavioural Patterns dictated by life style; age group; income bracket; family background.

(b) Consumer attitudes such as fashion; concern about the environment; safety; product performance.

(a) Consumer behavioural patterns can give important clues as to the future demand for a particular product. Studies conducted by Johnson Wax Ltd (116) and others (117) indicate that for the sectors of the consumer products market serviced by aerosols, the consumer spending patterns are both well established and stable. Based on UK data (116) behavioural patterns have been established relating to the aerosol product in terms of the following:-

- Percentage of the weekly income spent.
- Sex and age group of the consumers purchasing the items.
- Type of product and the frequency of purchase.
- Changes in these patterns relating to income and family background.

According to Kotler (118) as incomes rise people spend a higher proportion of their money on luxury goods and services. This has been confirmed by the Metal Box Organisation (22) who identified that the popularity of the aerosol is due primarily to its convenience and speed of use. This subject will be covered in greater detail in Chapter 6 where the relationships between consumer wealth indices and aerosol consumption will be explored. Information already presented in Chapter 3 shows that poor or developing countries consume few aerosols whereas relatively wealthy countries tend to use labour saving and easy to use products and are the highest consumers.

(b) Attitudes

Although aerosol marketers utilise part of their market research facilities to establish consumer spending patterns, the major focus tends to be on attitude studies. That is to say that research is aimed at understanding why consumers purchase aerosols and having done so, the degree of satisfaction with them. In addition measurements are made of attitudes to the following:-

- Fashion trends.
- Concerns about the environment.
- Concerns about product safety.
- Comments on product performance.
- Preference for alternatives to the aerosol.
- Comments on value for money.

Attitudinal studies have been conducted by both B.A.M.A. (119) and SC Johnson (120) and these have indicated that the single most important factor affecting consumer attitudes towards aerosols has been the ozone controversy. This has largely been as a direct result of coverage in the media. Recent studies (119) have indicated that the effect of this policy has diminished considerably although there is still a failure on behalf of the consumer to distinguish between C.F.C. propelled aerosols and hydrocarbon propelled aerosols. That is to say that in the consumers mind there is a strong probability that all aerosols are in some way bad. This attitude may interplay with a further negative identified in the above research namely that in the USA, consumer appreciation of the convenience aspects of aerosols has dropped from 74% of users in 1973 to 34% of users in 1980.

4.2.3.3 Economic Factors

Some of the reasons why consumers purchase aerosols were explored in the last sub section of this chapter. If consumers are to purchase aerosols, they must be conveniently available at retail outlets. In order that this situation will prevail, manufacturers must find good business reasons to produce them. This merits a consideration of the economic factors governing aerosol production and indirectly consumption. In summary the aerosol industry has grown worldwide because initially the public interest in this type of packaging was stimulated by convenient to use insecticide products as discussed in Chapter 2. It would seem that the aerosol industry has grown to its present size for the reasons listed below:-

(a) The aquisition of aerosol manufacturing technology was relatively straightforward.

(b) The aerosol manufacturing process was readily adaptable to mass production methods thereby incorporating economies of scale.

(c) Aerosol manufacturing and retailing achieved good profit margins.

(d) The aerosol package offered unique opportunities to market modified versions of old and existing products but also to introduce new products.

Therefore it is reasonable to presume that if any of the above conditions were to change, aerosol marketers might wish to review their position. For instance, prior to the ozone controversy, the manufacture of aerosols propelled with C.F.C.'s was relatively straightforward with no flammability risks involved. Processing depended largely on a knowledge of working with pressurised materials together with an ability to formulate household products. As discussed in this Chapter, the ozone controversy has changed the safety criteria and in endeavouring to move away from C.F.C propellants, many manufacturers have been forced to work with 'new' materials such as L.P.G. This in turn has made them consider the associated flammability problems and the necessary capital investment required to guarantee the safety of their workers.

From a formulation viewpoint, the switch from C.F.C. to hydrocarbons has meant major changes in raw materials and packaging often with subsequent increased costs and decreases in product performance. A review at the 1980 B.A.M.A. forum by Roberts (114) and others (115), concluded that manufacturers intending to convert to hydrocarbon propelled aerosols should anticipate increased problems and subsequently increased investment needs.

To some extent the lower feed stock price of L.P.G. compared with C.F.C. has counterbalanced the above considerations in Europe. However in the United States this has had little effect as the majority of aerosols have been propelled with hydrocarbons for some years. As stated, in the European region, economic advantages have still been possible although at the time of writing, (1983), some advantages have eroded due to the numerous world oil crises. In 1983, aerosols still represent an attractive investment in terms of net returns but considerable doubt exists within the industry as to how much longer this is likely to be the case.

Two further economic factors that are known to influence the brand share of an aerosol product are advertising and price reductions tied to sales quantities often called "dealing". These marketing procedures are by no means specific to aerosols and have been used with considerable success by Johnson Wax Ltd and their competitors during the last decade. Several studies have looked at the influence of advertising, price cutting and special dealing within the retail outlets (121), (122), (118), (123), and while the literature does not appear to contain studies specifically dealing with aerosols, there is no reason to believe why this form of packaging should not be comparable to other household products. Judging by the literature, most of these studies seem to be inconclusive in respect of the extent or even certainty of the effect of advertising in stimulating consumption. However the ability to gain an increased share of a given market seems to have been established. Berensen (128) concludes the effect of advertising diminishes greatly as the product life cycle proceeds towards maturity. Therefore as most aerosol products are within mature product categories, the main purpose of advertising and dealing expenditure is presumably to capture a greater share of the market - usually from the competition.

4.3 SUMMARY

This chapter has focused on the external factors likely to affect aerosol consumption. The aim has been to try and highlight those factors which are likely to have a major effect on future aerosol consumption. This has been done by consulting the literature and reviewing Johnson Wax Ltd data in order to obtain a qualitative and quantitative assessment.

Summarised results of this exercise are shown in Table 4.6 which identifies the flammability and safety issues as being of key importance. This theme is further developed via the scenario method in Chapter 6.

The ozone issue has been concluded to be relatively unimportant in terms of predicting the future of aerosols, partly due to the industry's on-going self regulation policies with C.F.C.'s and because it will be another decade before the facts are known on ozone depletion.

Finally, from the sociological viewpoint and using S.C. Johnson and other international data sources (55), (60), (61), it appears that no immediate major change in world buying power is anticipated nor in the way that we equip and maintain our homes where most aerosol products are used. If on the other hand, the buying public become convinced that aerosols are bad from the safety and health viewpoint, this could have a major negative effect. (See also Chapter 6).

TABLE 4.6 EXTERNAL FACTORS - RANKING OF IMPORTANCE

FACTOR	RANKING	DIR'N	FUTURE DEVELOPMENTS Optimists	Pessimists
Safety				
(i)Flammability Isssues	1	-	Stricter control on storage mostly at manufacturing sites. Reduced number of producers.	Stricter controls on storage - reduced distribution. Higher production costs. Further fire incidents alerting public concern - reduced consumption.
(ii)Inhalation	2	-	No firm evidence against aerosol comes to light - sprays designed to reduce respirables.	Research findings and consumer interest in clean air mediate against use of space sprays especially fragrance/solvent containing
Sociological Factors				
Changing attitudes to aerosols	3	-	Downward trend only temporary	Downward trend continues and strengthens in light of recession; need to have value and clean air punctuated by flammability issues.
Environmental				
Ozone Issue	4	+ or -	Ozone controversy shown to be a non issue due to (i) erroneous modelling (ii)self regulation controls.	New findings within 10 years show that ozone still being depleted.
Economic	5	+ or -	Aerosols shown to be good value to both manufacturer and consumer. Alternatives too costly to produce in large numbers.	High cost of safety measures reduce profit to point where aerosol marketers put money into other business.

CHAPTER 5: FORECASTING METHODS

5.1 INTRODUCTION

The future of the current aerosol products are of key interest to this study and having analysed every significant national market in Chapter 3, it was decided to forecast the demand for aerosol products to the year 2000. The purpose of this Chapter is to review established methods of technical forecasting, and to select and develop techniques for the aerosol forecast presented later in Chapter 6.

According to Chambers (125), forecasting techniques sub-divide into three types namely:-

* Qualitative Methods;
* Time Series Analysis and Projection;
* Causal Methods.

This chapter provides a systematic review of all of these techniques (presented as Table 5.1), and discusses the selection of those methods most suitable for forecasting the future of the aerosol.

5.2 REVIEW OF FORECASTING METHODS

A literature review was conducted over the period 1970 to 1980 and in addition, the Bibliography on Business and Economic Forecasting (125) was consulted with the results summarised in Table 5.1. These are discussed below.

5.2.1 Qualitative Methods

These methods of forecasting tend to be used when data is scarce and as the name implies, the technique relies on qualitative or judgemental information. Unfortunately such information often provides a poor basis for comparison and a large opportunity for varying interpretations. Such techniques are reported to be used mostly in new technology areas (126) especially where "inventions" are likely to be involved. In Table 5.1 Delphi; Market Research; Panel Consensus Forecasts; Historical Analogy and Cross Impact Analysis are presented as examples of Qualitative Methods.

The techniques of technological forecasting (161) also mainly employ qualitative forecasts some of which are described in Table 5.1, and the others e.g. morphological analysis are reviewed in Chapter 11. However as stated above, the concern with respect to varying interpretation tends to mediate against their use for the forecast of aerosol futures.

5.2.2 Time Series Analysis and Projection

This is perhaps one of the better known techniques of forecasting to which well tried statistical techniques can be applied. Essentially the forecaster uses the data on past performance to develop projections for the future. Fortunately, the surveys conducted in Chapter 3 provide historical data for aerosols on a national basis (World-wide) for a significant number of years. There are six variations of Time Series Analysis forecasting methods presented in Table 5.1. Of these particular attention was given to the exploration of techniques best able to produce a long range forecast.

5.2.3 Causal Analysis

This is claimed to be the most sophisticated kind of forecasting method (125). It endeavours to express mathematically the relevant causal relationships that govern the dependent variable, in this case aerosol consumption. Regression models are usually applied to relate sales or consumption to other factors that are initially hypothesised as being key elements of the study system, often comprising "Economic" and "People" factors. Eight Causal methods are listed in Table 5.1 and the choice of method for this study will be discussed below under Section 5.3.

Experience gained in the preparation of the survey of aerosol production and consumption (presented in Chapter 3) indicated that the task of preparing causal forecasts on a country by country basis might prove difficult or impractical for the following reasons:-

(a) For forecasting models that require extensive data both in terms of the number of factors and data points, this may be difficult or impossible to obtain for the aerosol industry.

(b) The complexity and cost of the task is probably beyond the scope of the study.

(c) It may be unnecessary in that by making forecasts for several 'typical' countries, extrapolations may be made to the rest of the world.

Due consideration brought forth the decision to defer the choice until experience had been gained in applying the selected forecasting techniques to the aerosol industry in the USA and UK. This is described in the next Chapter.

5.3 SELECTION OF TECHNIQUES

5.3.1 Delphi Technique

This was chosen because it was felt that at some point in the study, it was necessary to incorporate acknowledged expert opinion on the long term future of the aerosol industry. This was seen to be particularly relevant in view of the large areas of uncertainty surrounding the possibility of new more stringent Legal and Government restraints in various parts of the world. In addition the technique was known to have reasonably good accuracy for long term forecasts (125).

5.3.2 Time Series Analysis

As with many studies of this kind it seemed that no single technique would completely provide the required information, that is a comprehensive and well considered forecast to the year 2000. For example, it was of interest to know what would happen if aerosol consumption in each country more or less continued to the trends of the previous years. A Time Series Analysis and projection seemed to be ideally suited to this use. Although the medium and long term accuracy was reported to be poor (125) none of the Time Series Techniques gave particularly good predictions in this respect and a Box-Jenkins Technique was readily available to the author via a standard software package that could be utilised with available computer equipment. Further investigation also identified the "S Curve" analysis methods (125), (127), and their application to long range forecasting. They were therefore selected for use in Chapter 6.

5.3.3 Causal Analysis

The Causal Analysis approach held much appeal because it represented a new approach for the aerosol industry. It certainly had not been used in Johnson Wax Ltd and there were no published data on its use (126). Consumer surveys conducted by Metal Box (22), Johnson Wax Ltd (120) and Others (119), (117), as to the reasons why people buy aerosols tended to draw three main conclusions namely:-

* For Convenience and ease of use.
* For superior performance versus non-aerosol products.
* For cost effectiveness or value for money, even though the initial outlay was often higher than the non-aerosol product.

None of the above factors can be readily quantified except in so far that "convenience" generally tends to incur a cost and that it may be that there is a threshold level of income, or disposable income, below which "convenience" simply is beyond reach. Other concerns about using Causal Techniques were as follows:-

(i) Causal relationships in the UK could be different to those in other world countries particularly the lesser developed countries. As the UK had been chosed for causal relationship trials, (on the basis that it was easier to obtain data for this area) some errors could be introduced.

(ii) For many countries of the world, the type of information that may be needed to model future aerosol consumption could either be difficult or impossible to obtain.

(iii) It was realised that to produce a forecast on a country by country basis (worldwide), the choices of forecasting method may have to be governed by the type of available data rather than on the basis of method's, accuracy and precision.

Nevertheless it was decided to proceed with the trial of the causal technique using UK data gathered both within Johnson Wax Ltd and on a national basis (119). It was hypothesised that the factors relating to aerosol consumption could be categorised under the headings 'People Factors' and 'Business Factors'.

'People Factors' were seen to relate largely to buying power such as:-

* Disposable Income:
* Spending Patterns:
* Unit Cost.

'Business Factors' were those items which make the manufacture and sale of a product worthwhile to the company marketing it. The hypothesis here was as detailed by Berensen (128) and others (118); namely that each product has a life cycle comprising: 'Birth'; 'Rapid Growth'; 'Maturity'; 'Decline'; and 'Death'. The last stage i.e. Death is the point when a marketing company is no longer deriving sufficient profit from the products manufacture and sale. In other words, companies will not generally continue with uneconomic and non-profit making products. The business factors were therefore identified to be:-

* Gross Sales;
* Manufacturing Costs;
* Advertising Costs;
* Size Inventory;
* Gross Profit;
* Operating Profit.

Following this causal approach, multiple regression analysis, was performed examining the various factors and the relationship between them. To aid this activity a Honeywell software package was utilised. Runs were made to initially establish the importance of the "people" and "business" factors described above by regressing collected UK aerosol Hair spray data using C.P.P.Y. and sales units as the dependent variables. This exercise was followed by using the more readily available and detailed Johnson Wax Ltd data this time relating sales to people and business factors. The results of this activity are presented and discussed in the next Chapter.

5.3.4 Market Analysis

The difficulty in gathering overseas information based on `desk research' prompted the use of the S.C. Johnson international intelligence network to obtain local data. Direct or written contact was therefore made with colleagues in overseas countries to obtain local findings on the size and the future growth rate of the aerosol markets in order to prepare forecasts. Marketing colleagues were asked for their findings on their own country and their viewpoints about neighbouring countries, in order to build up a more comprehensive picture. The size of the user population was of particular interest and it was found that for many aerosol products, an arithmetical calculation establishes the upper threshold consumption level as:-

$$C = 52N/W$$

Where C is the aerosol consumption in units per year, N is the number of product users in the country, and W is the weeks of useful life obtainable from the product. Thus for example with a product like an aerosol shave foam, where there is only one man in a household and an 8 oz can lasts him four weeks, it is unlikely that, that household will purchase more than 12 cans per year.

In fact, bearing in mind that there are many `shavers´ who still use soap sticks, or electric razors, the per capita consumption for aerosol shavers will be considerably less than 12 cans per year.

5.3.5 Comparisons

It was decided that comparisons would be made on a side by side basis for all four forecasting methods to the year 2000 and further commentary made for all techniques (with the exception of Delphi), on how the forecasts might be modified, in the light of anticipated legislation and controls on aerosols.

5.4 SUMMARY

The intention of this Chapter was to review and select the techniques to be used in Chapter 6, in forecasting aerosol futures. Four techniques have been selected and the selection rationales presented with discussion.

TABLE 5.1 SURVEY OF FORECASTING METHODS

A. QUALITATIVE METHODS

TECHNIQUE	1. DELPHI METHOD	2. MARKET RESEARCH
Description	A panel of experts is interrogated by a sequence of questionnaires in which responses to one questionnaire are used to produce the next questionnaire. Any set of information available to some experts and not others is thus passed on to the others, enabling all the experts to have access to all the information for forecasting. This technique eliminates the bandwagon effect of majority opinion and dominant personalities.	The systematic, formal, and conscious procedure for evolving and testing hypotheses about real markets. The techniques most commonly used are called multi-variate statistical techniques.
Accuracy:		
Short term(0-3mths)	Usually not applicable	Usually used as inputs to other forecasting techniques
Medium term(3mths-2yrs)	Fair to very good	
Long term(2yrs and up)	Fair to Very Good	
Identification of turning points	Fair to Good	Fair to Very Good
Typical applications	Forecasts of long-range and new product sales, forecasts of margins and technological forecasting.	Forecasts of long-range and new product sales; forecasts of margins changes in market share; customer attitudes and buying habits.
Data required	A coordinator issues the sequence of questionnaires; editing and consolidating the responses.	As minimum, two sets of reports over time. One needs a considerable collection of market data from questionnaires, surveys and time-series analyses of market variables
Cost of forecasting with a computer	£1,500 +	£ 5,000 +
Is calculation possible without a computer?	Computer often not utilised	YES but very difficult
Time required to develop an application and make a forecast	2 months to 1 year	3 months

TABLE 5.1 CONTINUED

A. QUALITATIVE METHODS

TECHNIQUE	3. PANEL CONSENSUS	4. VISIONARY FORECAST
Description	This technique is based on the assumption that several experts can arrive at a better forecast than one person. There is no secrecy, and communication is encouraged. The forecasts are sometimes encouraged by social factors and may not reflect a true consensus. Results greatly influenced by group dynamics.	A prophecy that uses personal insights, judgement and when possible facts about different scenarios of the future. It is characterised by subjective guesswork and imagination in general, the methods used are non-scientific
Accuracy:		
Short term 0-3mths)	Poor to Fair	Poor
Medium term(3 mths-2yrs)	Poor to Fair	Poor
Long term (2yrs and up)	Poor	Poor
Identificaiton of turing points	Poor to Fair	Poor
Typical applications	Forecasts of long-range and new product sales; forecasts of margins.	Forecast of long-range and new product sales, forecasts of margins
Data required	Information from a panel of experts is presented openly in group meetings to arrive at a consensus forecast. Again, a minimum is two sets of reports over time.	A set of scenarios about the future prepared by a few experts in light of past events.
Cost of forecasting with a computer	£ 1,000	£500 +
Is calculation possible without a computer?	YES	YES
Time required to develop an application and make a forecast.	2 weeks	1 month

TABLE 5.1 CONTINUED

A. QUALITATIVE METHODS

TECHNIQUE	5. HISTORICAL ANALOGY	6. CROSS-IMPACT ANALYSIS
Description	This is a comparative analysis of the introduction and growth of similar new products, which bases the forecast on similarity patterns.	This consists of systematically assessing the possible impact of every single event on every other event. Estimates are obtained for each of the possible events that can occur, for their relative importance and probability of occuring
Accuracy:		
Short term(0-3mths)	Poor	Not applicable
Medium term(3mths-2yrs)	Good to Fair	Fair to Good
Long term (2yrs and up)	Good to Fair	Fair to Good
Identification of turning points	Poor to Fair	Fair to Good
Typical Applications	Forecasts of long-range and new product sales, forecasts of margins.	Forecasts of long-range and new product sales.
Data required	Several years' history of one or more similar products.	Estimates of each of the important events, their inter-relationships, and probabilities of happening. Usually requires the inputs of experts.
Cost of forecasting with a computer	£ 500 +	£1,000 +
Is calculation possible without a computer	Computers often not utilised.	YES but difficult
Time required to develop an application and make a forecast?	1 Month	1 Month +

TABLE 5.1 CONTINUED

B. TIME-SERIES ANALYSIS AND PROJECTIONS

TECHNIQUE	1. MOVING AVERAGE	2. EXPONENTIAL SMOOTHING
Description	Each point of a moving average of a time series is the arithmetic or weighted average of several consecutive points of the series, where the number of data points is chosen so that the effects of seasonals or irregularity or both are eliminated.	This technique is a weighted moving average, except that more recent data points are given more weight. Descriptively, the new forecast is equal to the old one plus some proportion of the past forecasting error. Adaptive forecasting is somewhat the same except that seasonals are also computed. There are many variations of exponential smoothing; some are computationally more complex, and some require more computer time.
Accuracy:		
Short term(0-3mths)	Poor to Good	Fair to Good
Medium term(3mths-2yrs)	Poor	Poor to Good
Long term (2yrs and up)	Very Poor	Very Poor
Identification of turning points	Poor	Poor
Typical Applications	Inventory control for low volume items.	Production and inventory control, forecasts of margins, and other financial data.
Data required	A minimum of two years monthly or weekly sales history, if seasonals are present; otherwise, less data. (of course, the more history the better.) The moving average must be specified.	The same as for moving average
Cost of forecasting with a computer	£<10	£ <10
Is calculation possible without a computer	YES	YES
Time required to develop application and make a forecast	1 Day or less	1 Day or less

TABLE 5.1 CONTINUED

B. TIME SERIES-ANALYSIS PROJECTIONS

TECHNIQUE	3. BOX-JENKINS	4. X - 11
Description	Exponential smoothing is a special case of the Box-Jenkins technique. The time series is fitted with a mathematical model that is optimal in the sense that it assigns smaller errors to history than any other model of the class. The type of model must be identified and the parameters then estimated. This is apparently the most accurate statistical routine presently available but also one of the most costly and time consuming ones.	Developed by Julius Shiskin of the Census Bureau, this technique decomposes a time series into seasonals, trend cycles, and irregular elements. Primarily used for detailed time-series analyses (and estimation of seasonals). Its use has been extended to forecasting and tracking and warning by incorporating other analytical methods. Used with special knowledge, it is perhaps the most effective technique for medium range forecasting - three months to one year - allowing one to predict turning points and to time special events.
Accuracy:		
Short term(0-3mths)	Very Good to excellent	Very Good to Excellent
Medium term(3mths-2yrs)	Poor to Good	Good
Long term(2yrs and up)	Very Poor	Very Poor
Identification of turning points	Fair	Very Good
Typical applications	Production inventory control for large volume items, forecasts of cash balances.	Tracking and warning; forecasts of company, division or department sales; setting and critiquing budgets.
Data required	The same as for a moving average. However, in this case more history is very advantageous in model identification and parameter estimation.	A minimum of three years' history to start. Thereafter the complete history.
Cost of forecasting with a computer	£70	£ 2.50
Is calculation possible without a computer?	NO	NO
Time required to develop an application and make a forecast.	1 or 2 Days	1 Day or less.

TABLE 5.1 CONTINUED

B. TIME-ANALYSIS AND PROJECTIONS

TECHNIQUE	5. PROJECTIONS	6. LEARNING-EXPERIENCE CURVE
Description	This technique fits a trend line to a mathematical equation and then projects into the future by means of this equation. There are several variations: e.g the slope-characteristic method, polynomials, semi-log graph paper.	The original learning curve first noticed in the manufacture of aircraft, focused primarily on the increased efficiency and decreasing manufacturing costs, which occured as production volume was accumulated in this particular product type. The recurrence of this efficiency improvement enabled production planners to closely predict future costs. The experience curve is a generalisation of the familiar learning curve. The Boston Consulting Group has expanded it to include other factors, such as cost -volume and all components of final product unit costs delivered to the customer (e.g. manufacturing costs, selling and distribution costs, and product development and administrative costs.)
Accuracy:		
Short term(0-3mths)	Very Good	Fair
Medium term(3mths-2yrs)	Poor to Good	Fair to Good
Long term(2yrs and up)	Poor to Good	Fair to Good
Identification of turning points	Poor	Fair
Typical applications	New product forecasts (particularly intermediate and long term).	Forecasts of a short to long range costs for established and new products; budgeting; forecasting manpower and capital requirements; scheduling; purchasing; pricing; and so forth.
Data required	Varies with technique used. However, a good rule of thumb is to use a minimum of 5 years' annual data to start. Thereafter, the complete history.	Several years' history of one or more products.
Cost of forecasting with a computer	Varies with application £5 - £100	£ 150 +
Is calculation possible without a computer?	YES	YES
Time required to develop an application and make a forecast	1 Day or less	1 Day

TABLE 5.1 CONTINUED

C. CAUSAL METHODS

TECHNIQUE	1. REGRESSION MODEL	2. ECONOMETRIC MODEL
Description	This function relates sales to other economic, competetive, or internal variables, and estimates an equation using the least-squares technique. relationships are primarily analysed statistically, although any relationship should be selected for testing on a rational ground.	An econometric model is a system of interdependent regression equations that describes some sector of economic sales or profit activity The parameters of the regression equations are usually estimated simultaneously. As a rule, these models are relatively expensive. to develop and can easily cost between £2,500 and £5,000 depending on detail. However, because of the system of equations inherent in such models, they will better express the casualities involved than an ordinary regression equation and, hence, will predict turning points more accurately.
Accuracy:		
Short term(0-3mths)	Good to Very Good	Good to Very Good
Medium term(3mths-2yrs)	Good to Very Good	Very Good to Excellent
Long term(2yrs and up)	Poor to Good	Good
Identification turning points	Very Good	Excellent
Typical applications	Forecasts of sales by product classes, forecasts of margins	Forecasts of sales by product classes, forecasts of margins.
Data required	Several years' quarterly history to obtain good, meaningful relationships. Mathematically necessary to have two more observations than there are independent variables.	The same as for regression.
Cost of forecasting with a computer	£150 +	£2,500 +
Is calculation possible without a computer?	YES	YES
Time required to develop an application and make a forecast	Depends on ability to identify relationships	2 Months +

TABLE 5.1 CONTINUED

C. CAUSAL METHODS

TECHNIQUE	3. INTENTION TO BUY AND ANTICIPATION SURVEYS	4. INPUT - OUTPUT MODEL
Description	These surveys of the general public (a) determine intentions to buy certain products or (b) derive an index that measures general feeling about the future and estimates how this feeling will affect buying habits. These approaches to forecasting are more useful for tracking and warning than forecasting The basic problem in using them is that a turning point may be signalled incorrectly (and hence never occur)	A method of analysis concerned with the inter industry or inter-departmental flow of goods or services in the economy of a company and its markets. It shows what flows of inputs must occur to obtain certain outputs. Considerable effort must be extended to use these models properly, and additional detail not normally available be obtained if they are to be applied to specific businesses. Corporations using input-output models have expended as much as £ 50,000 and more annually to develop useful applications.
Accuracy:		
Short term(0-3mths)	Poor to Good	Not applicable
Medium term(3mths-2yrs)	Poor to Good	Good to Very Good
Long term(2yrs and up)	Very Poor	Very Poor
Identification of turning points	Good	Fair
Typical applications	Forecasts of sales by product class.	Forecasts of company and division sales of industrial sectors and sub-sectors
Data required	Several years' data are usually required to relate such indices to company sales	Ten to fifteen years' history. Considerable amounts of information on product and service flows within a corporation (or economy) for each year for which an input-output analysis is desired.
Cost of forecasting with a computer	£ 5,000 +	£ 12,000 +
Is calculation possible without a computer?	YES	NO
Time required to develop an application and make a forecast	3 Weeks +	6 Months

TABLE 5.1 CONTINUED

CAUSAL METHODS

TECHNIQUE	5. ECONOMETRIC INPUT-OUTPUT MODEL	6. DIFFUSION INDEX
Description	Econometric models and input-output models are sometimes combined for forecasting. The input-output model is used to provide long term trends for the econometric model; it also stabilises the econometric model.	The percentage of a group of economic indicators that are going up or down, with this percentage then becoming the index.
Accuracy:		
Short term(0-3mths)	Not applicable	Poor to Good
Medium term(3mths-2yrs)	Good to very Good	Poor to Good
Long term(2yrs and up)	Good to Excellent	Very Poor
Identification of turning points	Good	Good
Typical applications	Company sales for industrial sectors and sub-sectors.	Forecasts of sales by product class.
Data required	The same as for moving average and X - 11.	The same as intention to buy survey
Cost of forecasting with a computer	£ 12,500 +	£ 1,500 +
Is calculation possible without a computer?	NO	YES
Time required to develop application and make a forecast	6 Months	1 Month +

TABLE 5.1 CONTINUED

C. CAUSAL METHODS

TECHNIQUE	7. LEADING INDICATOR	8. LIFE CYCLE ANALYSIS
Description	A time series of economic activity whose movement in a given direction precedes the movement of some other time series in the same direction is a leading indicator.	This is an analysis and forecasting of new product growth rates based on S-curves. The phases of product acceptance by the various groups such as innovators, early adapters, early majority, late majority and laggards are central to the analysis.
Accuracy:		
S hort term(0-3mths)	Poor to Good	Poor
Medium term(3mths-2yrs)	Poor to Good	Poor to Good
Long term(2yrs and up)	Very Poor	Poor to Good
Identification of turning points	Good	Poor to Good
Typical applications	Forecasts of new product sales.	Forecasts of new product sales
Data required	The same as intention to buy survey five to ten years' history.	As a minimum, the annual sales of the product being considered or of a similar product. It is often necessary to do market surveys.
Cost of forecasting with a computer.	£1,000 +	£ 1,000 +
Is calculation possible without a computer	YES	YES
Time required to develop an application and make forecast	1 Month	1 Month

CHAPTER 6: REGIONAL AND OVERALL FORECASTS OF MARKETS - FOR AEROSOLS

6.1 INTRODUCTION

The aim of this Chapter is to apply the forecasting techniques selected in Chapter 5 to the data compiled in Chapter 3 in order to produce a forecast of aerosol consumption to the year 2000. Three hypotheses were postulated to enable this activity to occur, namely:-

(i) The visionary type of forecast made by "experts" would be the best means of achieving this objective.

(ii) That aerosol consumption will continue to reflect the trends ofpast years.

(iii) That aerosol consumption can be shown to be dependent on "causal" relationships comprising socio-economic and business factors and that these could subsequently be used to predict future demand for aerosols..

Therefore during this Chapter these hypotheses will be tested, the results compared and likely future scenarios constructed from them. Conclusions will be drawn in the summary at the end of the Chapter.

6.2 VISIONARY FORECAST - DELPHI METHOD

6.2.1 Choice of Delphi Panel

As the Delphi technique is a judgemental forecast of the future, with successive rounds whereby the information collected separately from individuals in the first round, is then fed back and commented upon, clearly the choice of the panel is important. Initial concerns were in both finding the individuals with a detailed knowledge of the industry and changing world economies coupled with a willingness to participate in such a study. The options that were identified in this respect are listed in Table 6.1 together with the initial findings on experience and attitudes of potential respondents obtained from a pilot study. This was achieved by approaching the potential candidates and obtaining their verbal comments on the subject matter.

6.2.2 Delphi Format

In preparing for the first round of the Delphi exercise, a questionnaire was designed which was intended to gather the essential data needed to make the forecast. The questions were preceeded by a brief statement on the objectives of the exercise, and the whole format was designed to be applicable to a telex method of communication for speed of transmission and response. This format is shown in Table 6.2.

The second round of the Delphi exercise was designed to summarise the concensus view from the five questions of the first round and request further comment. The results of this Delphi activity are discussed under Section 6.6 later in this Chapter.

TABLE 6.1 CHOICE OF DELPHI PANEL - OPTIONS FOR CONSIDERATION

Panel Source	Type of Experience	Comments from Pilot
1. UK Aerosol Industry		
One or more Aerosol marketers	Aerosol markets UK, general business experience.	All reflected positive and optimistic viewpoint. Complete absence of comment regarding decline. Worst view was stabilisation and no growth.
Manufacturers Aerosol components e.g. cans, valves, propellents	Worldwide; Trade Association; General Business Experience	As for UK Aerosol Industry
2. Trade Association		
B.A.M.A. C.S.M.A.	Specialists on Aerosols. International Experience	Both unwilling to make any comment regarding decline of aerosols almost as a matter of policy.
3. Johnson Wax Ltd and S.C. Johnson Inc (International)	Aerosol marketing; general business and Economic forecasting skills. Specialised country knowledge. Local Trade Association experience.	Probably the most international viewpoint but this time largely pessimistic with knowledge mostly about their own market share. Overall much closer to consumer via regular product surveys which seemed to reflect the aerosol was losing ground.

TABLE 6.2 1ST ROUND DELPHI QUESTIONNAIRE

This is the first round of the Delphi forecast in which you kindly agreed to take part. The aim of this method of forecasting is to predict the future of aerosol products worldwide by considering whether the consumption is likely to increase or decrease; consumer attitudes; forthcoming legislation; and alternatives that might be attractive to aerosol marketers.

Please make your return to the undersigned by retransmitting this document (telex/facsimile/mail) complete with your selected choice of answer or answers to each question 1 through 5. Answer by either ringing your choice or by writing your comments on this text. When your responses have been analysed you will be provided with the results and asked if you wish to further modify your comments and modify the conclusions.

QUESTION 1 - WHICH COUNTRIES/AREAS ARE LIKELY TO SHOW INCREASING AEROSOL CONSUMPTION?

Please use the classification : Total World; U.S.A.; Western Europe; Rest of World (Asia, Africa, Eastern Europe, Middle East) and specify likely time period or periods from the following :

(i) > five years; (ii) > ten years; (iii) by the year 2000.

QUESTION 2 - IF AEROSOLS ARE SEEN TO BE IN DECLINE WHAT ARE THE REASONS?

a) legislation - (i) environmental
(ii) safety

b) better non aerosol alternatives

c) consumer attitudes that aerosols are bad

d) economics :- only rich countries can afford - poorer countries have less expenditure on non essentials.

e) lower profitability ratios

QUESTION 3 - IF AEROSOLS ARE SEEN TO BE INCREASING WHAT ARE THE REASONS?

a) Value for money.

b) Improving world economics.

c) Removal of concerns regarding environmental/safety.

d) Improved high profitability.

e) New developments.

QUESTION 4 - WHICH COUNTRIES ARE LIKELY TO BE AFFECTED MOST BY INCREASE/DECLINE?

(Please indicate positive or negative)

U.S.A.

Western Europe - leaders e.g. U.K., Germany

Western Europe - countries with good growth e.g.Spain

Rest of World - e.g. Asia, Africa, East Europe, Middle East, Oceana

QUESTION 5 - IF A DECLINE SCENARIO IS ENVISAGED, WHAT WOULD BECOME OF AEROSOL MARKETERS?

a) Become smaller.

b) Disappear.

c) Manufacturer will fill alternative products in the same business category.

d) Invest in a completely new business.

JMC ROBERTS
MILTON PARK, ENGLAND

6.3 TIME SERIES ANALYSIS - S - CURVES

6.3.1 Review of Existing Data

An examination of the aerosol consumption and production versus time curves discussed in Chapter 3 and presented in Appendix I indicated that for many countries, the overall consumption had approached what appeared to be a peak and looked to be in decline. Further consideration of this data led to the conclusion that in terms of worldwide aerosol consumption, three types of classification were possible, namely:-

(a) Lead countries with relatively high aerosol consumption - in decline in more recent years.

(b) Growth countries - where aerosol consumption is still showing an upward trend moving in the direction of the level of the "Leaders" as in (a) above.

(c) Under developed countries where probably due to economic conditions, aerosol consumption is at a very low level averaging out at a C.P.P.Y. of 0.8 with little upward movement.

The most prominent example of a lead country is the United States where it appears that aerosol consumption peaked in 1972 and has been in overall decline since. However in order to be sure that a second or third peak is unlikely, calculations were made for each product category to estimate what might be the upper limit of aerosol consumption using the relationship:- C = 52N/W as described in Chapter 5. The results of these calculations are shown later from which it can be seen that virtually every category in the United States has achieved saturation between 1970 and 1973. As outlined in Chapter 5, based on the number of households available, it is unlikely that these figures will be exceeded.

During the compilation of Chapter 3 it was noticed that considerably more data existed on aerosol production than on aerosol consumption especially once one moved away from Western Europe and the United States. Moreover, the production data had obviously been gathered over a longer period of time giving more data points. This has already been illustrated in Figure 2.2, which also presents a convenient classification for the purposes of forecasting. Therefore bearing in mind the ultimate objective of this Chapter is to predict the future growth or decline of aerosol products worldwide, the use of production data can be justified if it is assumed that:-

Total World Production = Total World Consumption

However it was realised that there will be some errors in the forecast from the consumption viewpoint for these areas, because no account is taken of exports and imports. In fact the picture reflected for the United States may be inflated as no account is taken up of exports. The same situation is true of Western Europe whereas the 'Rest of the World' figure may be deflated somewhat. Nevertheless it is likely that this is the best forecast that can be made because the production data appears to be considerably more reliable and spans a greater time period than that for consumption.

6.3.2 Forecasting Method

Turner (129) pointed out that S - Curves were suitable for long range forecasting and the Gompertz and Logistic types were useful for predicting the behaviour of consumer products up to their saturation or peak levels.

It had previously been established that the USA was a "lead" country and the only one in the world to have actually reached and surpassed aerosol saturation by approximately ten years (See section 6.2.2.) Therefore it was assumed that if an S - Curve could be fitted to the USA production/time data, this curve could be regarded as typifying aerosol production/time curves in general (i.e. the curve equation) and that all other world areas would ultimately show similar behaviour.

Further, because the USA had achieved actual saturation and there were approximately ten years of declining production/time data, this information would also be utilised to provide a model for other world areas during their decline phases.

USA aerosol production data for the years 1961 to 1982 was fitted to the S - Curves recommended by Turner 129) as follows:-

(i) Modified Exponential $Y_T = k + a^{b^t}$

(ii) Gompertz $Y_T = ka^{b^t}$

(iii) Logistic $Y_T = \dfrac{1}{k + a^{b^t}}$

Where Y_T = the trend value of aerosol production

k = a constant = the saturation or peak value of production

a and b = are parameters of the curve (constants)

t = time interval in years

The USA data was processed by reiterative trial and error methods and found to best fit the Gompertz relationship. Similar exercises were conducted on the data for the other regions namely, Western Europe; Rest of World; Total World.

The prediction of the decline phase proved to be more difficult in that the USA decline data was not described by any of the recommended equations. In fact De la Mare (127) and Turner (129) recommended the technique for predicting growth and not decline. Success was finally obtained using the relationship:-

$\text{Log } Y_T = \text{Log } k + b^{1/t} \log a$ -- all items as defined above.

Subsequently the equation parameters were calculated for other world areas and the equations derived were then used to make decline phase predictions. These predictions were extended to the year 2000 by modelling the USA slow decline phase (1976 to 1983) using a linear equation.

By way of comparison, an alternative forecast was prepared by conducting curve fitting exercises on production/time data for each world area using an available software package. Extrapolations were then made to the year 2000 via calculations for 1985; 1990; 1995; and 2000.

6.4 CAUSAL ANALYSIS

6.4.1 Review of Data

During the selection of forecasting methods detailed in Chapter 5, the hypothesised causal factors for regression analysis were conveniently classified under the headings of "People Factors" and "Business Factors". The initial plan was to test this hypothesis by regressing the above factors against the dependent variables of aerosol consumption and sales (£'s value and units). However the availability of such data proved to be a problem even when the search was limited to the UK due to confidentiality policies within aerosol manufacturers. In fact the only complete set of data published was for UK aerosol 'Hair Sprays' which was used for the initial runs.

To supplement the Hair Spray data and allow more in depth analysis - confidential information from Johnson Wax Ltd was collected and used. Two highly successful aerosol products and a non-aerosol product for comparison were chosen.

As discussed in Section 6.3, the most reliable and consistent data on aerosols related to production and therefore to allow consistent comparisons with the time series forecasts, data was needed relating causal factors to aerosol production. Moreover, data was needed on the causal factors for the major world areas of interest namely:-

* USA;
* Western Europe;
* Rest of World;
* Total World.

Data was only found to be available on a per country basis i.e. for the USA. Therefore a regional figure had to be calculated by weighting data from each constituent country on the basis of "population fraction" in order to obtain a composite (regional) figure.

"Population Fraction" (P.F.) was defined as:-

$$P.F. = \frac{\text{Population of Country}}{\text{Total population of region}}$$

6.4.2 Method of Analysis

The hypothesised causal factors were first tested on a UK national basis by running a stepwise multiple linear regression on the Hair Spray data. Having identified the key factors, further confirmatory tests were run using the data of Johnson Wax Ltd .

In order to ensure that the selected causal factors would correlate well with aerosol production data (for comparison with time series work), tests were made with a curve fitting package using production data from all the world areas of interest.

Having obtained suitable correlation of the causal factors with aerosol production in each of the three world areas, the intention was to make forecasts using available causal data (plus its predicted values to the year 2000) in order to forecast aerosol production to that year.

However, it was realised that aerosol consumption and production could be affected in a major way by the safety and other factors discussed in Chapter 4. In this chapter, the two major factors identified were those of "safety/legal controls" and "alternatives" to aerosols. That is to say that a reduction in aerosol consumption and production was seen to be directly related to the possibility of the introduction of more stringent legislation either on a government level or via the insurance companies applying their constraints to both factories and retail outlets. This latter concern was seen to relate primarily to flammability hazards connected with aerosols.

The second factor likely to reduce aerosol consumption was seen to be the improvement of aerosol alternatives such as pump and trigger sprays, such that a marketer could offer the same high degree of product efficacy at a similar price to aerosols without using a container pressurised with either L.P.G. or C.F.C.'s. Consideration of these possibilities led to the construction of three scenarios as follows:-

Scenario 1 - which visualised a total ban on aerosols within the major consumption areas such as the United States and Western Europe, caused either by government or national legislation or tighter insurance controls.

Scenario 2 - which involves a step change such as occured in the United States immediately following the ozone controversy. Such a step change would cause a rapid reduction in aerosol consumption and production but for a short period followed by a second period where aerosol production would continue again at a static or slightly decreasing rate. The only example of such a situation is that illustrated by aerosol production in the United States at the time of the Molina Rowland theory.

Scenario 3 - a gradual phasing out of aerosols as the more viable alternatives begin to take their place. Discussion at a recent forum held by the British Aerosol Manufacturers Association (114), largely supported the view that total ban would be unlikely. This conclusion was presented as the summarised findings of the various B.A.M.A. working parties in discussion with both government, insurance companies and retailers in both the United Kingdom and the United States.

Assuming this viewpoint then to be correct, Scenarios 2 and 3 appeared to be the most likely. These were therefore adopted and the causal analysis modified in order to take account of these possibilities. This was done by referring to the aerosol production/time data for the United States. As discussed earlier in Section 6.2 the United States is the only world country which has experienced a downward step change in aerosol production followed by a maturing or slight decline. It seems therefore reasonable to use the United States as a model and by reference to the production time curve (See Figure 2.2, Figure A 3.16 and Table A 3.16), it is possible to identify three distinct phases.

First there is the rapid growth phase which appears to occur up to 1973 when the effects of the environmental concern appeared to cause a rapid decline until the year 1976. After this point aerosol production seems to be in a slow decline phase.

Further analysis is possible by assuming that the rapid growth phase was a result of the disposable income available in the United States and the popularity of aerosols up to the point of the environmental concern and the possibility of increased incidence of skin cancer. The rapid decline phase from 1973 to 1976 can be assumed to be directly related to this concern and the slower decline phase from 1976 to date as a result of alternatives such as triggers and pump packs gradually replacing the aerosol on the grounds of being equally efficacious yet safer.

In order to quantify the effects of this hypothesis the percentage reduction effect of the step change for the United States was assessed by comparing the aerosol production predicted by causal data to 1976 with the actual figures recorded. It was then assumed that a similar step change would occur over the years 1982 to 1990 for all areas i.e. United States, Western Europe and Rest of World. This step change was estimated to be of the same percentage order as that experienced as a result of the ozone controversy but due to safety or legal constraints. The final assumption made in this hypothesis was that following the step change, aerosols would decline in all areas at a percentage rate similar to that experienced in the United States between the years 1976 and 1982, resulting from the gradual replacement by non-aerosol alternatives.

A final comparison point was provided by fitting polynominal expressions to the aerosol production time curves and extrapolating the resultant equations to the year 2000.

6.5 INFORMATION ON AEROSOL MARKETS FROM S.C. JOHNSON

6.5.1 Type of Data Available

Most S.C. Johnson companies market aerosols and within a particular Johnson company, the marketing personnel normally monitor their own and competitive products actively on an ongoing basis. By using their inhouse market research facilities and by employing specialist agencies, they usually know the size of markets of interest and their projected development e.g. growth (percentage per annum) or decline. In addition, information is frequently available on the types of product in the retail outlets and the percentage share of the category held e.g.

Furniture Polish - aerosols	55%
Paste Wax	20%
Liquid Wax	25%
	100%

The items of information requiring confirmation were as follows:-

(a) For USA; Western Europe (as a whole and by country); Rest of World - are aerosol products gaining an increased share; static or declining in the traditional S.C. Johnson markets?

viz

* Furniture Care;
* Air Fresheners
* Insecticides

(b) What are the prevailing consumer attitudes to aerosols as a packaging system?

(c) What news (if any) of government or insurance controls?

As most of the contacts were made via the Johnson telex network, the queries had to be brief and to the point. Brevity was also important from the point of view of generating a quick response. The above queries were directed to Johnson companies in the following countries:-

USA

	(Australia; Belgium; Denmark; Eire.
WESTERN EUROPE-----	(Finland; France; Germany; Holland; Italy;
	(Portugal;Spain; UK.
REST OF WORLD------	(Australia; Canada; New Zealand; Japan.

6.5.2 Method Used

The three key questions were posed to Marketing Manager colleagues in the Johnson companies outlined in Section 6.5.1 via a telex message which also asked for a rapid response, using data to hand rather than to instigate further work.

6.6 RESULTS OF FORECASTING EXERCISES

6.6.1 Delphi

The make up of the panel used is shown below.

RESPONDENT	SOURCE
Director B.A.M.A.	UK Aerosol Trade Association
Official C.S.M.A.	USA Aerosol Trade Association
Sales Manager from Aerosol component supplier	Metal Box Organisation
Marketing Manager Contractor	Aerosol Contract filling organisation
General Manager] Marketing Manager] Product Manager (Furniture Care)] Product Manager (Air Care)]	Johnson Wax Ltd
European Marketing Director	S.C. Johnson Inc.

The results of the first round are summarised in the questionnaire which initiated the second round which is presented as Table 6.3. This second round brought little in the way of further comments other that it was pointed out by the majority ("the pessimists"), that the optimistic line taken by those respondents representing organisations in a supply and service function to the aerosol industry were almost policy bound to reflect optimism. By way of return comment, the optimists claimed the majority viewpoint was overly pessimistic and based on a short term turndown in consumption and production.

TABLE 6.3 2ND ROUND DELPHI QUESTIONNAIRE

This is the second round of the Delphi format in which you kindly agreed to take part. Listed below are the collective rsults from Round 1 together with the overall conclusions.

Please relook at your initial answers in the light of the survey results below and if you wish, revise your answers or comments upon alternative viewpoints. Your response to the overall conclusions would also be appreciated.

RESULTS

QUESTION 1 :- Most respondents (circa 80%) agreed that only "Rest of World" countries would be likely to show increasing aerosol consumption and even this region would be continuing for maximum 10 years. The minority viewpoint, originating entirely from those panel members working in industries supplying or servicing aerosol marketers, disagreed in that they reflected a growth picture almost everywhere.

QUESTION 2 :- Again approximately 80% of the respondents agreed that aerosols were seen to be in decline although there was some division on the reasons. 50% felt that the main reason was due to consumer attitudes that aerosols were bad and 30% said it was likely to be due to increased forthcoming legislation on safety and environment. In fact there was total agreement on the factors affecting aerosol decline being either consumer attitudes or forthcoming legislation.

QUESTION 3 :- Answers to this question were almost the complete reverse to those given to Question 1. That is to say that only approximately 20% saw aerosols increasing and claimed the reason to be value for money and new developments. The majority viewpoint was that aerosols were not seen to be decreasing.

QUESTION 4 :- A mixed result was obtained here and it can best be summarised under the headings "OPTIMIST'S" and "PESSIMIST'S".

The "pessimist's" (who were in the majority) believed that the United States followed by Western Europe and last by Rest of World would be most affected in a negative sense by aerosol decline.

The "optimist's" (who were in the minority) believed that the United States and Western Europe's aerosol consumption would stabilise and the Rest of World would continue to grow giving an overall growth picture.

QUESTION 5 :- The result here was consistent with the rest of the answers in that the majority believed in a decline scenario such that aerosol marketers would probably still continue to trade with the existing products but in different packaging alternatives.

OVERALL CONCLUSIONS

Aerosol consumption will decline in an overall sense commencing now and reaching its peak in approximately 2 to 5 years. The main cause will be bad consumer attitudes brought about by comments in the media with regard to safety. Secondary cause will be increased

controls and legislation with regard to the storage of aerosols in retail warehouses. U.S.A. and Western Europe will feel this decline at the greatest extent but it will also start to affect the Rest of World after about a 5 year period. Most aerosol marketers will continue to trade on their current product range but in alternative packaging.

JMC ROBERTS
MILTON PARK, ENGLAND

6.6.2 Forecasts Using S-Curve Fitted Time Series Data

Aerosol saturation levels in the USA calculated by the relationship: C = 52N/W are presented in Table 6.4.

The USA production/time data was found to fit a Gompertz curve as shown in Figure 6.1. Part I of Table 6.5 further emphasises the closeness of fit by presenting actual values alongside those predicted by the Gompertz equation. Table 6.6 shows the Gompertz equation parameters for each world area namely: USA; Western Europe; Rest of World; Total World.

Predictions of aerosol production decline are illustrated in Figure 6.2 with decline equation parameters tabulated in Table 6.7 and the results in Table 6.8.

The complete forecast i.e. incorporating the slow decline phase modelled on the USA curve is shown in Figure 6.3 and in Table 6.8.

Alternative forecasts using curve fitting techniques followed by extrapolation are presented in Table 6.9 together with the summarised results of the above S - Curve analysis.

TABLE 6.4 CONFIRMATION OF AEROSOL SATURATION LEVELS IN USA

		HAIRSPRAY			PERSONAL CARE			HOUSEHOLD			INSECTS			MISCELLANEOUS		
		ACTUAL CONSUMPTION UNITS $\times 10^6$	C.P.H.P.Y.		ACTUAL CONSUMPTION UNITS $\times 10^6$	C.P.H.P.Y.		ACTUAL CONSUMPTION UNITS $\times 10^6$	C.P.H.P.Y.		ACTUAL CONSUMPTION UNITS $\times 10^6$	C.P.H.P.Y.		ACTUAL CONSUMPTION UNITS $\times 10^6$	C.P.H.P.Y.	
YEAR	NUMBER OF HOUSEHOLDS $\times 10^6$		ACTUAL	SAT'N LEVEL		ACTUAL	SAT'N LEVEL		ACTUAL	SAT'N LEVEL		ACTUAL	SAT'N LEVEL		ACTUAL	SAT'N LEVEL
1970	63	492	8	9	826	13	13	629	10	10	102	2	2	563	10	10
1973	68	461	7	9	974	14	13	690	10	10	135	2	2	642	10	10
1975	71	325	5	9	694	10	13	566	8	10	94	1	2	555	8	10
1980	79	296	4	9	449	6	13	642	8	10	114	1.2	2	594	8	10

NOTES

1. Hairspray average life 6 weeks.
2. Personal care aerosols mostly anti-perspirants and shave foam - average life 4 weeks
3. Household aerosols mainly comprise polishes, air-fresheners and oven cleaners - average life 4 - 6 weeks.
4. Insecticide aerosols comprise flying insect killers and crawling insect killers - average product life -24 weeks/season - 24 weeks.
5. Miscellaneous aerosols mainly consist of various paints, automotive products with an instantaneous use usually purchased once a year. There are ten varieties.
6. All above useage data from SC Johnson consumer research.
7. C.P.H.P.Y. - cans per household per year.

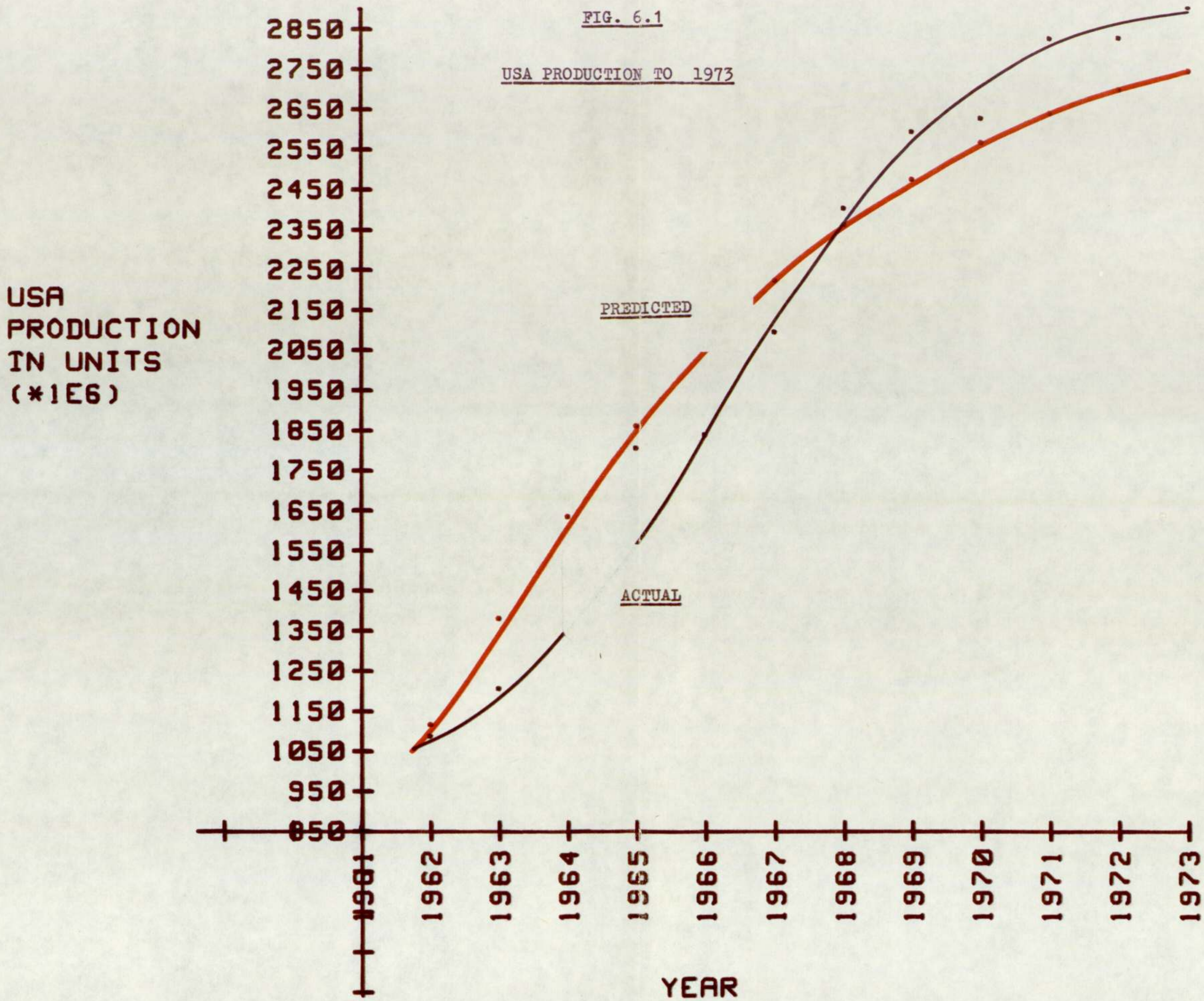


FIGURE 6.1 USA PRODUCTION TO 1973

TABLE 6.5 USA AEROSOL PRODUCTION ACTUAL DATA AND PREDICTED DATA

YEAR	ACTUAL DATA	PREDICTED DATA	COMMENTS
1961	856	841	
1962	1083	1112	
1963	1202	1378	PART I
1964	1365	1631	
1965	1801	1857	
1966	1835	2054	
1967	2091	2220	Predicted by
1968	2400	2359	$\log Yt = \log k + b^{t} \log a$
1969	2590	2472	
1970	2623	2563	
1971	2823	2636	
1972	2823	2694	
1973	2902	2902	
1974	2722	2722	
1975	2354	2485	PART II
1976	2295	2355	Predicted by
1977	2150	2278	$\log Yt = \log k + b^{1/t} \log a$
1978	2231	2227	
1979	2398	2192	
1980	2162	2165	

TABLE 6.6 GOMPERTZ EQUATION PARAMETERS

Aerosol production between 1961 and 1980 can be shown to fit Gompertz curves which have the equation:-

$$\log Y_T = \log k + b^t \log a$$

where Yt is the aerosol production in units x 10^6
k is the saturation level of aerosols in units x 10^6
b and a are constants which describe the curve

From recorded values of aerosol production, k, a and b have been calculated separately for USA, Western Europe Rest of World and Total World are shown below:-

	USA	WORLD TOTAL	W. EUROPE	REST OF WORLD
k	2902	6475	2500	2000
a	0.29	0.177	0.095	0.025
b	0.775	0.836	0.855	0.865
Year of saturation which k occurs	1973	1979	1982	1984

TABLE 6.7 AEROSOL PRODUCTION DECLINE EQUATION PARAMETERS

The Gompertz equation had been recommended for use in situations of production growth. To describe the decline in aerosol production, a different equation needed.

$$\log Y_T = \log k + b^{1/t} \log a$$

where k retains its original value
but b and a have new values.

From recorded aerosol production decline values for the USA between 1973 and 1980, b and a have been calculated and using these values, the constants for the World Total, Western Europe and Rest of World may be deduced to give the values:-

	USA	WORLD TOTAL	W.EUROPE	REST OF WORLD
k	2902	6475	2500	2000
a	0.685	0.585	0.482	0.319
b	0.169	0.187	0.191	0.194
Year of saturation which k occurs	1973	1979	1982	1984

These constant values may then be used in the relevent equation to predict aerosol production decline.

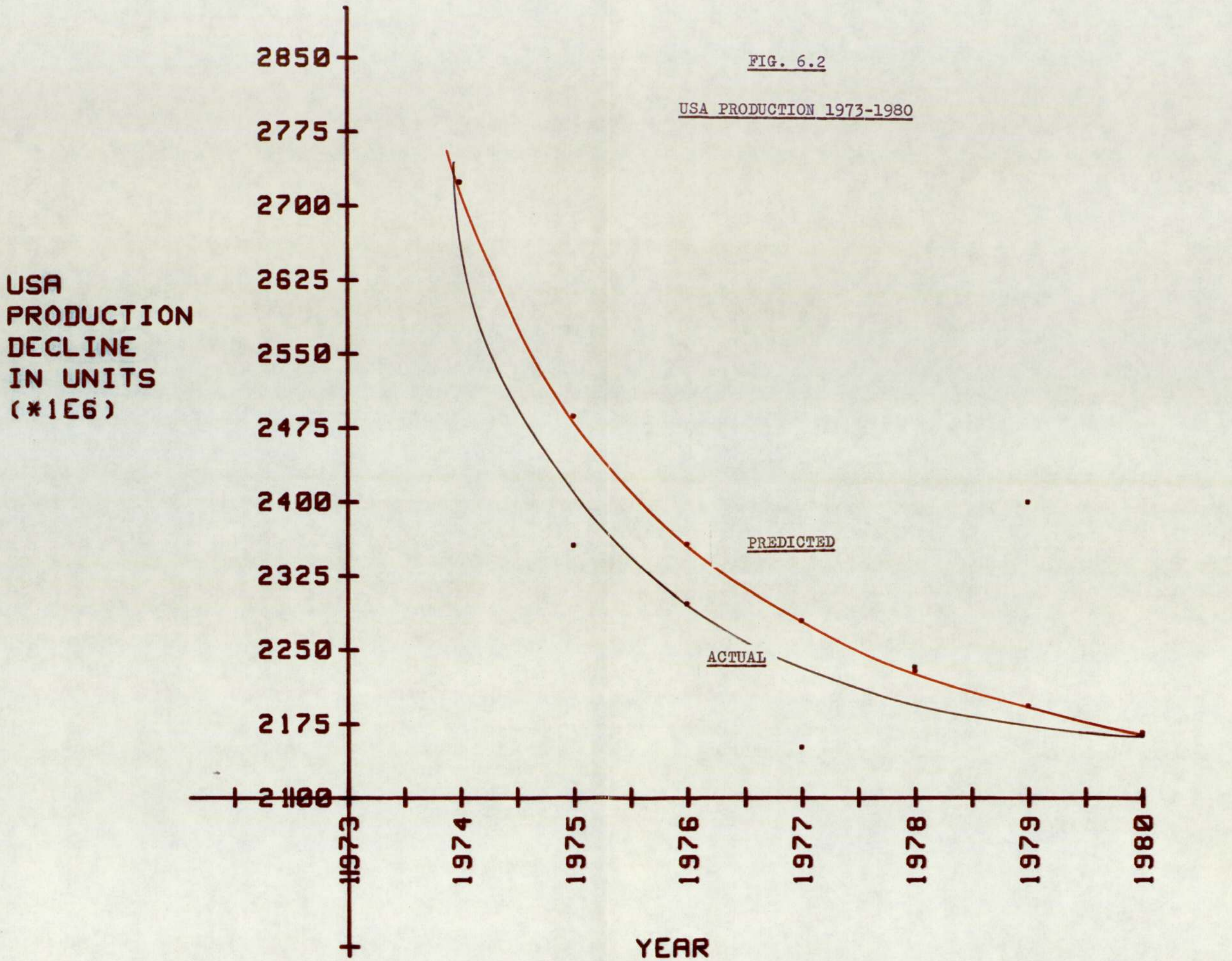


FIGURE 6.2 USA PRODUCTION 1973 TO 1980

TABLE 6.8 AEROSOL PRODUCTION (UNITS x 10^6) TO YEAR 2000

YEAR	TOTAL WORLD	USA	W. EUROPE	REST OF WORLD	COMMENTS
1961	1146	9856	240	50	
1962	1505	1083	330	92	
1963	1731	1202	410	119	
1964	2066	1365	530	171	
1965	2624	1801	630	193	
1966	2825	1835	750	240	
1967	3230	2091	860	279	
1968	3812	2400	1030	382	
1969	4291	2590	1275	426	
1970	4960	2623	1425	912	
1971	5335	2823	1620	892	
1972	5645	2823	1720	922	
1973	5910	2902	1930	1078	
1974	6002	2722	2076	1204	INCREASING
1975	4577	2354	1910	1215	PRODUCTION
1976	5804	2295	2174	1335	
1977	5773	2150	2196	1427	
1978	6027	2231	2140	1656	
1979	6475	2398	2206	1871	
1980	6267	2162	2234	1871	
1981	5134	2145	2290	1718	
1982	4764	2129	2500	1753	
1983	4550	2115	2175	1786	Some errors
1984	4411	2105	1817	2000	present.
1985	4315	2095	1642	1601	Total World≠
1986	4245	2088	1543	1208	USA +
1987	4190	2081	1480	1031	+ Europe +
1988	4148	2075	1437	936	Rest
1989	4113	2070	1405	877	
1990	4085	2065	1381	839	
1991	4060	2061	1362	809	
1992	4040	2058	1347	787	
1993	4023	2054	1334	771	DECLINING
1994	4007	2051	1324	757	PRODUCTION
1995	3994	2048	1315	746	
1996	3892	2046	1307	737	
1997	3971	2044	1300	729	
1998	3962	2042	1295	723	
1999	3953	2040	1289	717	
2000	3945	2038	1285	712	

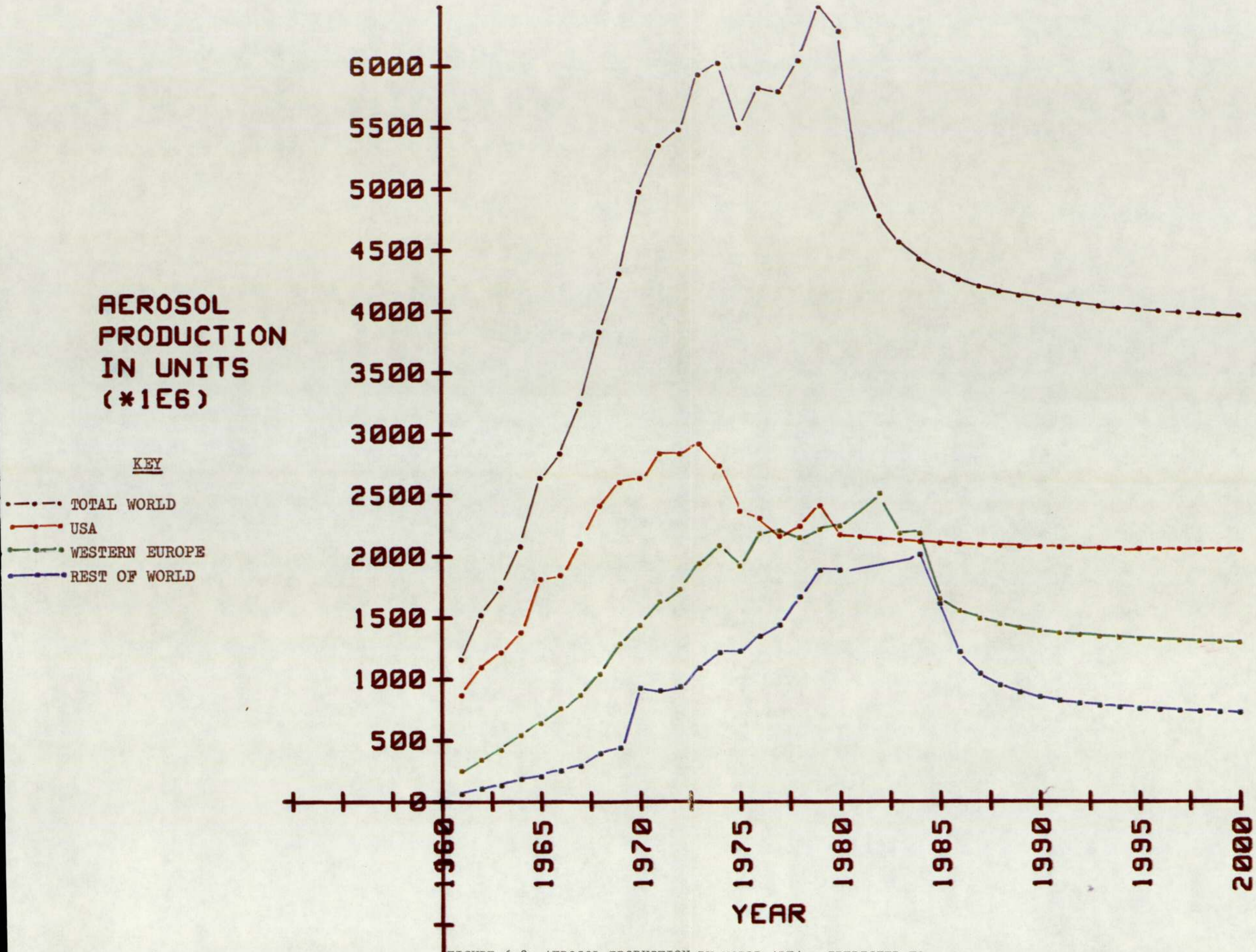


FIGURE 6.3: AEROSOL PRODUCTION BY WORLD AREA - PREDICTED TO YEAR 2000 BY S - CURVE AND USA MODELLING

TABLE 6.9 AEROSOL PRODUCTION TO THE YEAR 2000 - PREDICTED BY VARIOUS METHODS

	S - CURVE				PRODUCTION/TIME EXTRAPOLATION				CAUSAL TO SATURATION OR BY YEAR				CAUSAL + STEP + DECAY			
	USA	WEST. EUROPE	REST OF WORLD	TOTAL	USA	WEST. EUROPE	REST OF WORLD	TOTAL	USA	WEST. EUROPE	REST OF WORLD	TOTAL	USA	WEST. EUROPE	REST OF WORLD	TOTAL
1985	2095	1642	1601	4315	2227	3122	2310	(8556) 7659	2207	3121	2311	7638	1952	2761	2061	6774
1990	2065	1381	839	4085	2188	3721	2825	(10011) 8734	2158	3720	2826	8704	1099	1869	1387	4355
1995	2048	1315	746	3995	2149	4320	3340	(11466) 9809	2086	4319	3341	9746	1061	1804	1338	4203
2000	2038	1285	712	3945	2072	4319	3385	(12921) 10846	1987	4918	3856	10761	1022	1738	1289	4049

NOTES

Figures in parenthesis are calculated values from the extrapolated world total curve. These are included for comparison.

6.6.3 Forecasts by Causal Method

The `complete´ set of causal data on hair sprays in the UK is shown as Table 6.10. Information from Johnson Wax Ltd is shown in Tables 6.11, 6.12 and 6.13.

Stepwise multiple linear regression (S.M.L.R.P.) runs on the Hair Spray data are presented in Table 6.14. This data indicates how the key factors were selected.

S.M.L.R.P. runs on the Johnson Wax Ltd data are shown in Tables 6.15, 6.16 and 6.17. Figure 6.4 further illustrates attempts at correlation between aerosol product sales and the people and business factors utilising data from Johnson Wax Ltd which confirms the S.M.L.R.P. information gained on hairspray.

Correlations of selected causal factors with production data by world area are shown in Tables 6.18, 6.19, 6.20 and 6.21 and graphically in Figure 6.5.

Forecasts of aerosol production by world area to the year 2000 using the causal factors are shown in Table 6.9, (already presented on page 188).

Forecasts of aerosol production to the year 2000 by world area and incorporating the step change and decay hypothesis are shown in Figure 6.6 and in Tables 6.9 and 6.22.

TABLE 6.10 UK NATIONAL DATA - AEROSOL HAIR SPRAYS

	PEOPLE FACTORS							BUSINESS FACTORS		
Year	C.P.P.Y.	User Population ♀	User Population ♂	£p.a Gross Av. Income	£p.a. Income Mfg. Industries	Disposable Income/ Capita	Average Spending on Cosmetics £ /pw	Price p/ 8 oz Unit	Advertising Expenditure £'000
1968	1.4	17,733	17,473	901	1217	560.0	0.26	35	1,116
1969	1.5	17,712	17,477	992	1503	575.3	0.27	43	734
1970	1.8	17,690	17,478	1075	1631	631.9	0.30	38	685
1971	2.1	17,564	17,300	1098	1882	680.5	0.33	42	1,323
1972	2.0	17,583	17,370	1321	2159	773	0.40	30	1,623
1973	2.4	17,573	17,387	1527	2554	882	0.40	31	1,923
1974	2.6	17,570	17,431	1708	3107	1006	0.53	57	1,808
1975	2.4	17,577	17,483	1838	3527	1182	0.62	42	2,264
1976	2.5	17,614	17,549	2630	3825	1332	0.66	51	1,631
1977	2.6	17,608	17,550	3367	4148	1477	0.68	62	1,818
1978	2.5	—— NO DATA ——			4499	1722	0.65	68	1,800
1979	2.5	—— NO DATA ——			4875	2018	0.70	72	1,750
1980	2.4	—— NO DATA ——			5300	2174	0.69	85	1,850
1981	2.6	—— NO DATA ——			5837	2429	0.72	90	1,803

TABLE 6.11 PLEDGE AEROSOL

	AEROSOL SALES		PEOPLE FACTORS					BUSINESS FACTORS						
Year	£ Reported $x10^3$	£ Deflated $x10^3$	Est'd No.of Users 10^6	£ Av. Gross Income p.w.	£ Disposable Income/ Capita	H/H Products Spending Pattern % Weekly Earnings	£ GNP/ Capita	Unit Price p	Gross Profit %	Operating Profit %	Advertising Cost %	Distrib'n Cost %	Mfg. Cost %	Other Costs %
1968						1.0		20	67					
1969				25.4	573.3	1.0	726.2	21	67					
	(4915)													
1970	1556	1556	16.8	28.91	631.9	1.1	785.5	21.5	68	10	26	3	32	15
	(4236)			30.8	680.5		873							
1971	1339	1315	17.0	31.37	692.29	1.1	889.1	22.5	62	- 1.9	29	3	37	16
	(5131)			35.1	773.3		960.4							
1972	1772	1669	17.2	36.20	797.20	1.1	1095	24	67	10	21	3	37	16
	(5137)			37.6	773.3		960.4							
1973	1783	1699	17.3	41.52	926.4	1.1	1149.3	27	64	11	20	4	36	17
	(6039)			45.5	1005.8		1233							
1974	2062	1911	17.5	49.12	1085.3	1.1	1330.7	31	62	11	16	5	38	17
	(6525)			53.5	1182		1506							
1975	2216	1986	17.7	59.74	1319.6	1.2	1680.7	33.5	62	15	13	3	38	15
	(7183)			59.6	1332		1750							
1976	2556	2247	17.7	67.83	1516.8	1.1	1990.7	40	58	10	12	3	42	16
	(8124)			67.9	1477		1951							
1977	2737	2365	17.8	73.56	1709.6	1.1	2257.9	43.5	59	0.08	12	3	41	16
	(8352)			72.6	1722		2216							
1978	3044	2607	18.0	84.77	2011.3	1.1	2586.9	50	59	14	13	3	41	16
	(7872)			83.2	2018		2479							
1979	3150	2667	18.1	98.28	2382.7	1.2	2928.4	54	60	22	11	3	41	12
	(8424)			88.5	2174		2676							
1980	3986	3333	18.2	105.8	2600	1.0	3200	59	60	16	12	3	40	12
	(7800)			96.7	2429		3016							
1981	4019	3367	18.4	115.4	2900	1.1	3600	64	62	21	4	3	38	15
1982				122.1	3200	1.1	4000	68						

Data in Brackets = Sales Units

TABLE 6.12 GLADE AIRFRESHENER AEROSOL

	AEROSOL SALES		PEOPLE FACTORS					BUSINESS FACTORS						
Year	Reported $£ \times 10^3$	Deflated $£ \times 10^3$	Est'd No of Users $\times 10^6$	£ Av. Gross Income p.w.	£ Disposable Income/ Capita	H/H Products Spending Pattern % Weekly Earnings	£ GNP/ Capita	Unit Price p	Gross Profit %	Operating Profit %	Advertising Cost %	Distrib'n Cost %	Mfg. Cost %	Other Costs %
1970	(2474) 240	240						14.5	35	3.8	1.4	2.9	65	15
1971	(1741) 188	185						17.5	40.2	7.7	1.4	3.0	59.8	15.7
1972	(1942) 235	228						21	49.1	15.9	0.5	3.2	50.9	15.9
1973	(2618) 356	339						24	43.6	8.3	2.6	3.9	56.4	17.1
1974	(2336) 355	329						27	58.8	6.6	0.5	4.6	41.2	17.2
1975	(2678) 458	410						29.5	37.1	- 0.8	0.6	3.1	62.6	18.3
1976	(2623) 501	440		AS FOR PLEDGE				33.5	42.8	7.5	0	3	57.2	15.9
1977	(4360) 933	806						35.5	40.7	4.4	0	3	59.3	15.8
1978	(3921) 996	853						42.5	45.2	12.0	0	3.1	54.8	14.7
1979	(2997) 863	731						45.5	47.1	12.4	0	3.1	52.9	12.3
1980	(3070) 1007	842						48	46.4	12.4	0	2.5	53.6	12.4
1981	(3020) 1048	878						52	64.7	6.2	0	2.6	53.5	14.9

Data in Brackets = Sales Units

TABLE 6.13 SILVER POLISH NON-AEROSOL

	AEROSOL SALES		PEOPLE FACTORS					BUSINESS FACTORS						
Year	Reported £ x10^6	Deflated £ x10^6	Est'd No of Users x10^6	£ Av. Gross Income p.w.	£ Disposable Income/ Capita	H/H Products Spending Pattern % Weekly Earnings	£ GNP/ Capita	Unit Price p	Gross Profit %	Operating Profit %	Advertising Cost %	Distrib'n Cost %	Mfg. Cost %	Other Costs
1970	(1488) 317	317						26	68.1	39.5	2.9	2.9	31.9	15.1
1971	(1489) 335	329						27.5	65.9	33.6	7.7	3.0	34.1	15.7
1972	(1662) 394	382						29	67.4	28.8	11.1	3.2	32.6	16.6
1973	(1608) 402	383						33	58.8	23.3	10.2	3.9	41.2	17.1
1974	(1697) 448	415						34	58.4	27.3	3.5	4.6	41.6	17.2
1975	(2061) 575	515			AS FOR PLEDGE			40	56.1	18.6	9.1	3.1	43.9	17.9
1976	(2497) 734	645						43.5	54.7	23.1	4.5	2.9	45.3	15.9
1977	(2677) 830	717						49	54.1	21.5	5.1	3.0	45.9	15.4
1978	(3183) 1041	891						53	49.6	28.1	0	3	50.4	14.4
1979	(3039) 1094	1079						55	53.1	23.2	5.8	3	46.9	11.8
1980	(3000) 1275	1066						57	55	24.1	7	2.5	45	12.3
1981	(2434) 1188	995						59	57.2	28.3	0.5	2.6	42.8	14.8

Data in Brackets = Sales Units

TABLE 6.14 RESULTS OF REGRESSION ANALYSIS - HAIR SPRAY

NO.	INDEPENDENT VARIABLE NAME	F.RATIO VALUE	R^2 VALUE	ERRORS IN FIT	RATING OF CORRELATION
1.	Male population	3	0.35	Large	Poor
2.	Female population	2.5	0.31	Large	Poor
3.	Gross Average income	10	0.42	Large	Poor
4.	Income in manufacturing	60	0.89	Small - medium	Good
5.	Disposable income per capita	191	0.98	Small	Very Good
6.	Average spent on cosmetics - £p.w.	15	0.44	Large	Poor
7.	Price per 8 oz unit (pence)	8	0.38	Large	Poor
8.	Advertising expenditure £ ´000/yr	4	0.35	Large	Poor

NOTES

High F ratio and R^2 value close to unity
are indications of satisfactory correlation.

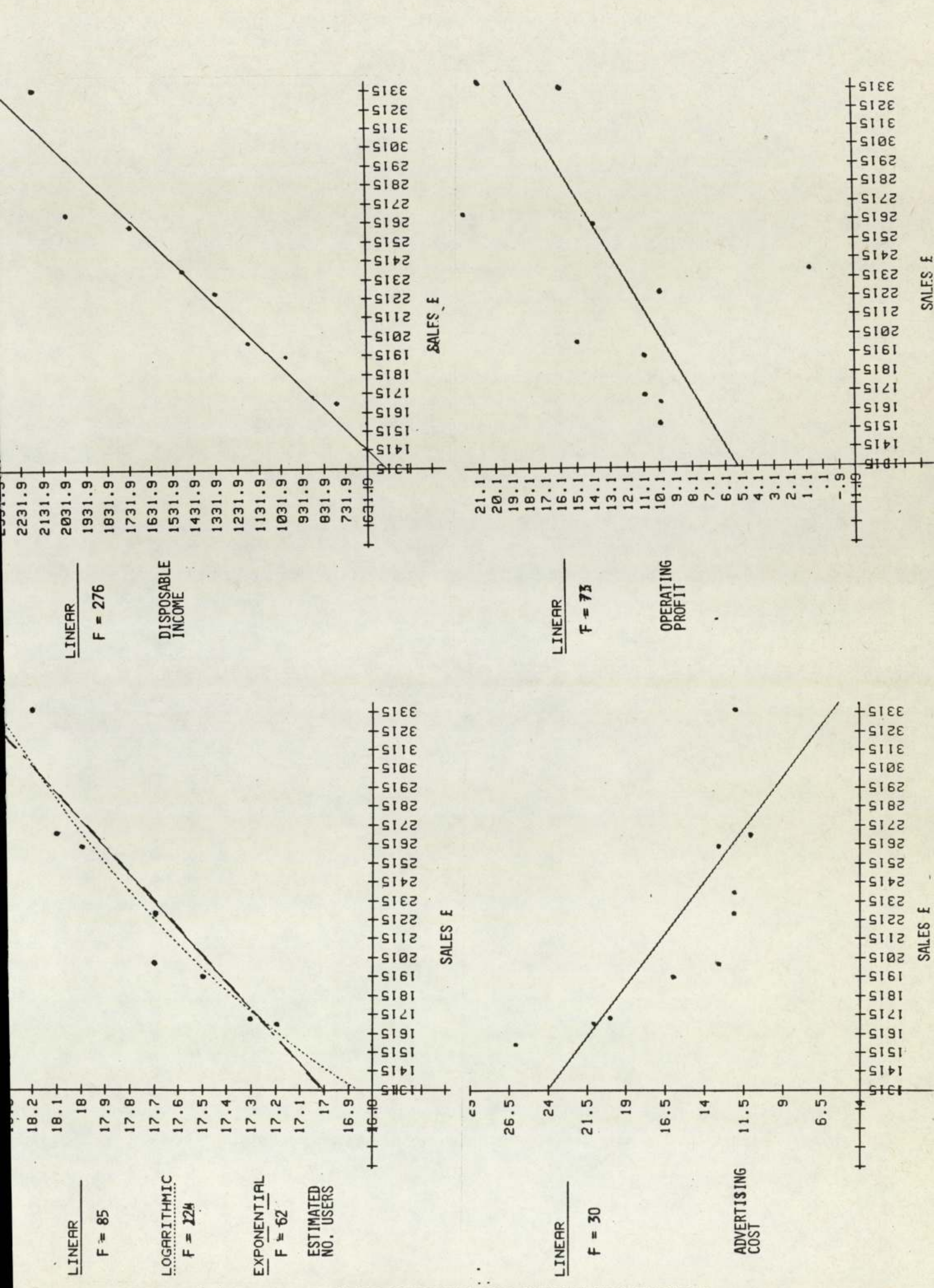


FIGURE 6.4 CORRELATION OF 'PEOPLE' AND 'BUSINESS' FACTORS WITH AEROSOL PRODUCT SALES

TABLE 6.15 S.M.L.R.P. ON JOHNSON WAX DATA (PLEDGE)

Values	No. Users	Av. Gross Income	Disposable Income/ Capita	% Wage on H/H products	GNP per Capita	Unit Price	Gross Profit	Operating Profit	Advertising Spend	Distrbn′ Cost	Mfg. Cost	Other Cost
F. Ratio	1.5	80	261	8	27	13	4	2	14	7	6	11
$R.^2$ Value	0.41	0.68	0.98	0.34	0.46	0.41	0.29	0.30	0.37	0.39	0.64	0.38
Errors	<- Large - >		Small	<- - - - - - - - - - - - -				Large- - - - - - - - - - - - - - - - - - ->				
Overall Rating	<- Poor- - >		Good	<- - - - - - - - - - - - -				Poor ->				

TABLE 6.16 S.M.R.L.P. ON JOHNSON WAX DATA (GLADE)

Values	No. Users	Av. Gross Income	Disposable Income/ Capita	% Wage on H/H products	GNP per Capita	Unit Price	Gross Profit	Operating Profit	Advertising Spend	Distrbn′ Cost	Mfg. Cost	Other Cost
F. Ratio	8	71	276	4	45	8	6	4	8	12	2	13
R^2 Value	0.38	0.71	0.98	0.41	0.51	0.37	0.31	0.30	0.36	0.42	0.25	0.40
Errors	<- Large- ->		Small	<- - - - - - - - - - - - -				Large- - - - - - - - - - - - - - - - - - ->				
Overall Rating	<- Poor - ->		Good	<- - - - - - - - - - - - -				Poor ->				

TABLE 6.17 S.M.L.R.P. ON JOHNSON WAX DATA (L.T.S.P.)

Values	No. Users	Av. Gross Income	Disposable Income/ Capita	% Wage on H/H products	GNP per Capita	Unit Price	Gross Profit	Operating Profit	Advertising Spend	Distrbn′ Cost	Mfg. Cost	Other Cost
F. Ratio	22	65	217	9	23	9	8	7	4	3	4	7
R^2 Value	0.44	0.66	0.97	0.45	0.43	0.33	0.29	0.31	0.36		0.28	0.32
Errors	<- Large ->		Small	<- - - - - - - - - - - - -				Large- - - - - - - - - - - - - - - - - - ->				
Overall Rating	<- Poor- ->		Good	<- - - - - - - - - - - - -				Poor ->				

TABLE 6.18

AREA U.S.A. .... TOTAL POPULATION 221 million ....

COUNTRY	POPULATION FRACTION	DISPOSABLE INCOME PER CAPITA PER YEAR (US$)								CONTRIBUTION TO AREA DISPOSABLE INCOME/CAPITA YEAR							
		60	63	70	75	76	77	79	80	60	63	70	75	76	77	79	80
U.S.A.																	
TOTALS									2502	2831	4285	6294	6969	7686			

TABLE 6.19

AREA ..WESTERN. EUROPE..............

TOTAL POPULATION ...347911 ($x10^3$)...........................

COUNTRY	POPULATION FRACTION	DISPOSABLE INCOME PER CAPITA PER YEAR (US$)								CONTRIBUTION TO AREA DISPOSABLE INCOME/CAPITA/YEAR							
		60	63	70	75	76	77	79	80	60	63	70	75	76	77	79	80
BELGIUM	0.028	1126	1354	2417	5887	6406	7449			31.5	37.9	67.7	164.8	179.4	208.6		
DENMARK	0.015	1191	1539	2992	6745	7408	8199			17.9	23.1	44.9	101	111	123		
FINLAND	0.014	1001	1273	1998	5045	5387	5660			14.0	17.8	28.0	70.6	75.4	79.2		
FRANCE	0.154	1202	1570	2505	5710	5874	6380			185	242	386	879	905	983		
W GERMANY	0.176	1222	1531	2748	6019	6472	7465			215	269	484	1059	1139	1314		
GREECE	0.027	410	540	1090	2204	2353	2701			11.1	14.6	29.4	59.5	63.5	72.9		
IRELAND	0.010	600	737	1235	2417	2375	2711			6.0	7.4	12.4	24.2	23.8	27.1		
ITALY	0.164	637	891	1585	2800	2723	2725			104	146	260	459	447	447		
NETHERLAND	0.040	880	1092	2234	5491	5937	6989			35.2	43.7	89.4	219.6	237	280		
NORWAY	0.012	1093	1364	2461	5996	6440	7253			13.1	16.4	29.5	72.0	77.3	87.0		
PORTUGAL	0.028	290	351	678	1482	1498	1503			8.1	9.8	19.0	41.5	41.9	42.1		
SPAIN	0.107	317	481	985	2651	2663	2896			33.9	51.5	105	284	285	310		
SWEDEN	0.024	1678	2110	3721	7561	8030	8369			40.3	50.6	89.3	181	193	201		
SWITZERLAND	0.018	1463	1889	3072	7820	8333	8918			26.3	34.0	55.3	140.8	150	161		
U.K.	0.161	1261	1476	2035	3664	3546	3896			203	238	328	590	571	627		
TOTALS										944	1202	2028	4346	4499	4963		

TABLE 6.20

AREA ..REST OF WORLD............... TOTAL POPULATION ..3767 million................

COUNTRY	POPULATION FRACTION	DISPOSABLE INCOME PER CAPITA PER YEAR (US$)								CONTRIBUTION TO AREA DISPOSABLE INCOME/CAPITA YEAR							
		60	63	70	75	76	77	79	80	60	63	70	75	76	77	79	80
OCEANA	0.006	1171	1339	2090	4772	5037	5260			7.0	8.0	12.5	28.6	30.2	31.7		
N. AMERICA	0.038	545	666	960	1813	2003	1971			20.7	25.3	36.5	68.9	76.1	74.9		
AFRICA	0.121	108	128	187	371	506	608			13.1	17.1	22.6	44.9	61.2	73.6		
S.AMERICA	0.063	304	343	530	1090	1255	1353			19.2	21.6	33.4	68.7	79.1	85.2		
ASIA	0.654	85.4	105.6	178.3	352.6	394.3	421.4			55.8	69.1	116.6	230.6	257.9	275.6		
EAST EUROPE	0.177	333	490	990	2499	2538	2578			58.9	86.7	175	442.0	449.0	456.3		
TOTALS										174.7	227.8	396.6	883.7	953.5	997.3		

TABLE 6.20.1

AREA ..ASIA........................ TOTAL POPULATION ..2465 million................

COUNTRY	POPULATION FRACTION	DISPOSABLE INCOME PER CAPITA PER YEAR (US$)								CONTRIBUTION TO AREA DISPOSABLE INCOME/CAPITA YEAR							
		60	63	70	75	76	77	79	80	60	63	70	75	76	77	79	80
AFGHANISTAN	0.006	50	80	111	141	162	165			0.3	0.5	0.7	0.8	1.0	1.0		
BANGLADESH	0.035	10	25	74	106	121	140			0.4	0.9	2.6	3.7	4.2	4.9		
BURMA	0.017	57	63	74	90	110	118			1.0	1.1	1.3	1.5	1.9	2.0		
CHINA	0.391	45	59	68	71	73	75			17.6	23.1	26.6	27.8	28.5	29.3		
INDIA	0.264	69	84	94	136	132	141			18.2	22.2	24.8	35.9	34.8	37.2		
INDONESIA	0.060	73	65	70	200	242	289			4.4	3.9	4.2	12.0	14.5	17.3		
IRAN	0.015	176	192	369	1600	1986	2005			2.6	2.9	5.5	24.0	29.8	30.1		
IRAQ	0.005	198	208	300	1159	1806	1850			1.0	1.0	1.5	5.8	9.0	9.3		
JAPAN	0.047	417	608	1690	3856	4293	4503			19.6	28.6	79.4	181.2	201.8	211.6		
KOREA NORTH	0.007	143	134	250	519	691	866			1.0	0.9	1.8	3.6	4.8	6.1		
KOREA SOUTH	0.015	300	281	525	1090	1244	1280			4.5	4.2	7.9	16.4	18.7	19.2		
MALAYSIA	0.005	251	264	361	716	813	840			1.3	1.3	1.8	3.6	4.1	4.2		
NEPAL	0.005	10	22	74	104	150	180			0.1	0.1	0.4	0.5	0.8	0.9		
PAKISTAN	0.032	75	83	163	175	221	306			2.4	2.7	5.2	5.6	7.1	9.8		
PHILIPINNES	0.019	163	179	170	333	364	412			3.1	3.4	3.2	6.3	6.9	7.8		
TAIWAN	0.007	180	182	185	211	250	302			1.3	1.3	1.3	1.5	1.8	2.1		
THAILAND	0.019	93	107	167	323	351	379			1.8	2.0	3.2	6.1	6.7	7.2		
VIETNAM	0.021	81	120	172	405	423	514			1.7	2.5	3.6	8.5	8.9	10.8		
OTHERS	0.032	73	65	70	200	242	289			2.3	2.1	2.2	6.4	7.7	9.2		
SRI LANKA	0.006	134	145	164	238	214	231			0.8	0.9	1.0	1.4	1.3	1.4		
TOTALS	0.654									85.4	105.6	178.3	352.6	394.3	421.4		

TABLE 6.20.2

AREA ...REST OF WORLD (AFRICA) (0.133)   TOTAL POPULATION ...456 million...

COUNTRY	POPULATION FRACTION	DISPOSABLE INCOME PER CAPITA PER YEAR (US$)								CONTRIBUTION TO AREA DISPOSABLE INCOME/CAPITA YEAR							
		60	63	70	75	76	77	79	80	60	63	70	75	76	77	79	80
ALGERIA	0.042	272	227	291	803	876	904			11.4	9.5	12.2	33.7	36.8	38.0		
EGYPT	0.090	123	147	202	308	392	448			11.1	13.2	18.2	27.7	35.3	40.3		
KENYA	0.034	81	93	127	213	221	276			2.8	3.2	4.3	7.2	7.5	9.4		
MOROCCO	0.043	155	188	221	440	550	580			6.7	8.1	9.5	18.9	23.7	24.9		
ZIMBABWE	0.016	204	206	265	474	503	621			3.3	3.3	4.2	7.6	8.0	9.9		
SOUTH AFRICA	0.062	357	419	661	1170	1067	1174			22.1	26.0	41.0	75.1	66.2	72.8		
SUDAN	0.039	103	110	145	274	518	973			4.0	4.3	5.7	10.7	20.2	38.0		
TUNISIA	0.014	192	236	267	728	710	756			2.7	3.3	3.7	10.2	9.9	10.6		
UGANDA	0.029	57	79	127	250	500	650			1.7	2.3	3.7	7.3	14.5	18.9		
ZAIRE	0.06	40	45	76	127	150	180			2.4	2.7	4.6	7.6	9.0	10.8		
ETHIOPIA	0.067	47	52	68	91	122	162			3.1	3.7	4.6	6.1	8.2	10.9		
GHANA	0.025	182	211	236	463	908	911			4.6	5.3	5.9	11.6	22.7	22.8		
IVORY COAST	0.017	167	201	324	732	848	1150			2.8	3.4	5.5	12.4	14.4	19.6		
MADAGASCAR	0.019	96	101	123	230	430	521			1.8	1.9	2.3	4.4	8.2	9.9		
MOZAMBIQUE	0.022	45	120	208	275	364	500			1.0	2.6	4.6	6.1	8.0	11.0		
NIGERIA	0.164	73	83	130	363	550	620			12.0	13.6	21.3	59.5	90.2	98.7		
TANZANIA	0.039	45	120	208	275	364	500			1.8	4.7	8.1	10.7	14.2	19.5		
OTHERS < 4M	0.218	57	79	127	250	500	650			12.4	17.2	27.7	54.5	109	142		
TOTALS	0.121									108	128	187	371	506	608		

TABLE 6.20.3

AREA .... EASTERN EUROPE .... TOTAL POPULATION .... 442197 ($x10^3$) ....

COUNTRY	POPULATION FRACTION	DISPOSABLE INCOME PER CAPITA PER YEAR (US$)								CONTRIBUTION TO AREA DISPOSABLE INCOME/CAPITA YEAR							
		60	63	70	75	76	77	79	80	60	63	70	75	76	77	79	80
BULGARIA	0.020	333	490	990	2499	2538	2578										
EAST GERMANY	0.038																
HUNGARY	0.024																
YUGOSLAVIA	0.050																
POLAND	0.080																
RUMANIA	0.050																
TURKEY	0.100																
RUSSIA	0.597																
OTHERS	0.04																
TOTALS	0.117									333	490	990	2499	2538	2578		

TABLE 6.20.4.

AREA .SOUTH.AMERICA................ TOTAL POPULATION .239.million..................

COUNTRY	POPULATION FRACTION	DISPOSABLE INCOME PER CAPITA PER YEAR (US$)								CONTRIBUTION TO AREA DISPOSABLE INCOME/CAPITA YEAR							
		60	63	70	75	76	77	79	80	60	63	70	75	76	77	79	80
ARGENTINA	0.112	588	611	984	1854	2050	2003			66	68	110	208	230	224		
BOLIVIA	0.022	89	110	197	415	570	603			2	2	4	9	13	13		
BRAZIL	0.496	233	305	472	1095	1252	1384			116	151	234	543	621	686		
CHILE	0.046	228	311	659	625	681	705			10	14	30	29	31	32		
COLUMBIA	0.111	224	241	310	508	650	700			25	27	34	56	72	78		
ECUADOR	0.034	204	188	251	566	652	741			7	6	9	19	22	25		
PERU	0.072	191	221	322	518	542	650			14	16	23	37	39	47		
VENEZUALA	0.057	859	715	943	2128	2357	2622			49	41	54	121	134	149		
OTHERS	0.164	89	110	197	415	570	603			15	18	32	68	93	99		
TOTALS	0.063									304	343	530	1090	1255	1353		

TABLE 6.20.5

AREA NORTH AMERICA TOTAL POPULATION 143416 ($\times 10^3$)

COUNTRY	POPULATION FRACTION	DISPOSABLE INCOME PER CAPITA PER YEAR (US$)								CONTRIBUTION TO AREA DISPOSABLE INCOME/CAPITA YEAR							
		60	63	70	75	76	77	79	80	60	63	70	75	76	77	79	80
CANADA	0.169	1909	1958	3366	6322	7446	7485			323	331	569	1068	1258	1265		
CUBA	0.070	76	83	94	184	248	260			5.3	6.2	6.6	12.9	17.4	18.2		
DOMINICAN REP	0.038	221	282	338	696	739	818			8.4	11.0	12.8	26.4	28.1	31.1		
EL SALVADOR	0.033	224	241	281	427	503	580			7.4	7.9	9.3	14.1	16.6	19.1		
GUATAMALA	0.050	250	275	310	517	620	701			12.5	13.8	15.5	25.9	31	35.1		
MEXICO	0.496	307	363	609	1191	1135	1010			152	256	302	591	563	501		
OTHERS	0.144	250	275	310	517	620	701			36.0	39.6	44.6	74.4	89.3	101		
TOTALS	0.038									545	666	960	1813	2003	1971		

TABLE 6.20.6

AREA OCEANA .... TOTAL POPULATION 22000 (x10³) ....

COUNTRY	POPULATION FRACTION	DISPOSABLE INCOME PER CAPITA PER YEAR (US$)								CONTRIBUTION TO AREA DISPOSABLE INCOME/CAPITA YEAR							
		60	63	70	75	76	77	79	80	60	63	70	75	76	77	79	80
AUSTRALIA	0.655	1438	1650	2675	6278	6709	7003			942	1081	1752	4112	4394	4587		
NEW ZEALAND	0.141	1445	1647	2030	4026	3855	4007			204	232	286	568	544	565		
PAPUA NEW GUINEA	0.140	120	132	255	448	484	530			17	18	36	63	68	74		
OTHERS	0.064	120	132	255	448	484	530			8	8	16	29	31	34		
TOTALS	0.006									1171	1339	2090	4772	5037	5260		

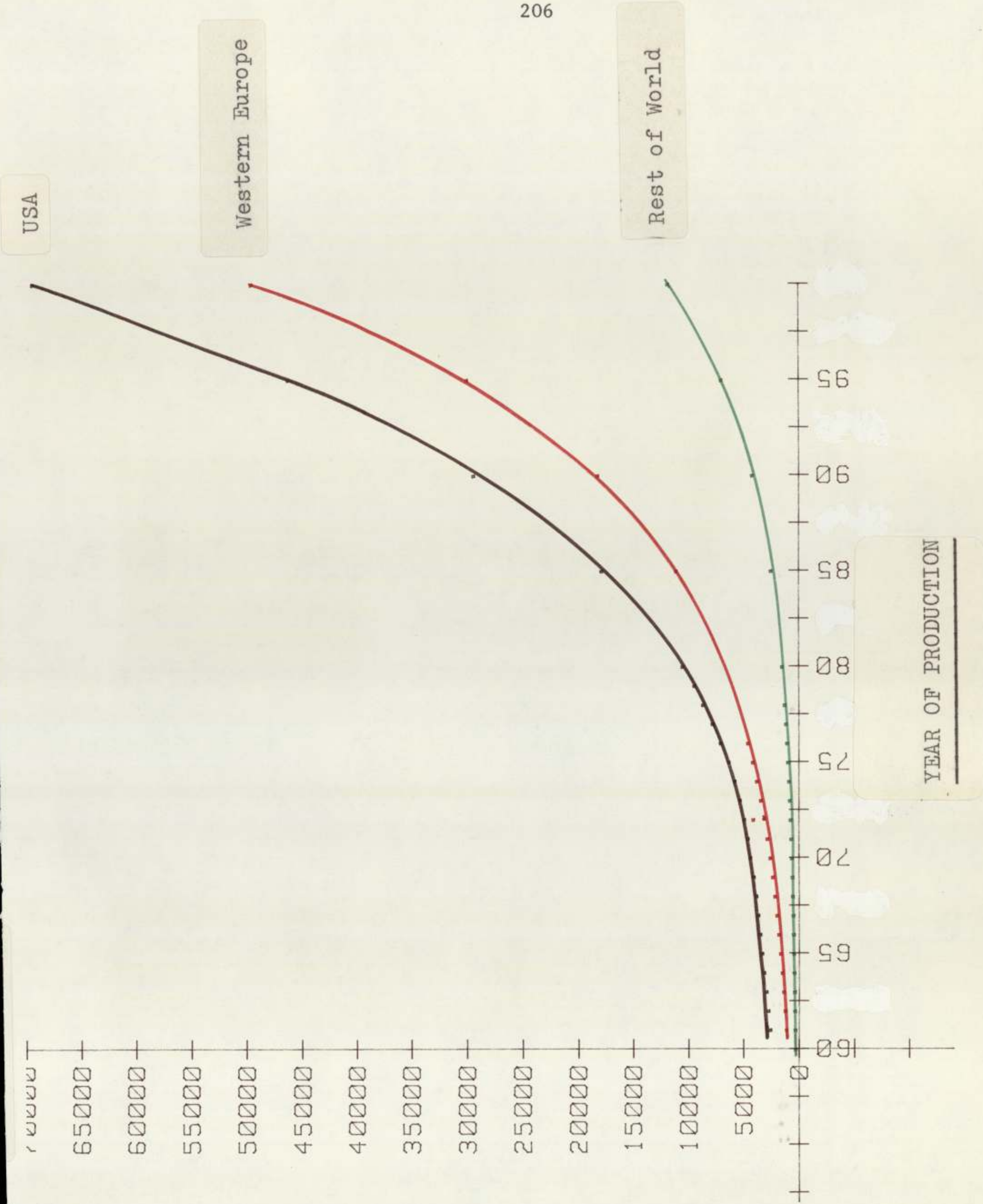


FIGURE 6.5 CORRELATIONS OF DISPOSABLE INCOME/CAPITA WITH AEROSOL PRODUCTION IN EACH WORLD AREA.

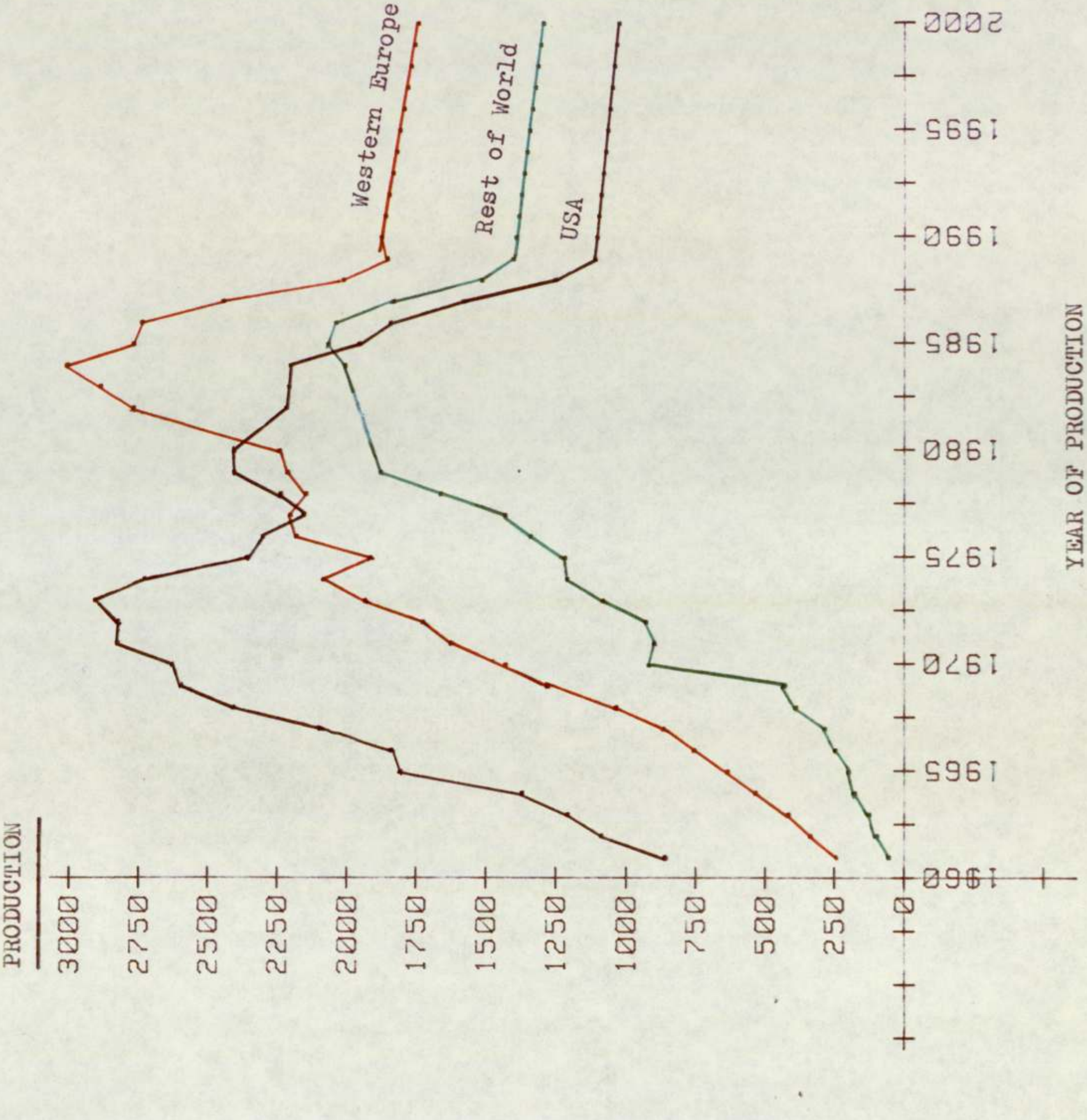


FIGURE 6.6 FORECASTS OF AEROSOL PRODUCTION BY WORLD AREA USING STEP CHANGE AND DECAY HYPOTHESIS

TABLE 6.21 CORRELATION OF DISPOSABLE INCOME PER CAPITA WITH PRODUCTION

	USA		WESTERN EUROPE		REST OF WORLD	
Year	D.I.Capita/	Production Units x 10^6	D.I.Capita/	Production Units x 10^6	D.I.Capita/	Production Units x 10^6
1961	2480	830.1	987	246.0	183	162.1
1962	2645	1056.2	1091	365.6	204	57.2
1963	2809	1267.4	1206	485.3	227	46.2
1964	3020	1521.6	1334	605.7	252	147.1
1965	3185	1708.4	1475	725.7	280	248.9
1966	3350	1885.7	1631	845.8	312	353.5
1967	3533	2072.4	1803	965.5	347	456.2
1968	3715	2248.7	1992	1084.6	386	559.2
1969	3933	2448.9	2203	1204.8	429	661.2
1970	4256	2725.9	2435	1324.4	477	763.7
1971	4478	2904.4	2692	1444.2	531	867.3
1972	4823	3164.8	2976	1564.0	591	970.8
1973	5228	3448.0	3290	1683.7	658	1074.6
1974	5700	3751.4	3638	1803.8	732	1177.6
1975	6265	4083.1	4021	1923.4	814	1280.2
1976	7000	4472.5	4446	2043.3	906	1383.6
1977	7732	4821.7	4915	2163.1	1008	1486.7
1978	8590	5191.1	5434	2283.0	1121	1589.4
1979	9373	5497.3	6007	2402.7	1248	1693.1
1980	10428	5871.7	6641	2522.5	1388	1795.8
1985	17773	7743.3	10966	3121.5	2366	2311.2
1990	29332	9501.9	18107	3720.4	4032	2826.3
1995	46157	11093.4	29900	4319.4	6872	3341.5
2000	69296	12519.7	49373	4918.3	11712	3856.7

TABLE 6.22 STEP CHANGE AND DECAY DATA

	Year	Predicted Linear Relationship Value	% Drop	Final Predicted Value	
USA	1982	2212	-	2212	
	1983	2202	-	2202	
	1984	2196	-	2196	
	1985	2188	89.22	1952	
	1986	2181	84.25	1837	
	1987	2173	72.57	1577	
	1988	2165	57.65	1248	
	1989	2157	51.32	1107	
	1990	-	-	1099}	
	1991	-	-	1092}	
	1992	-	-	1084}	
	1993	-	-	1076}	Predicted
	1984	-	-	1068}	by
	1995	-	-	1061}	Linear
	1996	-	-	1053}	Relationship
	1997	-	-	1045}	
	1998	-	-	1037}	
	1999	-	-	1030}	
	2000	-	-	1022}	
WESTERN EUROPE	1982	2762	-	2762	
	1983	2881	-	2881	
	1984	3001	-	3001	
	1985	3121	89.22	2761	
	1986	3241	84.25	2731	
	1987	3361	72.57	2439	
	1988	3481	57.65	2007	
	1989	3600	51.32	1848	
	1990	3720	50.23	1869	
	1991	-	-	1855	
	1992	-	-	1842	
	1993	-	-	1828	
	1994	-	-	1815	
	1995	-	-	1804	
	1996	-	-	1789	
	1997	-	-	1776	
	1998	-	-	1763	
	1999	-	-	1750	
	2000	-	-	1738	
REST OF WORLD	1982	2001	-	-	
	1983	2104	-	-	
	1984	2207	-	-	
	1985	2310	89.22	2061	
	1986	2413	84.25	2033	
	1987	2516	72.57	1826	
	1988	2619	57.65	1510	
	1989	2722	51.32	1397	
	1990	2825	-	1387	
	1991	-	-	1377	
	1992	-	-	1367	
	1993	-	-	1357	
	1994	-	-	1347	
	1995	-	-	1338	
	1996	-	-	1328	
	1997	-	-	1318	
	1998	-	-	1309	
	1999	-	-	1299	
	2000	-	-	1289	

6.6.4 Market Information from SC Johnson Companies

The results of the telexed questionnaires are presented as Table 6.23 and discussed in Section 6.7.4.

6.7 DISCUSSION AND CONCLUSIONS

6.7.1 Delphi Forecast

This indicated that aerosols were seen to be in decline by all panel members directly involved in manufacture and marketing aerosol products, due to consumer attitudes and anticipated constraints. It was not possible to quantify these effects.

6.7.2 S - Curve Forecast

Once again the S - Curve method forecasted declines in production from 1983 although this decline is not so dramatic as might be expected by some of the media reports (104), (105). In fact the total world production at the year 2000 is reduced by 39% of its 1979 (maximum) value by this forecast. Western Europe and Rest of World are seen to be affected most with reductions from the 1979 figure of 42% and 62% respectively. This forecast does not take account of any legal/insurance constraints.

6.7.3 Causal Forecast

The causal forecast which relates aerosol production to disposable income/capita is optimistic indeed and as such likely to be made

TABLE 6.23 INFORMATION ON AEROSOL MARKETS FROM SC JOHNSON INTERNATIONAL NETWORK

RESPONSES BY WORLD AREA

QUESTION (Ref.6.5.1)	USA	WESTERN EUROPE								REST OF WORLD					
		Aus.	Be.	De.	Fr.	Ge.	It.	Sp.	UK	Af.	Aus	Can.	Jap.	N.Z.	S.Am.
a) Market Share															
Furniture Care	fall	fall	fall	fall	static	fall	rise	rise	fall	rise	fall	sl.fall	fall	static	rise
Air Fresheners	fall	static	fall	fall	static	static	rise	rise	fall	rise	fall	static	fall	static	rise
Insecticides	static	fall	static	fall	fall	fall	rise	rise	fall	rise	static	static	static	static	rise
b) Consumer Attitudes Government or	mixed	+´ve	mixed	-´ve	mixed	-´ve	+´ve	+´ve	mixed	+´ve	+´ve	+´ve	-´ve	+´ve	+´ve
c) Insurance Controls	exist	coming	none	exist	coming	coming	none	none	coming	none	coming	existing	exist	none	none

LEGEND

fall = market share reducing
rise = market share rising
static= market share steady
+´ve = positive attitude
-´ve = negative attitudes

acceptable to aerosol industry associations and suppliers. It agrees well with the forecast based on extrapolation of the production/time data but yields a figure approximatley two and a half times higher than other forecasts. This is due to its failure to take account of the constraints reviewed in Chapter 4.

The causal forecast incorporating the step change and decay patterns experienced in the USA gives good agreement with the S - Curve route. These latter forecasts are concluded to be the most accurate produced by this study.

6.7.4 Market Information from SC Johnson Companies

In summary the data returned via the telexed questionnaires reflected a declining picture in North America and Western Europe due to consumer attitudes and heavy concerns about legal constraints.

The rest of the world picture seemed largely oblivious of any problems with the possible exception of Australia and Japan who tended to follow the United States.

Quantification was found to be difficult although reductions in consumer preference for aerosol products in the USA was found to be up to 50% for some categories with similar data being gathered in the UK and Western Europe.

6.8 SUMMARY

In this chapter, forecasts of aerosol production by broad world areas have been prepared for the years 1985; 1990; 1995; and 2000, using several techniques.

As might be expected, those quantitative techniques involving extrapolation either directly with respect to "production/time data" or indirectly via "causal factors" - tend to yield a growth picture. This is because the only data which shows any decline is that of USA production during the years 1974 to date.

However where attempts have been made to build in some "realism" to the estimate e.g. by modelling actual USA data, then forecasts have been produced which agree well with the qualitative methods used. That is to say that both the qualitative and quantitative methods have yielded the result that aerosols are in decline and the rate of this circumstance depends largely on the possibility of legal constraints as well as consumer attitudes.

These forecasts indicate that the USA will lead the decline and that Western Europe and Rest of World will continue to grow until 1985 when the decline will begin. As shown in Chapter 3, there will be both geographical and product category variants such as:-

* Scandinavia will continue to take a tough line on aerosols whereas Spain and Italy will apply controls more slowly

* African; Asian and South American countries are likely to react more slowly to anti-aerosol pressures but because they are dependent on the USA and Western Europe for supplies, will also decline.

* Products which are used regularly in and around the home are likely to decline more rapidly than the occasional or specialist products which make up the 'Miscellaneous' category e.g. auto-care products. In fact, evidence has been presented in Chapter 3 which indicates that there may be some growth there.

CHAPTER 7: THE DEVELOPMENT OF THE AEROSOL PACKAGING SYSTEM

7.1 INTRODUCTION

In the previous Chapter, the decline of the aerosol was forecasted by various techniques. The concerns surrounding aerosol safety were attributed to be a major cause of this decline and in this and subsequent chapters, some of the other product options will be reviewed.

These options are:-

(1) Continue to market the current product range in "safe" aerosol packages.

(2) Continue to market the current product range in non-aerosol alternatives.

(3) Initiate a search for new business opportunities.

Option (1) above will be the subject of this chapter, option (2) will be reviewed in Chapter 8 and option (3) in Part II of this thesis.

The history of the aerosol package was described in Chapter 2 and Table 2.16. During this chapter some of the more interesting modifications on the aerosol system will be reviewed in terms of previous developments which although interesting, failed to gain commercial acceptance together with those currently enjoying some attention from the industry. For convenience these will be discussed under `previous developments´ and `recent developments´, further sub divided according to whether they are based on propellant changes, packaging changes or a combination of changes.

Much of the propellent work is recent, following the publication of the Molina Rowland ozone depletion hypothesis in 1974 (1). The packaging developments started well before this publication but more recently there have been packaging innovations which were obviously stimulated by this hypothesis. Some of the work undertaken so far by Johnson Wax Ltd is also included in this chapter, the main purpose of which is to review all developments and draw conclusions as to their degree of usefulness and the likelihood of future commercial viability.

7.2 PREVIOUS DEVELOPMENTS

7.2.1 Propellent Changes

Table 7.1 summarises some of the more important propellent changes and alternatives that have already been tried with varying degrees of commercial success. As stated in Chapter 2, hydrocarbon propellents have been utilised for aerosols for many years although the re-formulation of many of the consumer products away from chlorofluorocarbons (CFC´s) back to hydrocarbons in 1976 brought considerable problems for many marketers. Some of these difficulties were discussed at B.A.M.A. symposium in 1980 and the paper given by Roberts (114) dealt with the subject in detail Since the Molina Rowland hypothesis (1), hydrocarbon propellents have continued to gain ground over the CFC types, although there is still a relatively low number of aerosol producers that are equipped to fill hydrocarbons. For example in the UK less than half of the manufacturers have this capability mostly because of the flammability considerations discussed and reviewed in Chapter 4.

The most widely used CFC propellents are propellents 11 and 12 as discussed in Chapter 2. These were originally selected as having the best combination of physical and chemical properties, although the ozone controversy has cast considerable doubt upon their suitability from the ecological viewpoint. These concerns are fully described in Chapter 4 and in summary are related to the presence of chlorine in the molecule. According to B.A.M.A. (7) those fluorocarbons that do not contain chlorine but do contain hydrogen can be considered as more satisfactory alternatives, and several of these compounds have been and continue to be researched as future propellents (10). Some of these are detailed in Table 7.1 from which data it may be concluded that the short term emergence of a new halocarbon propellent is unlikely.

A further liquifiable gas propellent is dimethyl ether and although this has many interesting advantages such as complete miscibility with water, and properties similar to L.P.G., its cost and general availability make it less attractive.

Compressed gas aerosols have been researched and utilised for at least thirty years (21). Carbon Dioxide is probably the most common propellent followed by Nitrous Oxide both having found use in the past in food-stuffs such as whipped cream and ice cream toppings and in hair sprays and insecticides. As shown in Table 7.1 these propellents seem to be more satisfactory where a finally divided spray is not an essential requirement

The use of propellent mixtures in order to try and optimise propellent properties has mostly been in evidence since the Molina Rowland publication. Some marketers claim satisfactory results in this respect (7), but the precise advantages of this development are often difficult to see.

7.2.2 Packaging Developments

The previous developments in aerosol packaging are summarised in Table 7.2 which covers the period 1965 to 1973. The various packages summarised in this Table are illustrated in Plates 7.1 through 7.5.

With the exception of the Sepro can system, all of the barrier systems described in this Table have failed to gain commercial acceptance and now represent historical interest only. The Sepro can will be discussed more fully in a later section of this Chapter and as stated in Table 7.2, the Mini-Sol plastic aerosol package has gained acceptance for cosmetic items now representing approximately 10% of aerosols filled in the United States. The use in Western Europe is approximately 9% of the total cosmetic aerosols.

PROPELLENT DEVELOPMENTS

TOXICITY AND FLAMMABILITY	ENVIRONMENTAL	SAFETY COMMERCIAL CONSIDERATIONS
Toxicity - satisfactory.	Essentially without major problem - see Chapter 4.	Cost effective conversion from CFC to HC requires substantial investment, and gaining ground over CFC everywhere.
See "Developments".		This work is continuing but costs of gaining acceptance of new CFC is very high (10).
As for LPG.	As for LPG	Availability and cost problems have prevented widespread use.
Satisfactory	Satisfactory	Although the gases are inexpensive 'per se', they require the use of either expensive solvents <u>or</u> high pressures with heavier components Commercial acceptance limited [2.5% total for Europe (7).]
Some improvements possible over total CFC use		Not really viable on a large scale when extra cost of plant and equipment considered versus few advantages. Not widely used.

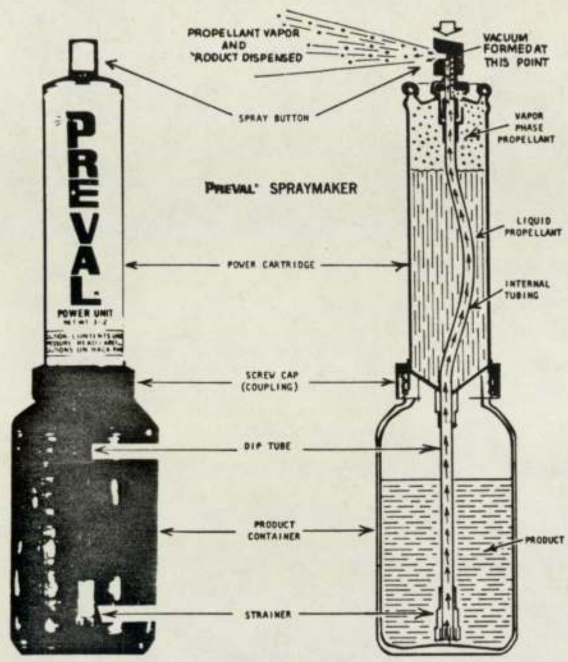


PLATE 7.1 PREVAL PACKAGE

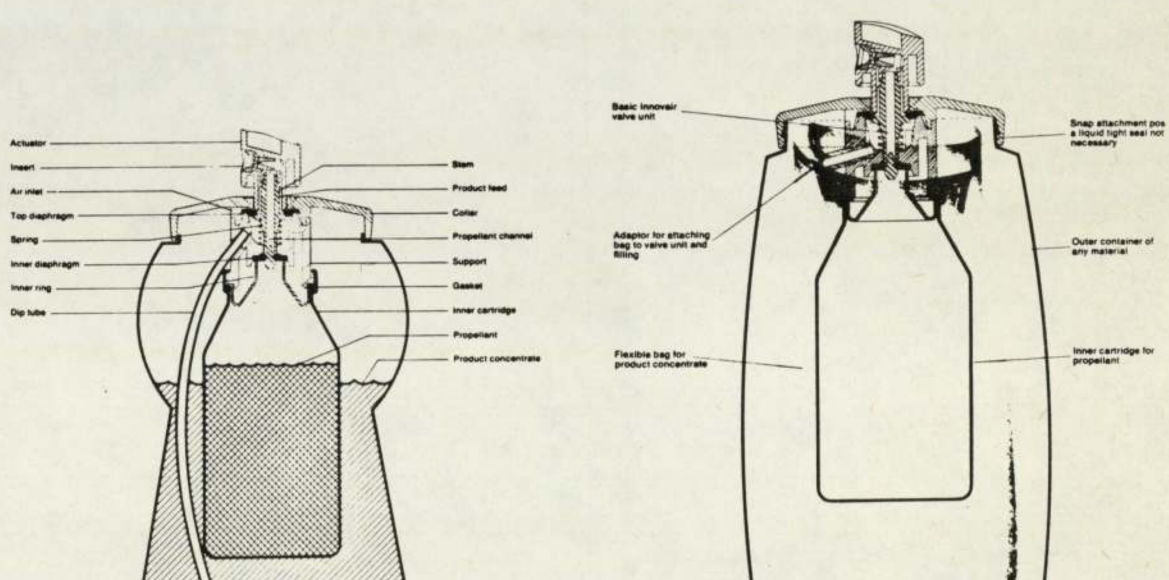
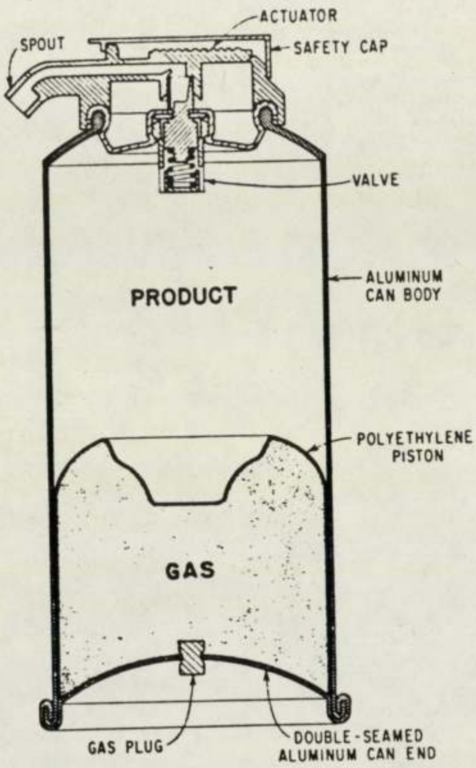


PLATE 7.2 INNOVAIR PACKAGE



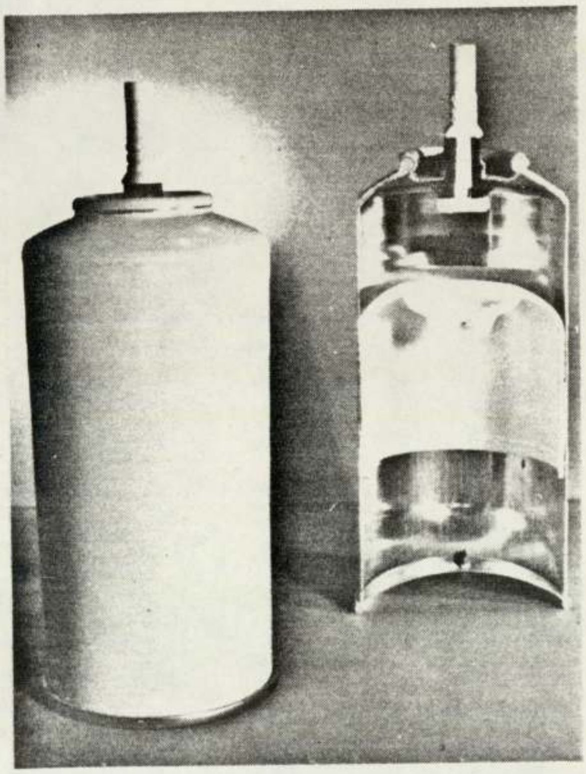


PLATE 7.3 POWR-FLO PACKAGE

TABLE 7.2 PREVIOUS AEROSOL PACK DEVELOPMENT

NAME	WORKING PRINCIPLE	COMMERCIAL ACTIVITY	COSTS	DISADVANTAGES	COMMENTS
Preval - See Plate 7.1. (Precision Valve Co.)	Separated propellent and active product package the latter being non pressurised.Refills available.	Nil	Unknown. 2 x comparable aerosol (190).	Poor valve shut off. Serious leakage problems. Potential for misuse by inversion.	Developed in 1965. System now abandoned.
Innovair (Ciba-Geigy) See Table 7.1	Internal propellent cartridge containing CFC 12 on solid absorbent. Active product in non pressurised outer container	Several USA firms worked on system (190) Now abandoned.	Unknown but reported to be high i.e.2 - 3 x conventional pack (190).	Differential expansion of containers - leakage. High filling costs. Only low propellent type formulations can be used.	Developed c 1965 with 3 generations of design. now abandoned.
Powr-Flo (Sterigard Corp & American Can c 1970).See Plate 7.2.	Variation of bag in can concept using small quantities of propellent which is its main advantage. Propellent injected into can base via plugged hole.	Not fully tested in commercial applications.Plant for 80,000 units per month started in 1972. Later went national in USA.Largely unaccepted by industry.	Not fully known.1 - 3 x conventional based on early data (190).	Problems in filling product especially in bags becoming trapped.	Largely now abandoned.
Sepro-Can (Continental Can Co 1966) See Plate 7.2 and Section 7.4.2.	Automated "squeeze tube" barrier system i.e.outer pressurised can with inner plastic bag containing active product.	Commercially available in USA in Europe and elsewhere (136),(138).	Comparable with conventional for special products.1.1 - 1.5 x conventional H/H aerosol (136).	Higher Costs. Limited availability in a in a variety of sizes.Special filling equipment needed.	The only barrier system so far found commercially acceptable.Gives unique opportunity for special products e.g.Edge Shave Foam.
Minisol Plastic Aerosol (Pelorex Corp 1972).See Plate 7.2.	Conventional Aerosol principle but in plastic with simplified valve and actuator attached to the injection moulded base.	Good success in cosmetics and perfume categories.	Low. 0.5 - 0.8 x conventional pack.	Limited in size Sometimes problems in sealing components. Spray of limited quality due to simplicity of valve.	Good acceptance of package for cosmetic and "travelling" sizes.

PLATE 7.4 SEPRO CAN PACKAGE

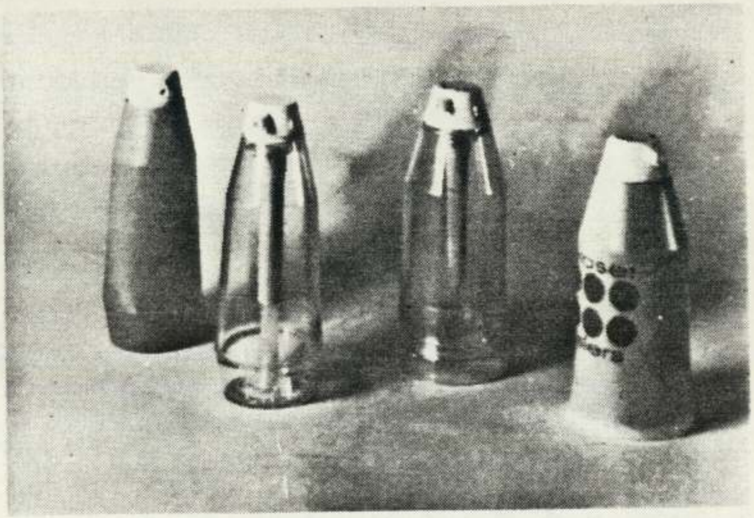


PLATE 7.5 MINI SOL PACKAGE

7.3 RECENT DEVELOPMENTS

7.3.1 Aerosol Propellents

The more recent work on new aerosol propellents can be classified under two headings, namely:-

(a) Continuing studies towards an alternative chlorofluorocarbon propellent.

(b) Investigation of the practical uses of the alternative propellents such as dimethyl ether; liquifiable gas/compressed gas mixtures.

Most of the potentially useable CFC's have already been mentioned in Table 7.1 although over sixty alternatives exist (10). These alternatives were subject to a three stage protocol as follows:-

(i) Short term acute and mutagenicity indicator study using a few kilogram of test substance and costing about £ 2,000 sterling per compound.

(ii) A medium term test for mutagenicity and teratogenicity using around 500 kilogrammes of the substance and costing up to £70,000 sterling per compound.

(iii) A long term life time inhalation study using tons of test substance and costing up to £400,000 sterling per compound.

None of the alternative substances have so far passed the full protocol and although more recent results were available in 1981, further studies are still necessary to complete the assesment. Moreover the substances which are more likely to give satisfactory toxicity results are new compounds for which commercial scale manufacturing technology has still not been fully worked out. Though work is still underway, when viewed on a commercial basis, there is doubt as to the future of this project because the two major companies involved (Dupont and ICI) have already invested millions (of £ 's) with no return.

The most recent reference on the use of a compressed gas with a liquifiable gas namely Fluorinated Dimethyl Ether is via USA patent 139,607 assigned to WR Grace and Co. This patent describes the use of Difluoromethyl Ether and gaseous Carbon Dioxide as an aerosol propellent which has three advantages namely:-

* Low flammability;
* Harmless to environment;
* Good working pressure (45 p.s.i.g.);
* Satisfactory spray.

Finally there has been a good deal of unpublished work completed within SC Johnson by Schmidt (131), Waaganar (132) and Roberts (133) at their Milton Park Egham Research Centre. The purpose of this work, completed during 1982, was to identify those consumer products within the S.C. Johnson range that adapted most readily to the use of Dimethyl Ether to give advantages over Hydrocarbon propellent. A further purpose of this work was to optimise the manufacturing process for Dimethyl Ether propelled products using conventional or slightly modified aerosol filling machinery.

7.3.2 Packaging Developments

There are no significant recent packaging developments that warrant mention under this section. Those developments that have and are occuring relate to further improvements to such items as:-
Can welds; internal lacquer coatings and the introduction of "necked in" cans - a purely cosmetic change. Similar minor modifications to valves are also in evidence, particularly to those recommended for compressed gases and claimed to enhance atomisation.

7.4 ANTICIPATED FUTURE DEVELOPMENTS

7.4.1 Propellents

Apart from the research in to CFC alternatives sponsored by the major CFC producers, there appears to be little research underway aimed at new aerosol propellents. Therefore the conclusion must be that apart from perhaps a greater use of some of the existing propellent systems already mentioned in this study, it is unlikely that there will be anything new in the forseeable future.

7.4.2 Packaging

As shown in this study (both in Chapter 2 and Section 7.2.2) there have already been a number of novel and innovative developments to the basic aerosol package. By the definitions already used in Chapter 2, an aerosol consists of a can; a valve; an active product; and a propellent. Consequently when one considers the developments already reviewed in terms of propellents, barrier systems and valve technology, it seems that the aerosol packaging system has been fully explored and optimised already. Therefore no major modifications in packaging are anticipated although it is possible that there will be a greater proliferation of plastic aerosols; improved valve designs for compressed gas/liquified gas mixtures and hopefully some improved can linings for tinplate containers which will help to avoid can corrosion (134).

All other forms of spray system, pressurised or non pressurised have been assumed to fall outside the basic aerosol specification and will be discussed in a subsequent chapter. As the basic aerosol system has been so well optimised, this has tended to make further major improvements difficult to achieve both in technical and economic terms. Those technical developments so far achieved do not appear to justify investment in the current market environment where it is unlikely that consumers are prepared to pay more for relatively small benefits.

7.5 SUMMARY AND CONCLUSIONS

In this Chapter previous and very recent developments to the aerosol packaging system have been reviewed and evaluated in terms of their likely effect on future demand for aerosols.

In summary, it may be stated that although the previous and most recent developments (propellents and packaging) represent steps in a fairly comprehensive programme, they are unlikely to have a beneficial effect on the future of the industry. Moreover, looking to the future, it is improbable that further developments either in the pipeline or yet to be started, are likely to make substantial and commercially viable improvements to the current aerosol package which has probably been optimised to the full extent in terms of performance and economic factors.

CHAPTER 8: ALTERNATIVE DISPENSING SYSTEMS TO THE AEROSOL

8.1 INTRODUCTION

In the previous Chapter the developments relating to a "safe" aerosol packaging system were reviewed and it was concluded that despite numerous developments in propellents and packaging components, these activities are unlikely to affect the present trends in aerosol product demand.

Non-aerosol alternatives i.e. packaging systems that will dispense a product on demand, have developed in parallel with the aerosol packaging system but have probably received a new lease of life since the advent of the ozone controversy. Many of these systems largely mimic the aerosol endeavouring to produce an atomised spray but without the use of the conventional throughput of propellent. Some have even been designed to look like aerosols e.g. finger pumps, while others are constructed to look completely different e.g. trigger sprays. Few have so far enjoyed commercial success.

During this chapter these alternative dispensing systems will be reviewed and compared to the aerosol packaging system in terms of efficacy, cost and overall suitability to the business categories currently served by the aerosol. Conclusions will also be drawn regarding the possibility of some of these packaging alternatives being able to capture markets already enjoyed by aerosols, with the aim of assessing future business opportunities.

Essentially the alternative dispensing systems to the aerosol divide into two main categories namely:-

(a) Those generating their working pressure by some form of pump which may be of the finger; trigger or plunger type.

(b) Systems dispensing the product by inward collapse of the container system walls i.e. "squeeze" pressure either manual or mechanical.

All of the above types of packaging system will be reviewed during this chapter, using a similar format to that utilised for aerosol systems namely looking at previous developments, recent developments and anticipated future developments.

8.2 PREVIOUS DEVELOPMENTS

8.2.1 Pump Systems

The pump systems are summarised in Table 8.1 and further illustration is provided by way of Plates 8.1 through 8.4. Some of these were developed during the main aerosol development period (see Table 2.16) and some following the publication of the Molina Rowland hypothesis.

As shown in Table 8.1, although atomising sprays of the 'Flit Gun' type and "squeeze" bulb/glass bottle type have been in evidence for over fifty years, the major developments have been via the finger and trigger pump systems. However, the review also shows the degree of ingenuity and innovation that has already been applied, all be it unsuccessfully, to alternative dispensing systems.

TABLE 8.1 PREVIOUS DEVELOPMENT OF PUMP SYSTEMS

TYPE	WORKING PRINCIPLE	COMMERCIAL ACTIVITIES	COSTS	DISADVANTAGES	COMMENTS
Flit Gun (c 1930)	Hand pump plus reservoir of active product. One discharge/stroke of pump (c.f.bicycle pump).	Market throughout the world	Unobtainable.	Large unit.Poor atomisation.	Of historical use only.
CALMAR pump for garage use.(c1940)	Metallic pump for "Windex" car windscreen glass cleaner. Early finger pump type packed separate from active product -assembled by user.	Widespread use in USA when taken up by Drackett Products Co.	Unobtainable.	Too large and prone to corrosion.	As for Flit Gun.
CALMAR Integrated pack.	PVC pump shipped for the first time attached to bottle of active product with special quick release mechanism.	National in USA Some sold in Europe.	Still too high.	Compatability problems.High cost.	As for Flit Gun.
CALMAR (c1962)	Working principle unaltered but materials changed from PVC to ABS and polyolefines	Well accepted. Sold in USA, Europe, elsewhere.	Lower than PVC.	Still poor spray in sense of drooling, dripping	As for Flit Gun
Apha Trigger Spray (c1965)	Pump action similar to finger system but but activated by Trigger/Pistol grip.	Well accepted for industrial and non consumer products	3 x finger system.	Initial cost. Mechanical reliability. Need for special bottle design.	A major development which has received increased impetus by ozone controversy
CALMAR Fine Spray finger pump (c 1965)	Pump cylinders made narrow and pressure raised from 10p.s.i. to 80p.s.i.	Well adopted by by cosmetic houses for hair spray.	1.5x normal finger pump.	Still finger fatigue problem remained.	A further major step in pump systems.
Albert/Calmar pump (c1975)	Special non-drip shut off pump developed.	System applicable to finger and trigger formats. Hair sprays up to 40% of USA mkt.	2.5 x aerosol cost. 1.5 -2 x cheapest finger pump.	Still marginally behind aerosol counterparts in spray performance and ease of use.	This development was the last major technical step.

TABLE 8.1 CONTINUED

TYPE	WORKING PRINCIPLE	COMMERCIAL ACTIVITIES	COSTS	DISADVANTAGES	COMMENTS
Selvac - Plant Industries (c 1975)	Elastomeric bag or bladder inside outer container - pressurised to 80 p.s.i.g.during filling.	Currently(1983) being marketed by Container Industries Inc. as 7.5 ounce system - without success. Plans to go commercial in 1983 with 12 x 10^6 Units/year	Up to 5 x comparable aerosol i.e. 55 c/unit or 35p/unit.	Numerous:- Minimal product choice due to compatability. Cannot deliver effective spray. High package cost. Numerous permeatation problems. Special filling equipment needed.	Not a serious alternative to Trigger pumps.
Aerofill Sprayer - Alpha Corp. (c 1976)	Spring loaded piston forces product out out of container.	Experimental only. Abandoned in 1972.	Unknown but high.	Poor spray performance due to low pressure (0.5 p.s.i.g.) High cost of manufacture Inconvenient to use.	Of historical interest only.

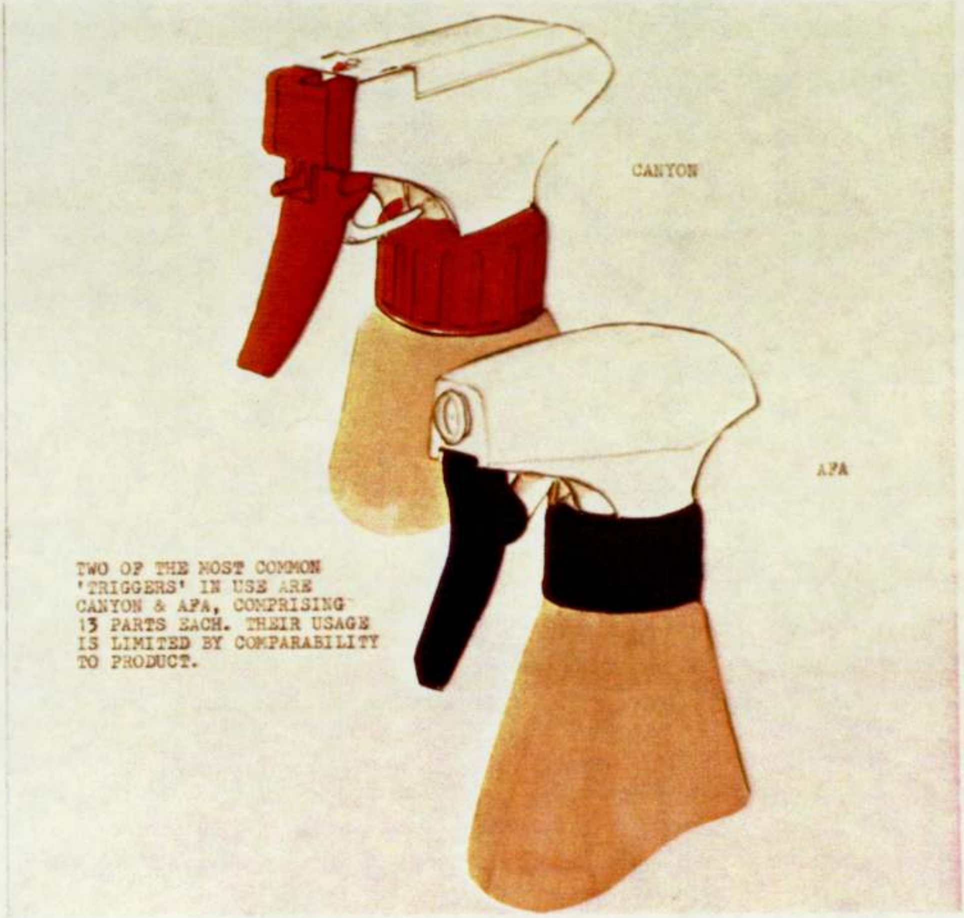


PLATE 8.1 APHA TRIGGER SPRAY UNIT

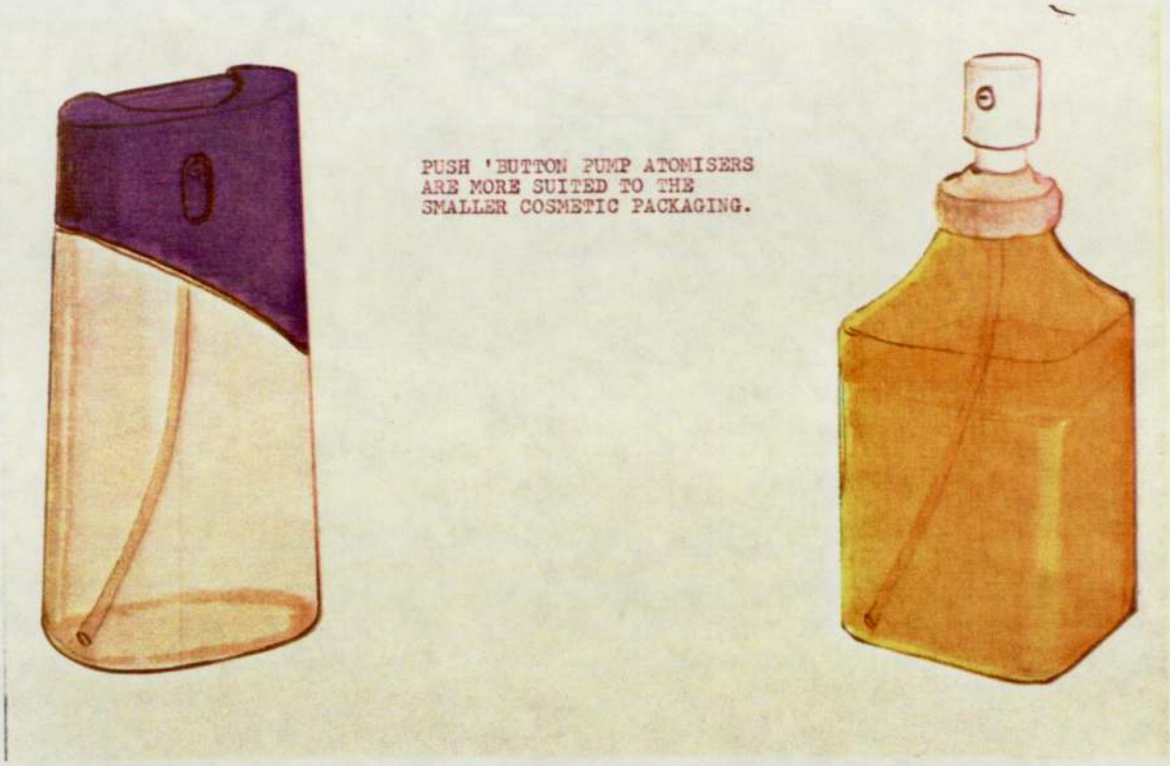


PLATE 8.2 CALMAR FINGER PUMP

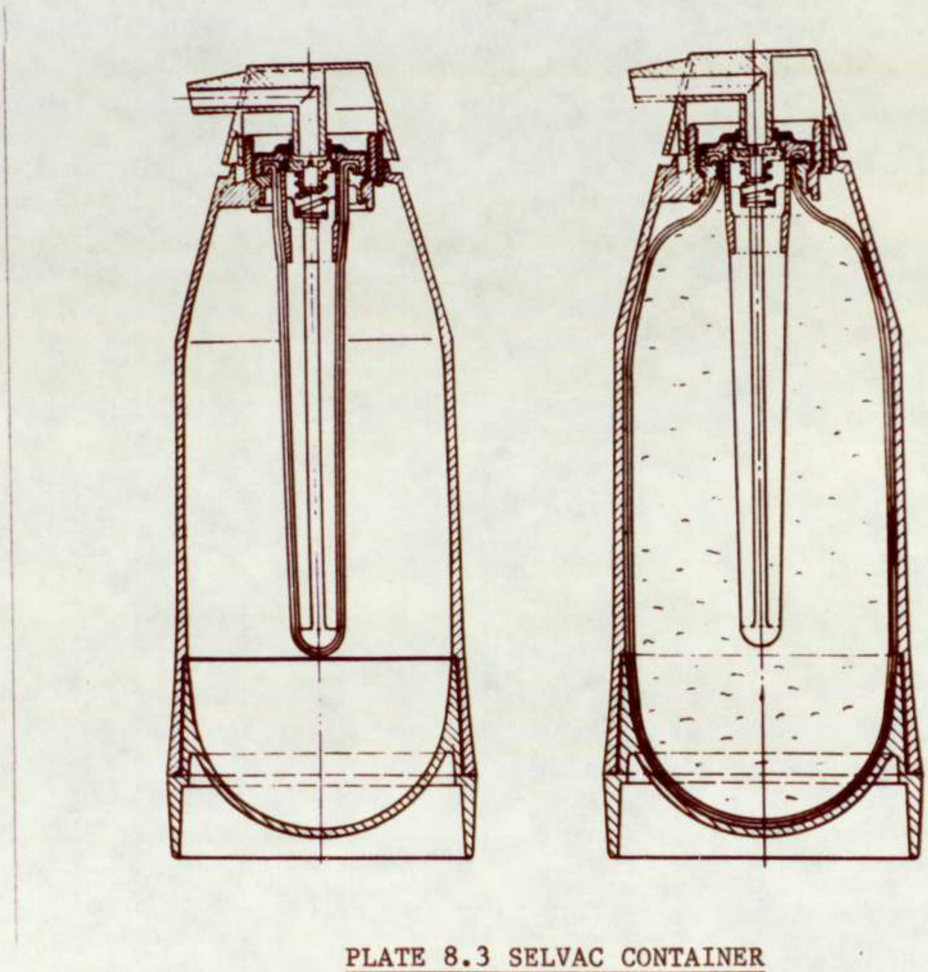


PLATE 8.3 SELVAC CONTAINER

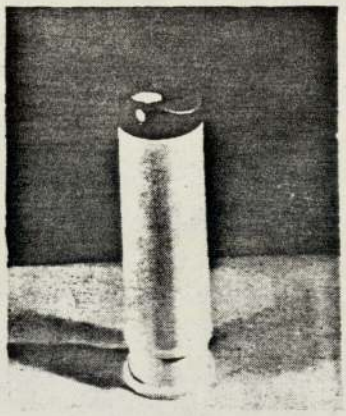


PLATE 8.4 AEROFIL SPRAY UNIT

8.2.2 Squeeze Delivery Systems

Squeeze delivery systems are those where the driving force and delivery of product is provided by (usually hand) pressure collapsing the walls of the container and forcing the product to the exterior. In general such systems are capable of only delivering bulk liquid as a jet or as a dispensed quantity but not as any form of atomised spray. A possible exception to this is the 60 year old perfume atomising unit where a glass bottle containing fragrance is connected via some rubber tubing to a bladder or squeeze bulb which over pressurises the fragrance and allows it to be pumped in the form of a spray. A further exception is the 'Sepro' container to be discussed in the next section.

Some of the typical squeeze packs which are illustrated in Plates 8.5 to Plate 8.8 need little further explanation other than to draw attention to some of the problems of incomplete delivery for viscous products. This is because the more viscous type of product tends to stick to the inner walls and there is not enough driving force to expel it. Table 8.2 shows some of the typical costs associated with sqeeze pack containers.

PLATE 8.5 EARLY FRAGRANCE BULB

PLATE 8.6 SQUEEZE PACK WITH DIP TUBE

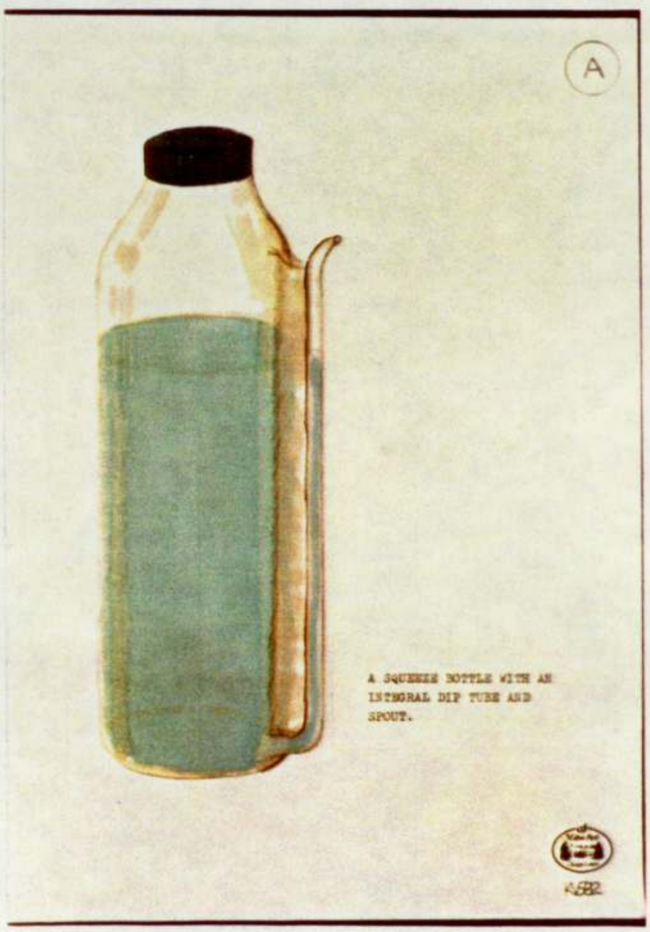


PLATE 8.7 SQUEEZE PACK WITH INTEGRAL DIP TUBE

PLATE 8.8 PUMPTAINER PACKAGE

TABLE 8.2 TYPICAL SQUEEZE PACK COSTS (250) ml SIZE)

REFERENCE	DESCRIPTION	Cost Analysis pence/unit			TOTAL
		Pack	Diptube	Closure	
Plate 8.6	Squeeze pack + dip tube	4	0.5	3	7.5
Plate 8.7	Squeeze pack + integral dip tube	4	-	2	6
Plate 8.8	Pumptainer	4	0.5	3	7.5

8.3 RECENT DEVELOPMENTS

8.3.1 Pump Packs

As illustrated in the previous section the prime development of the pump system is that of the trigger unit. Nevertheless since the advent of the ozone controversy, this area has received a good deal of attention from aerosol engineers and technologists servicing the `Speciality Chemicals´ industry. Table 8.3 shows some of the more recent developments in this regard also illustrated in Plates 8.9 through to Plate 8.16.

As shown, apart from a number of interesting curiosities, the trigger pump for household products and the finger pump for cosmetic and toiletry products appear to be major projects worth further investment. In addition the Calmar pump for liquid delivery such as liquid soaps and its subsequent refinement for toothpastes is also a useful component for future consumer and household products.

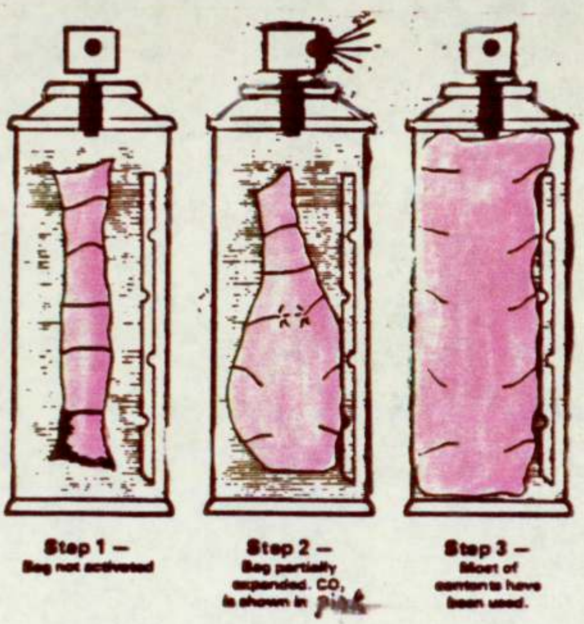


PLATE 8.9 ENVIRO SPRAY SYSTEM

TABLE 8.3 RECENT PUMP PACK DEVELOPMENTS

TYPE	WORKING PRINCIPLE	COMMERCIAL ACTIVITY	COSTS	DISADVANTAGES	COMMENTS
Enviro Spray (c 1982)	Self generating inner bag of CO_2 forces product from outer container. (See Plate 8.9).	Still experimental.	2 x conventional aerosol.	Limited use - spray atomis-ation poor. Heavy capital investment for for production. Possible corrosion problems.	Not likely to seriously rival conven-tional system. Still under evaluation by SC Johnson.
Kervin (Belgium) Piston (c1980)	Piston in can pres-surised by compressed air at 102 p.s.i.g.	Experimental in W.Europe only.	Not fully est-ablished.Likely to be 2 - 3 x conventional in aluminium. Some reduction possible if made in tin plate.	Unproven. Fall off atomisa-tion as can empties.	Abandoned due to high cost. Restarted in November 1983.
Apha Trigger Pump	Working principle based on well established Apha horizontal piston with umbrella valve and no rubber parts.	Just started to market in Europe and USA.	20 US cents/ unit - 12.8p/ unit.	Unknown.	Needs evaluation alongside J.Wax and SCJ units.
Johnson Wax Ltd Pump	Trigger system based on 7 working parts only.(See Plate 8.14.	Pilot mould approved May 1983.Production mould commis-sioned for Sept 1983.Initial run 2 x 10^6 units.	15 US cents/ unit or 9.6p.	May be out-priced by SCJ parent unit. Also Apha unit.	With data avail-able this looks to be prime option for industry for next decade.
S.C. Johnson Pump	Trigger system based on liquid soap pump. Bayonet bottle fitting gives SCJ exclusive use. (See plate 8.14.)	Pilot mould under modific-ation. Anticip-ated production in US in March 1984.	10 US cents/ unit,, 6.4p. Expected to be in production in 1984 in house.	Not yet eval-uated.Compat-ability with products could be a problem.	This may prove to be the ultimate choice.
Calmar Pump for bulk delivery. (Plate 8.15)	As for 1975 but with spount and activation device. Immediate priming.	Widely sold throughout Europe and USA.		Start sequence not always understood by consumer.	A successful though costly item for bulk delivery.

TABLE 8.3 CONTINUED

TYPE	WORKING PRINCIPLE	COMMERCIAL ACTIVITY	COSTS	DISADVANTAGES	COMMENTS
Mistlon Canyon Pump Japan (c 1982) (Plate 8.11)	Integral hand pump produces compressed air which delivers product via conventional aerosol valve. Special double coned can needed with pump barrel inside can and detachable piston. Can pumped up to desired pressure.	Reported to be now available. Minimum order 500,000 cans.	Said to be equal to conventional aerosol package (188). Experimental work just complete. Japanese marketing strongly.	Must be pumped up before use.	Slightly better than Triggers but suspect performance inferior WRT conventional aerosol. Actual costs need to be confirmed.
Olozon Pump (Air Spray) (Plate 8.12)	Plastic refillable container with a removable pump spray hand/dip tube unit. Principle as for Mistlon.	Manufacturing facilities in Finland and UK.	1 - 3 x aerosol.	Cost. Plastic - handling problems. Poor spray.	Being looked at seriously for non-space sprays

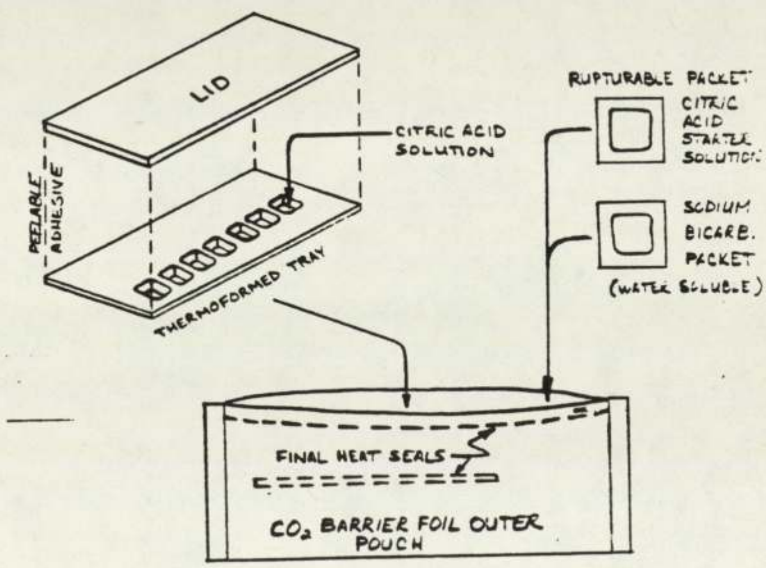


PLATE 8.10 CONSTRUCTION DETAILS FOR ENVIRO SPRAY CO_2 GENERATOR

PLATE 8.11 MISTLON PUMPED AEROSOL

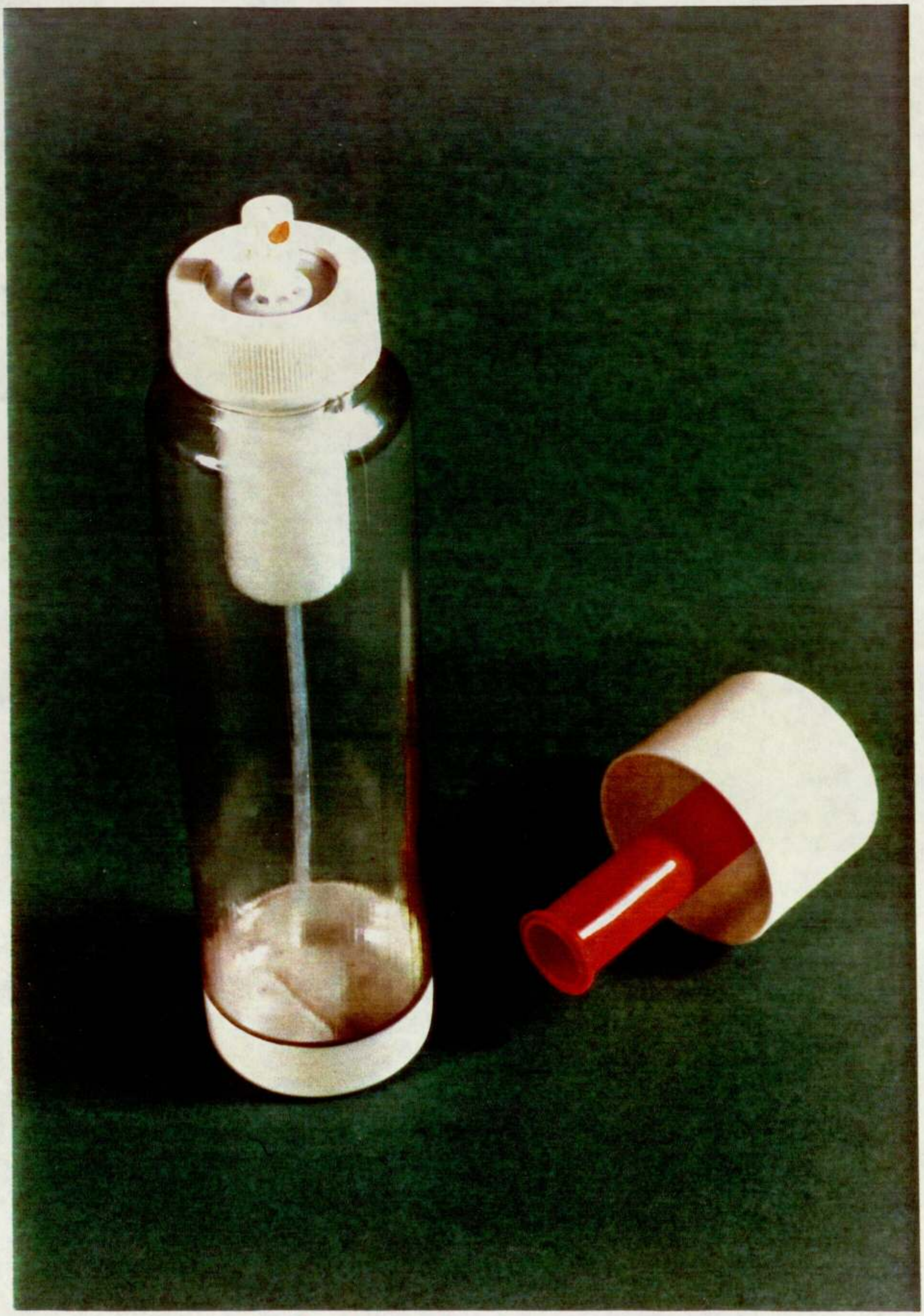


PLATE 8.12 OLOZON (AIRSPRAY) PUMPED AEROSOL

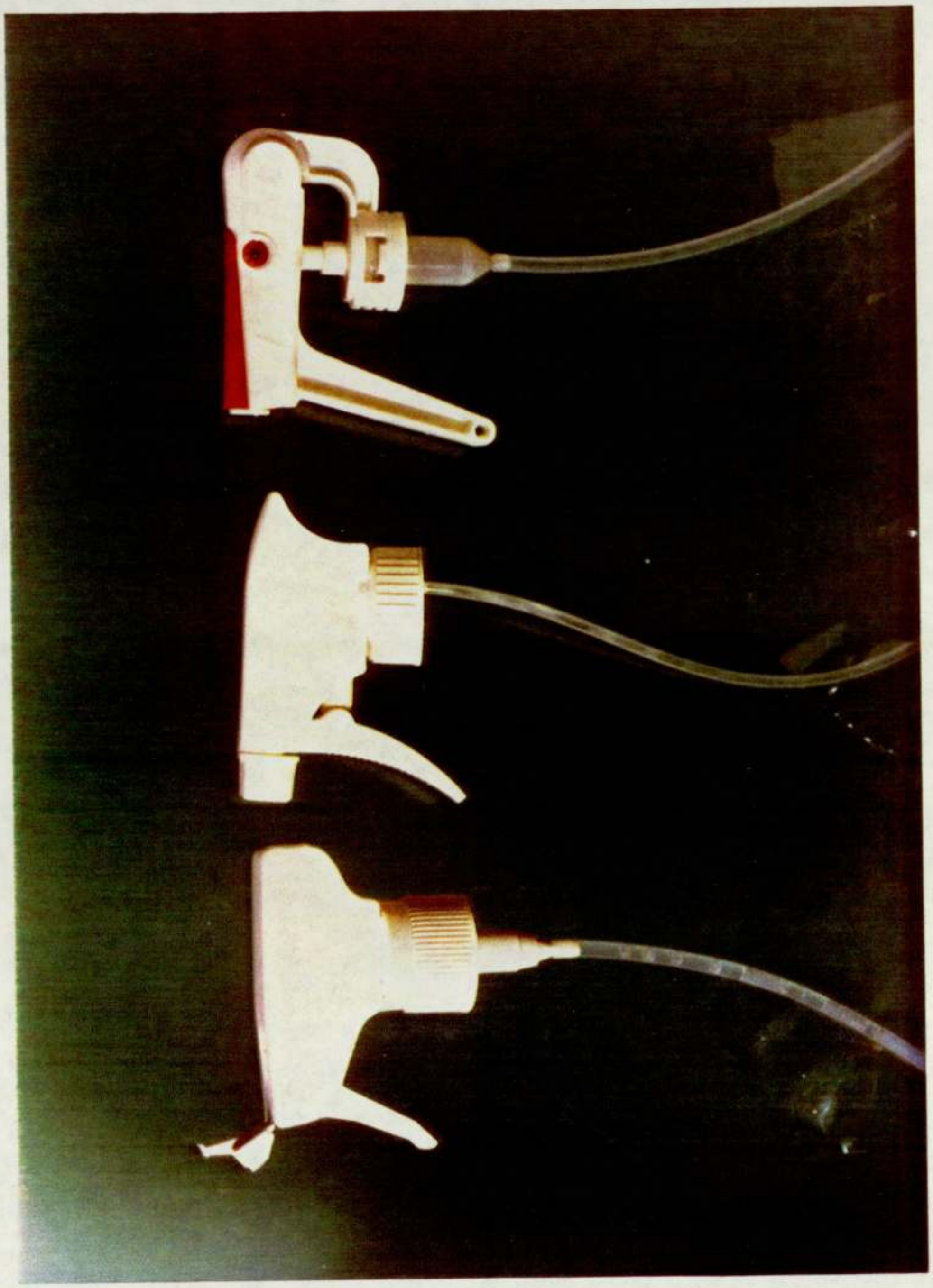


PLATE 8.13 NEW LOW COST TRIGGER PUMP UNITS

(JOHNSON WAX LTD/DPV; APHA; S.C.J. M.A.P. UNIT)

PLATE 8.14 LIQUID SOAP PUMP FROM CALMAR

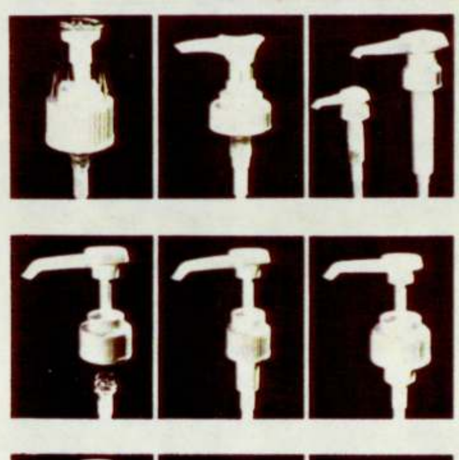


PLATE 8.15 VARIETY OF BULK LIQUID PUMPS

8.3.2 Squeeze Packs

Table 8.4 shows some of the recent developments in squeeze packs together with Plates 8.17 and Plate 8.19. An interesting manual system, (Plate 8.17) is obtained by the addition of a small foaming device to the basic collapsible bottle such that suitable liquid products can be dispersed as a foam. Another new design has a pleat in the side wall giving a bellows like effect but increased ability to dose the ingredients. In fact systems approaching the pump have been developed from the bellows version of the simple squeeze pack and for products that do not have to be atomised, these represent a very low cost and reliable version of dispenser. (See also Table 8.2).

As stated earlier, the 'Sepro' aerosol container is really an automated version of the squeeze pack with a plastic bottle contained inside an aerosol can, squeezed by a small amount of propellent in tha base of the can applying pressure to the plastic bottle wall. These packs are still under development (137), (138), although already in commercial production in the United States and Western Europe (138). They represent not only a way of saving on propellent costs and propellent migration into the environment but also offer some unique product opportunities as well (139). Regretfully the current problems of high packaging costs still largely remain although now that work has started here in Europe, aerosol marketers are hopeful of some improvements in this direction.

TABLE 8.4 RECENT SQUEEZE PACK DEVELOPMENTS

TYPE	WORKING PRINCIPLE	COMMERCIAL ACTIVITY	COSTS	DISADVANTAGES	COMMENTS
Cosval Foamer	Collapsible bottle with porous plug and dip tube delivery. Air bleed causes foamy product delivery.	Marketed in USA and Europe by Apha Co.	High 1.5.x aerosol.	Cost. Need for strong operator. Incomplete delivery	Costs are likely to prevent widespread use.
Gerro Bellows Pack.	One side wall of bottle has bellows or bellow incorporated in lower bottle periphery.	Experimental only.	Low. 0.5 x aerosol.	Stress cracking Consumer dislike of aesthetics. No atomisation possible.	More likely to succeed in professional/ industrial markets.
Sepro Can via Continental Can, Crown Can and Lechner in Europe and others in USA.	As discussed in See Table 7.1.	Selling well in USA (2 -5% total aerosol) Experimental only in Europe.	1.5 - 2 x conventional aerosol.	High cost. Special filling equipment.	Work continues: a)to find European source in tin-plate rather than aluminium container b)to be able to fill on conventional aerosol equipment. c)to reduce cost.

PLATE 8.16 RECENT SQUEEZE PACK COSVAL FOAMER SYSTEM

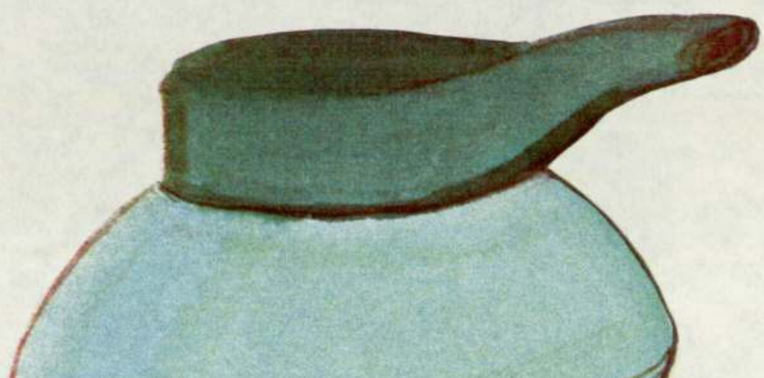


PLATE 8.17 ROUND BELLOWS PACK

GERRO-PAK.
A PUMP-LESS CONTAINER WITH
A SINGLE BELLOWS CREASE
WHICH COULD BE MADE TO GIVE
A MEASURED DOSE BY LIMITING
THE AMOUNT OF BELLOWS
MOVEMENT.

PLATE 8.18 GERRO PACK DESIGN

8.3.3 Other Developments

Table 8.5 summarises some ot the other developments in dispensing systems for the consumer products market together with Plates 8.20 to 8.22.

The "Jenny Can" or compressed air re-chargeable aerosol has been marketed in the UK for about two years and has enjoyed a moderate success there. Although an interesting concept, serious comparisons with conventional aerosols are largely a waste of time. In fact it represents a poor quality atomising unit comparable with a type of hand pump spray that can be used in the garden. It is difficult to see how this unit can be taken seriously, priced at nearly £ 10 with such poor performance.

Vacuum propelled systems are again an interesting concept but one that is associated with so many technical difficulties that it is hard to take it seriously. In short, for good atomisation one needs a driving force supplied by pressure together with some liquified propellent for increased atomisation. Without the liquefied propellent, pressure alone does not seem to work, which is why the compressed aerosols largely fail to deliver efficient performance. This subject is discussed more fully in Appendix II. The vacuum systems suffer from all these disadvantages plus the difficulty of providing low cost vacuum seals. Therefore it is difficult to see how they can be commercially viable, although they are still being evaluated (140).

For bulk product delivery, a very recent development is the "Vario Dispenser" from the English Glass Company (141). This unit consists of an indexed piston and the manufacturers claim it can be used for a variety of products such as Shampoo; Toothpaste; Polish; Glue and almost every bulk liquid consumer product.

TABLE 8.5 OTHER DELIVERY SYSTEMS

TYPE	WORKING PRINCIPLE	COMMERCIAL ACTIVITY	COSTS	DISADVANTAGES	COMMENTS
Levy Vacuum Pack (c 1981)	Standard aerosol container fitted with pleated bag attached to bellows. Product in bag connected to valve. Outer container evacuated and and releasing valve allows air ingress to outer can which forces out product. Up to 20 p.s.i.g. driving force claimed.	Pack experimental only. No cans have been tested.	Unknown. Projected at equal to Sepro container.	Cost. Loss of dispensing "pressure". Incomplete delivery. Failure of components to withstand vacuum.	Little chance of commercial viability.
Jenny Can Rechargeable Aerosol.	Aluminium can with auto pump adaptor and demountable spray head. Simply fill with any "product" - pump and spray.	Marketed in W.Europe - limited success.	£10/can.	Numerous - not really an aerosol alternative - more comparable with a pump garden spray.	Included for completeness only. Product destined to fail commercially (2).

PLATE 8.19 JENNY CAN RE-CHARGEABLE AEROSOL

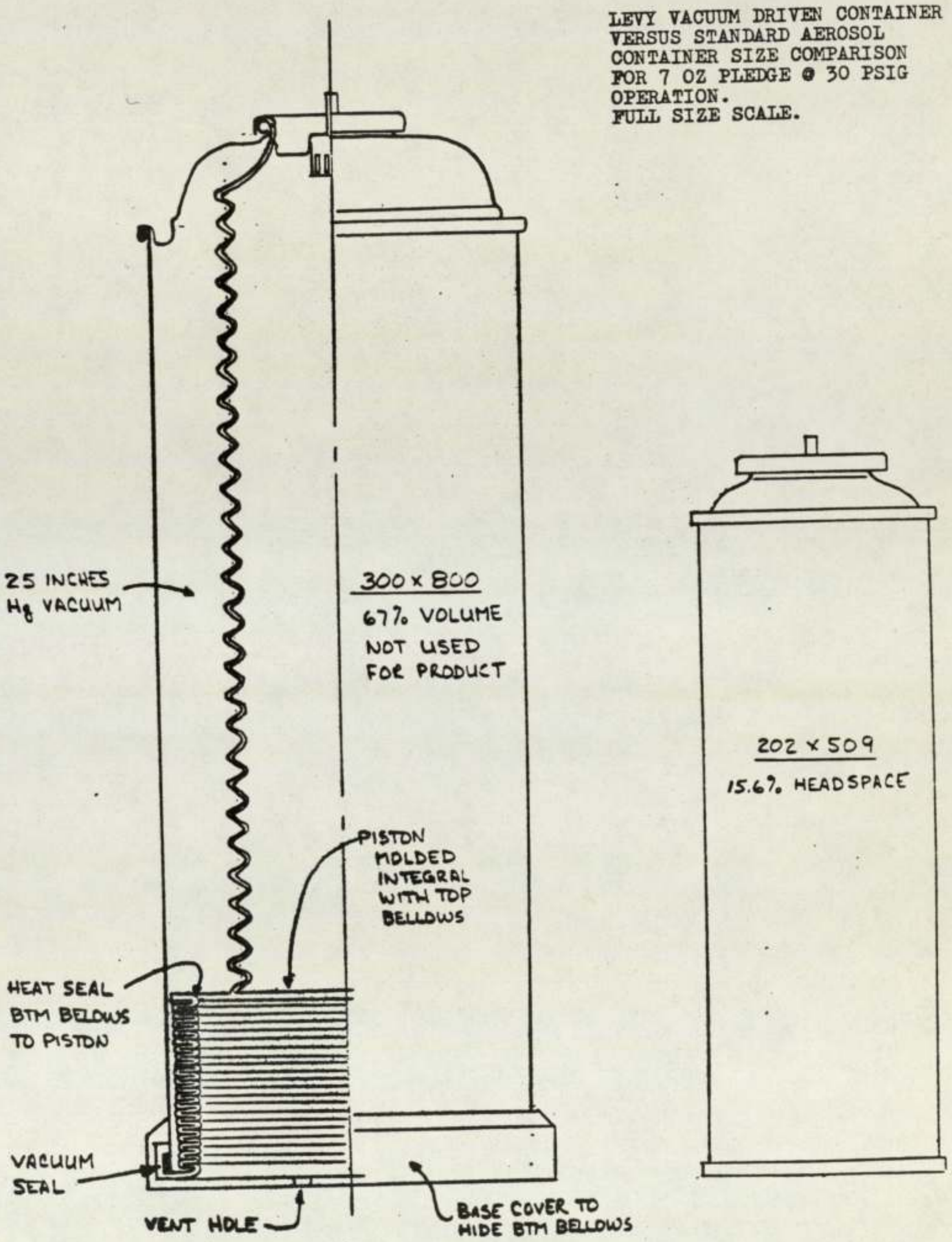


PLATE 8.20 LEVY VACUUM CONTAINER

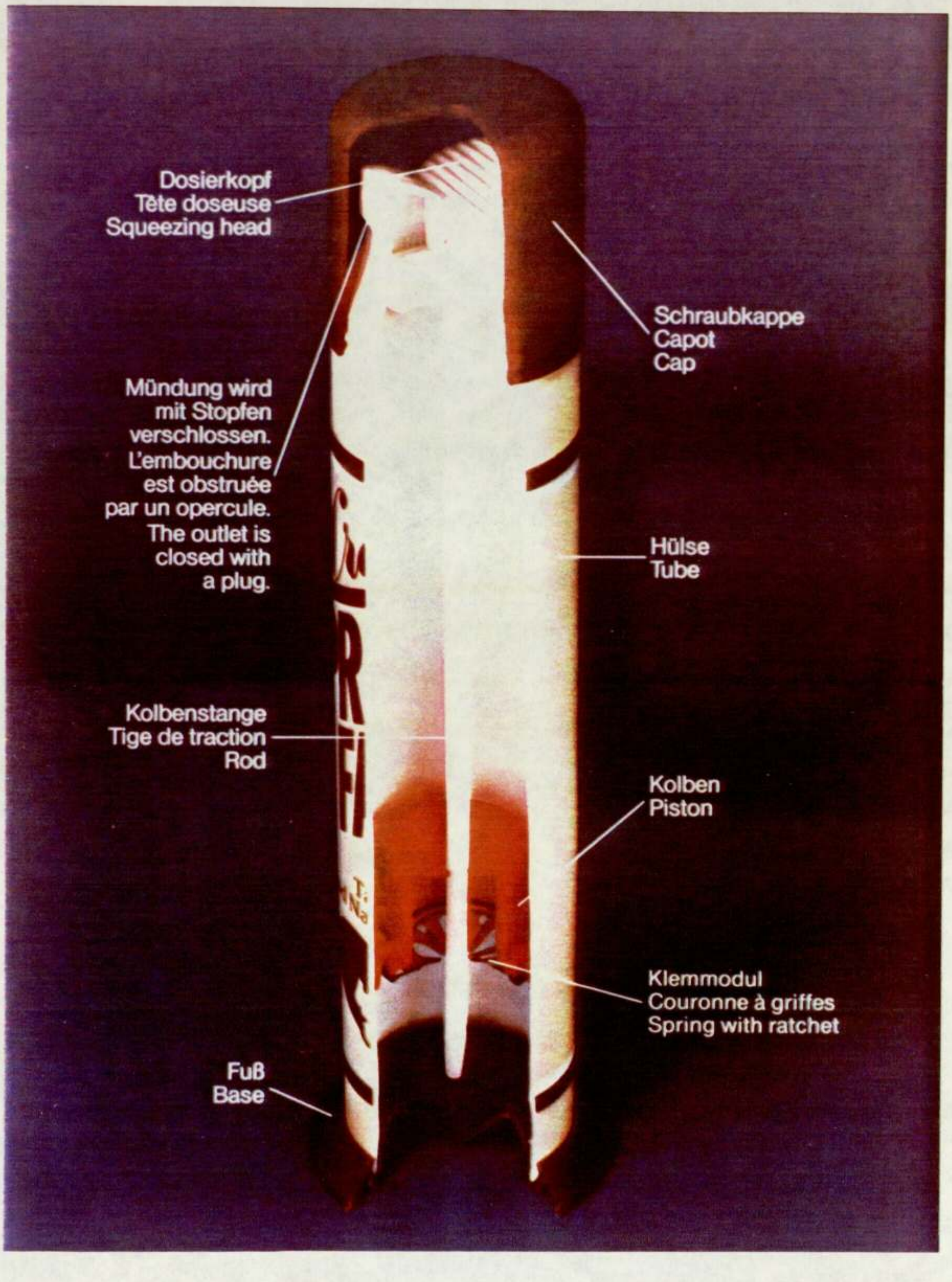


PLATE 8.21 VARIO PACK SYSTEM

8.4 FUTURE DEVELOPMENTS

8.4.1 Pump Packs

Now that atomisation has more or less been optimised both in finger and trigger systems together with good valving, such that the elimination of dripping and drooling has been achieved, the major problems remaining are related to unit cost and improved filling speeds (142).

This has been reported (143) to be where the likely future developments will lie such that technically efficient and economically advantageous units are the result. There is likely to be further improvement with regard to the aesthetics of trigger packs, which currently give the designer a number of problems in terms of bottle design for stability and transport.

A further possibility for future development are the compressed air 'aerosol type' packs such as the Mistlon and Olozon pumps. At present (1983) there are mixed feelings about their acceptability in both performance and manufacturing terms but in the case of the Mistlon unit, it could be handled on conventional aerosol equipment.

8.4.2 Squeeze Packs

In terms of the manual squeeze packs, it is difficult to foresee any further improvements other than perhaps to modify the shape of the pack allowing for easier squeezing and more complete emptying of the unit by the consumer.

Considering the Sepro type systems, further improvements are likely to be concerned with the reliability of the inner pleated bag, the overall unit cost and the ability to produce and distribute these components on a worldwide basis.

8.4.3 Other Systems

It is likely that most of the other systems will be abandoned in the near future in favour of either the conventional aerosol or more likely the finger pump, trigger and squeeze systems.

8.5 SUMMARY AND CONCLUSIONS

This chapter has reviewed non-aerosol dispensing systems which provide alternatives to the aerosol. From this review it may be concluded that the most successful alternatives to the conventional aerosol are the finger and trigger pump systems which can produce a reliable atomised spray when utilised with a variety or products. It must be noted however that even in their current highly optimised state of development, the lack of liquified gas propellent reduces their atomisation efficacy to a point substantially behind the conventional aerosol (143), (144). This can be important for space spray products.

Further developments are concluded to be in the pipeline in terms of optimising the unit cost of these pump systems together with modifications to existing filling machinery to allow greater filling speeds with lower scrap rates.

Sqeeze packs are likely to continue to be used although only where atomisation is not a requirement and as an alternative to the bulk liquid delivery pump.

Uncertainty surrounds the possible adoption of the compressed air powered 'aerosol' type systems such as the Mistlon and Olozon units.

PART II: PURSUANCE OF NEW BUSINESS OPPORTUNITIES

The possible future options facing an aerosol manufacturer were listed in Chapter 7, namely:-

(a) - work toward a "safe" aerosol product.

(b) - substitute non-aerosol alternatives to maintain existing business and for future developments.

(c) - pursue new business opportunities either within existing product categories or by introducing new ones - illustrated in Figure 9.

The possibilities associated with option (a) above were evaluated in Chapter 7 and concluded that it was feasible but non-viable. Chapter 8 described non-aerosol methods of packaging - option (b) above - concluding that this only provided a partial solution. The next step is, therefore, evaluation of option (c). This was carried out as a case study which evaluates the necessary steps and resource commitments to ensure at least business survival should the forecasts presented in Chapter 6 become a reality.

Johnson Wax Ltd was selected as the case study company and Part II of this dissertation aims to assess the impact of possible aerosol decline and the dimensions of the challenge and opportunities that this might present.

The case study is presented in chronological order as follows:-

Chapter 9: The present company situation is described covering current business developments, market data, and anticipated product plans including the introduction of aerosol alternatives.

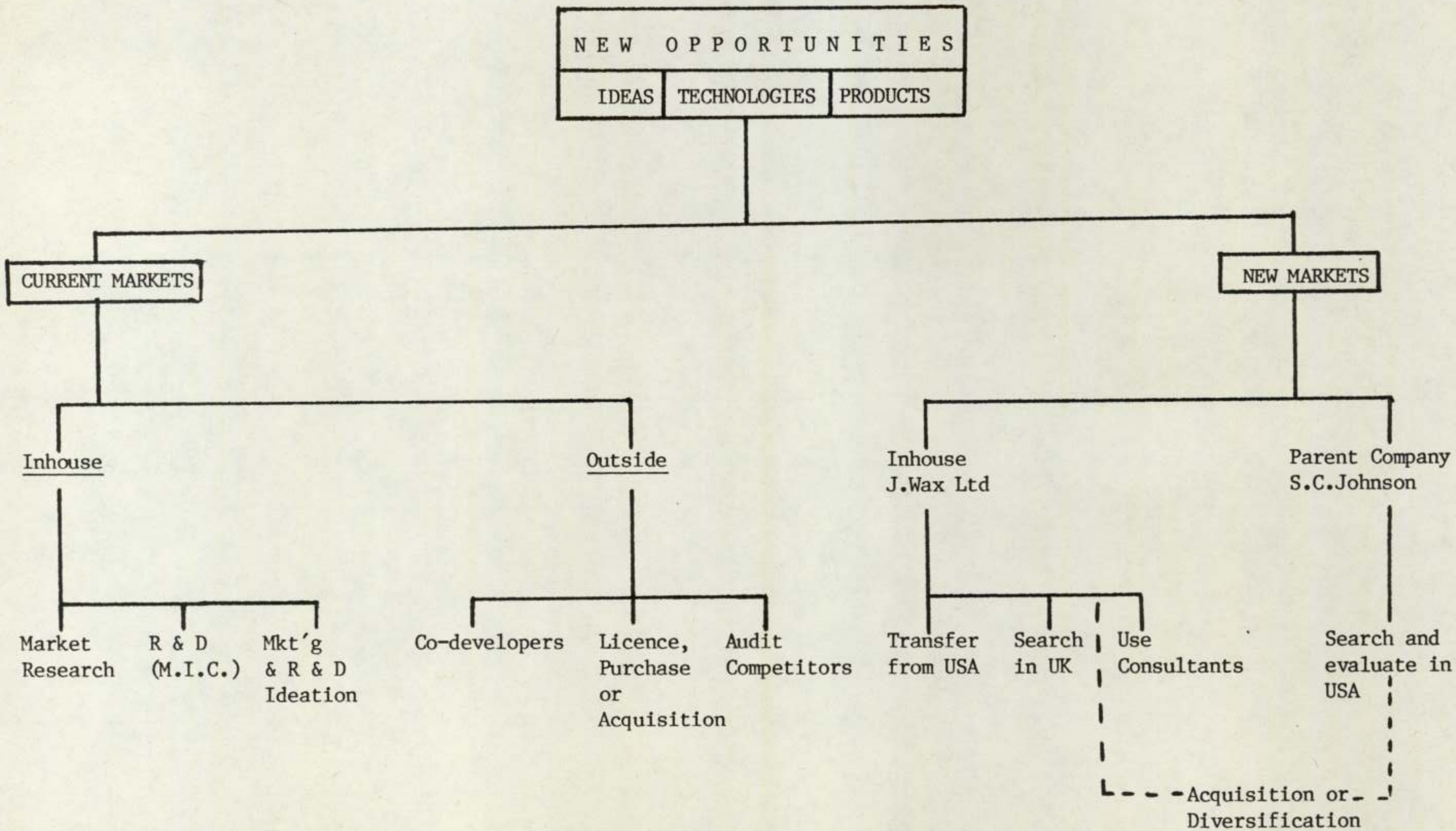


FIGURE 9. PURSUANCE OF NEW OPPORTUNITIES

Chapter 10: Past and present diversification activities at Johnson Wax Ltd are detailed concerning movement into new markets, and an inventory of existing skills.

Chapter 11: A search and evaluation procedure for new opportunities is devised and a pilot study initiated.

Chapter 12: Results from the new opportunities pilot programme are reported and discussed.

Chapters 13 and 14: The conclusions and recommendations for further work are presented in annotated form for the whole of this dissertation.

The methodologies developed and implemented in this Chapter are not only designed to find new products for Johnson Wax Ltd to launch, but also to develop a procedure to maximise the longer term future of the company by exploring all possible sources of new ideas in a methodical and evaluatory way. These two complementary objectives necessitate a rather complex presentation which is exacerbated by the particularly broad and novel scope of the overall project. Figure 9.′ illustrates this, showing both the overall direction and scope of the work, and the division between original research and reviewed literature.

It is anticipated that, although the above case study is orientated towards Johnson Wax Ltd, many of the conclusions should be applicable to other aerosol manufacturers and industry in general. This is especially true of Chapter 11 which is concerned with finding new ideas and product innovation, screening, selection and implementation.

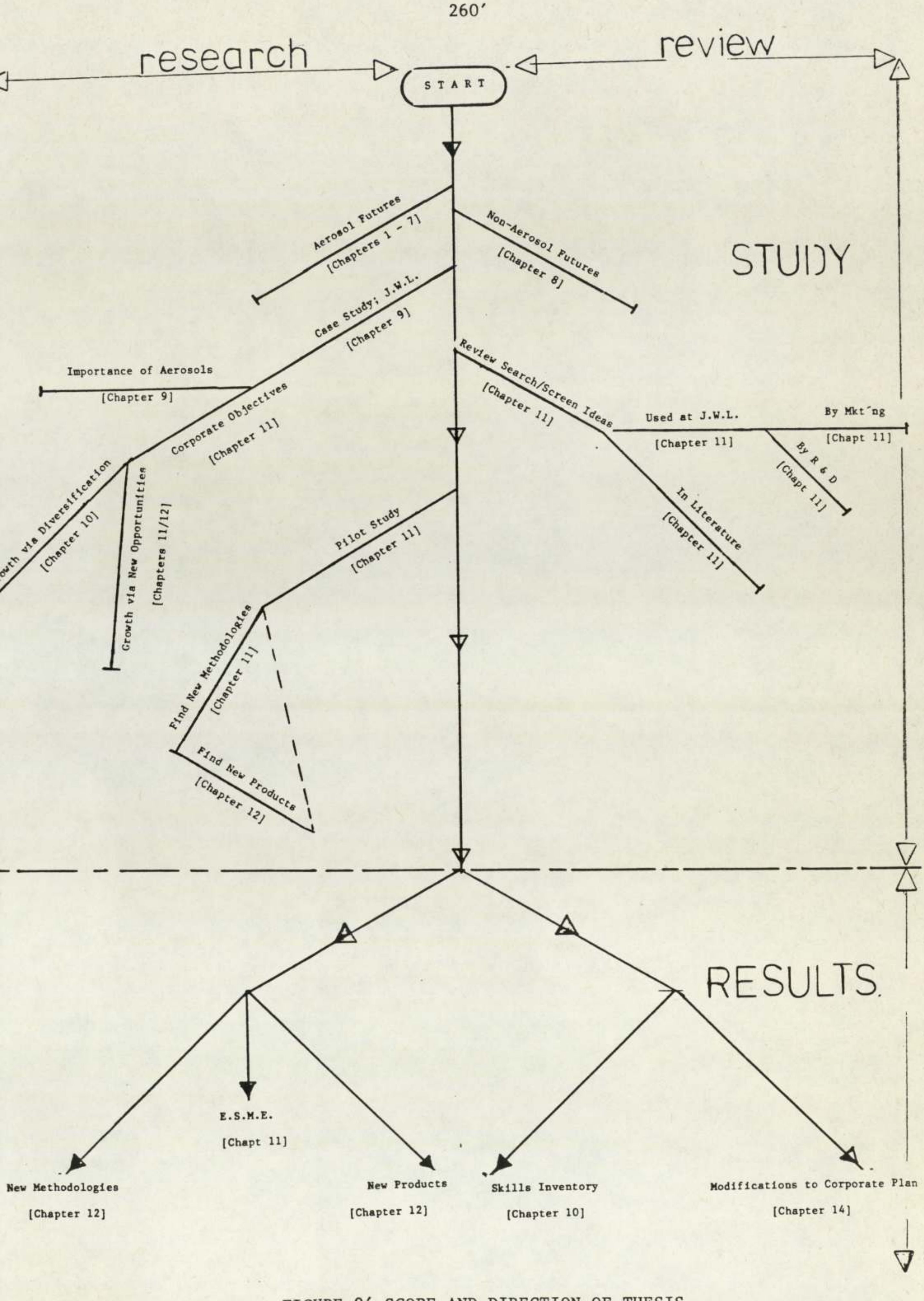


FIGURE 9' SCOPE AND DIRECTION OF THESIS

CHAPTER 9: THE PRESENT COMPANY SITUATION

9.1 INTRODUCTION

Johnson Wax Ltd are the British subsidiary of the privately owned multi-national corporation S.C. Johnson, of Racine, Wisconsin, USA. The parent company has been established for 85 years and had a gross sales level for the 1981/1982 fiscal year of over £ 1000 million (sterling equivalent) with a net worth of over £ 150 million.

This study is only concerned with Johnson Wax Ltd in the UK, who employ approximately 600 people at their Frimley Green factory located near Camberley, Surrey and a further 60 people at their R & D centre in Egham, Surrey. All personnel at the Camberley site are entirely committed to the British company but only 20% of the activity at the R & D centre is allocated to the UK - the balance being used to service the rest of Western Europe.

9.1.1 Business Interests of Johnson Wax Ltd

Johnson Wax Ltd divide their business interests into the following segments:-

Consumer Business: This is the largest sector of the company's activities which is concerned with the supply of household products for retail primarily through the grocery multiples but also in general and hardware stores. This segment of the business is further illustrated in Appendix III.

Industrial Business: This consists of consumer products sold to the hotel and catering trade but also to the other branches of industry. More recently a series of speciality chemicals have been developed, such as printing inks, industrial degreasers and other speciality chemicals for metal working and food processing. Appendix III further describes this business.

Export Business: This is concerned with the export of mainly aerosol products from the British factory to the Middle East, Scandinavia, Africa and other parts of Europe. (See Chapter 3).

Intercompany Business: This is the sale of products made by Johnson Wax Ltd to other Johnson companies usually within Europe, Africa or the Middle East.

9.1.2 Scope of the Case Study

It was decided to base this study on the consumer segment for the following reasons:-

(a) It is the largest single business segment for Johnson Wax Ltd representing over 56% of the total company business as gross sales in 1981/1982.

(b) With the exception of a small number of speciality chemicals, the product range is substantially the same for each segment, consisting of polishes, cleaners, and air fresheners, (see Section 9.2). Therefore many of the new product ideas evolving from the study will be applicable to all business sectors.

(c) Although the export business is currently important to Johnson Wax Ltd (estimated at 26% of gross sales in 1981/1982), it is likely to considerably diminish in the near future as plans for local manufacture within areas currently supplied by Johnson Wax Ltd are realised. For example more than 85% of Johnson Wax Ltd's exports currently go to Saudi Arabia. The commissioning of the Johnson Egyptian factory in January 1983 is scheduled to quickly supply goods to this area and is likely to greatly reduce the UK export business.

(d) By focusing attention only on this largest segment (consumer), the review of business information is simplified with regard to handling the range of data available without changing the emphasis of the companies interests or needs.

9.2 CURRENT PRODUCT RANGE IN THE UNITED KINGDOM

In Section 2.2, the aerosol industry was described as having five main categories namely:-

* Hair sprays;
* Personal Care;
* Household Products;
* Insecticides;
* Miscellaneous Products.

Johnson Wax Ltd are currently active in only three of these:-
Household Products, Personal Care, and Miscellaneous Products. However this classification is not sufficiently detailed for a review of products and search for new opportunities. Not all of the products are aerosols, and thus the more detailed classification normally used by the industry (23), (24), (26), (27), (28), (148), will be adopted:-

* Furniture Care;
* Air Care;
* Metal Care;
* Floor Care Products;
* Fabric and Laundry Care Products;
* Personal Care (including Hair Care);
* Auto Care Products;
* Oven Care (Cleaner) Products;
* [Insecticides - not in the consumer business sector]

The current product range is illustrated in Figure 9.1. These products are mostly retailed through the grocery multiples, although some of them appear in Do-It-Yourself (DIY) and hardware stores as well as other smaller retail outlets. The range of these products is further illustrated in the current company information booklet "The Name is Johnson Wax" which forms Appendix III of this thesis.

The most recent analysis of the Johnson Wax consumer business is presented in Table 9.1 which details the range of products currently marketed in terms of sales value, units sold, and type of delivery system that is aerosol and non-aerosol. From this analysis, it is seen that the major single source of revenue is "Pledge" and the least significant group is the personal care products.

Furniture care products as a group account for 47% of total consumer sales, the other large group being Air Care at 29%. None of the other products or groups are large and with 76% of all sales derived from Furniture and Air care products, Johnson Wax Ltd might be considered a

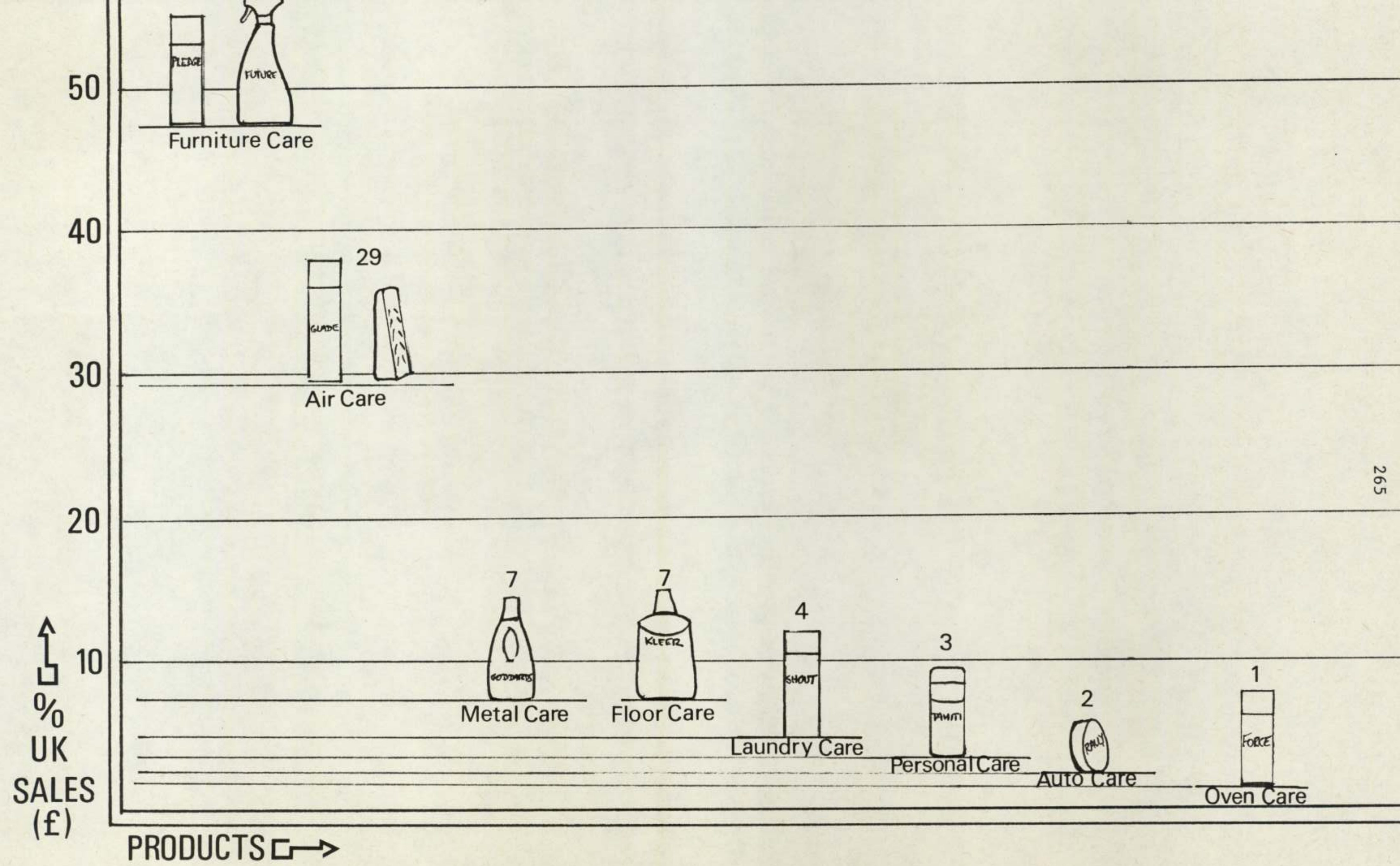


FIGURE 9.1 JOHNSON WAX UK CONSUMER BUSINESS

TABLE 9.1 JOHNSON WAX LTD BUSINESS 1981/1982

PRODUCT CATEGORY AND NAME	ANNUAL SALES £Sales Volume	% Total Value	Case Volume Units x 12	% Total Cases	Aerosol	Non-Aerosol
Pledge	4,019,058	20.7	646,331	19.2	*	
Favour	270,221	1.4	35,051	1.0	*	
Sparkle	2,705,719	13.9	450,904	13.4	*	
Wood Care	325,692	1.7	41,361	1.2	*	
Paste Wax	458,041	2.4	91,747	2.7		*
Future	1,403,003	7.2	214,955	6.4		*(trigger)
TOTAL FURNITURE CARE	9,181,735	47.3	1,480,349	43.9		
Glade Aerosol	1,003,960	5.2	252,773	7.5	*	
Glade Secrets	332,870	1.7	109,900	3.3		*
Glade Shake 'N' Vac	2,312,608	11.9	391,294	11.6		*
Glade Solid	1,336,613	6.9	303,350	9.0		*
Glade Flo-Thru	576,105	3.0	104,927	3.1		*
De-odair	134,049	0.7	18,766	0.6	*	
TOTAL AIR FRESHENERS	5,696,206	29.4	1,181,010	35.1		
Silver Polishes	1,144,633	5.9	184,117	5.5		*
Metal Polishes	274,552	1.4	53,640	1.6		*
TOTAL METAL CARE	1,419,185	7.3	237,757	7.1		
Klear	1,116,897	5.8	124,132	3.7		*
Beautyflor	73,994	0.4	7,435	0.2		*
Glory	137,861	0.7	13,323	0.4	*	
TOTAL FLOOR CARE	1,328,752	6.9	144,888	4.3		
Dry Clean	156,478	0.8	25,380	0.8	*	
Shout	383,598	2.0	75,257	2.2	*	
Shout Liquid	73,566	0.4	10,079	0.3		*(trigger)
Final Touch	46,204	0.2	9,364	0.3	*	
Other Laundry	45,973	0.23	8,528	0.3	*	
TOTAL FABRIC CARE	703,771	3.6	128,608	3.9		
US Roller	13,937	0.07	3,427	0.1		*
US Shampoo	4,717	0.02	988	0.03		*
Agree Creme Rinse	383,557	2.0	18,571	0.6		*
Agree Shampoo	57,262	0.3	68,630	2.0		*
TOTAL PERSONAL CARE	458,473	2.4	91,616	2.7		
Force(Oven Cleaner)	82,198	0.4	Included in Others		*	
Auto (Polish,Shampoo)	398,680	2.1	37,356	1.1		*
Other Products(App(III)	167,926	0.9	60,545	1.8		*
TOTAL MISCELLANEOUS	648,804	3.4				
GRAND TOTAL	19,436,925	100.0	3,362,129	100.0		

"Two Product Company". Concern exists within the company that the profit base is too narrow and therefore vulnerable to attack by competitors.

Figure 9.2 illustrates how the Johnson Wax Ltd consumer business has depended on aerosols over the last decade. This agrees with many of the national trends presented in Chapter 3 and shows that there is already a drift away from the aerosol as a product delivery system within the Johnson Wax Ltd consumer business. Nevertheless, aerosols still accounted for approximately half of the gross sales in the fiscal year 1981/1982 and could represent an annual loss of up to 10 million should some of the concerns discussed in Chapters 4 and 6 be realised. This point is further developed later in this chapter.

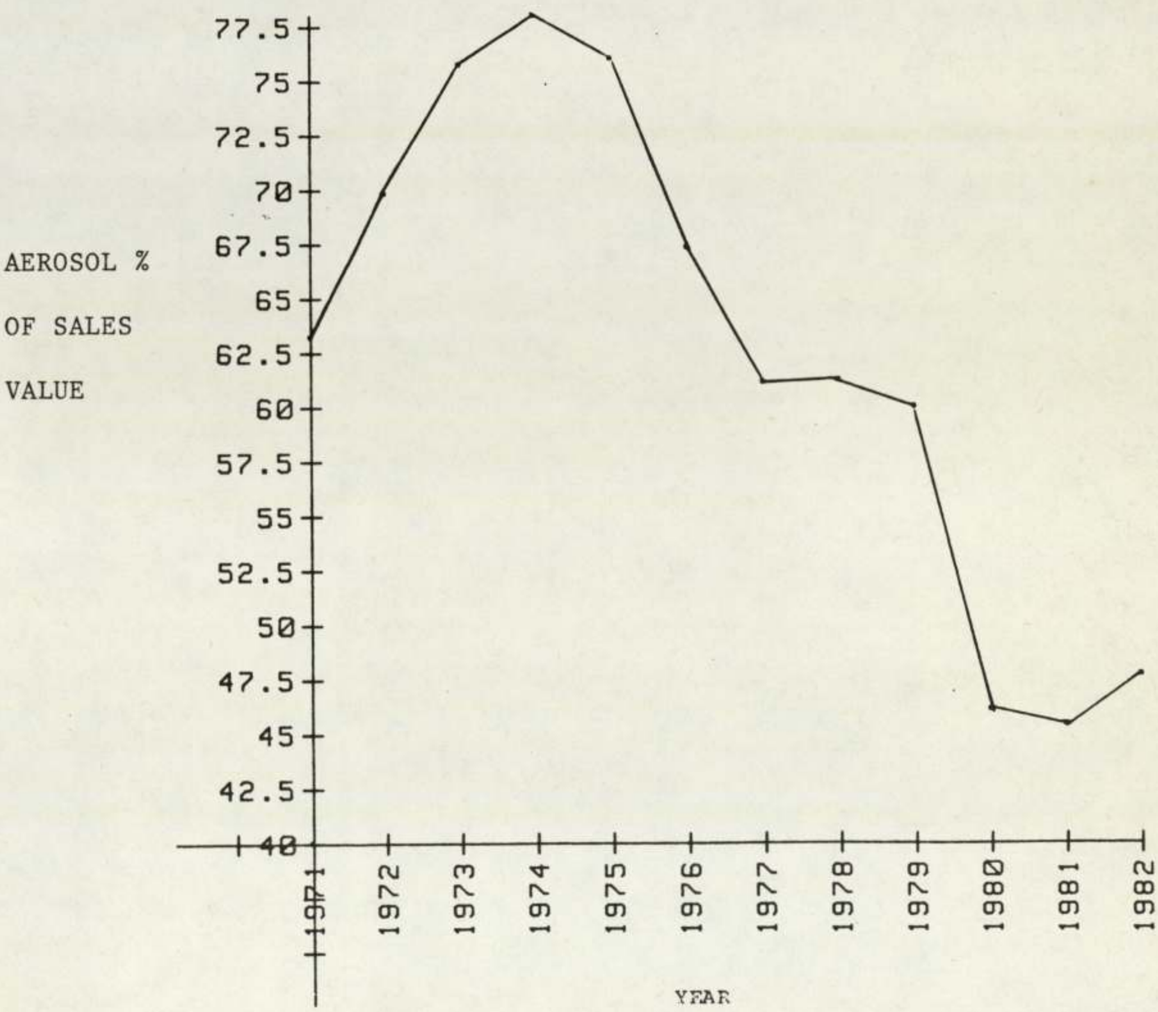


FIGURE 9.2 JOHNSON WAX LTD DEPENDANCE ON AEROSOL PRODUCTS

9.3 REVIEW OF UK CONSUMER MARKETS IN WHICH JOHNSON WAX LTD OPERATE

9.3.1 Introduction

In Section 9.2, the current product range was described and analysed from a business viewpoint. In order to complete this analysis, a review was made of each consumer market within which Johnson Wax Ltd currently trade in order to assess its size, growth trends and the severity of competition. This information will enable an assessment of further opportunities within existing markets.

A common format is utilised for each product category to present data on the following:-

(i) Market size in value (£s) and volume (units).

(ii) Growth trends and any changes in product type e.g. aerosols to non-aerosols.

(iii) Number and name of competitors and their ranking by percentage market share.

(iv) Product distribution patterns.

(v) Anticipated future market developments.

9.3.2 Market Data

The full range of market data applicable to the consumer business of Johnson Wax Ltd which was assembled for this thesis is presented as Appendix IV and contains the following tables arranged in order of decreasing significance.

Table A 9.1 - Furniture Care (Polish) Products.

Table A 9.2 - Air Care Products.

Table A 9.3 - Metal Care Products.

Table A 9.4 - Floor Care Products.

Table A 9.5 - Laundry (Fabric) Care Pre-treater Products.

Table A 9.6 - Personal Care (Antiperspirants/Deodorant) Products

Table A 9.7 - Personal Care (Hair Shampoo) Products.

Table A 9.8 - Personal Care (Hair Conditioner) Products.

Table A 9.9 - Personal Care (Foam Bath) Products.

Table A 9.10- Auto Care Products.

Table A 9.11- Oven Care (Cleaner) Products.

The important results from this survey are presented below.

9.3.3 Discussion

For Furniture Care products (Table A 9.1, Appendix IV), little future growth is anticipated nor changes in market shares or product distribution patterns. Trigger pump alternatives are considered to be unlikely to gain acceptance as a competitor to aerosols in the short term. (See Section 8.4.1).

The Air Care market is seen to be stabilising with little growth and some minor brands failing. (Table A 9.2). Most companies are searching for new products but their success is considered unlikely as the generic product is probably fully exploited.

The Metal Care products market (Table A 9.3) provides little opportunity for growth but the brands are extremely profitable yielding more than 70% gross profit).

Laundry Care products (Table A 9.5) show a similar growth but are considerably less profitable. Thus pre-treatment products have failed to develop as planned due to the continual improvement of detergent powders and the lack of perceived product benefit over detergents.

Floor Care products are in decline due to increased use of carpets and alternative floor coverings to linoleum, PVC tiles, and wood. Falling profit margins are also said to be responsible such that major producers are losing interest.

Auto Care products have also matured and are forecast to decline due to improved car product finishes and the introduction of six year corrosion protection warranty. The sterling value of the market in nominal terms has remained at between £ 5 and £ 10 million pounds since 1978.

Oven cleaners are declining as are floor care products, due to improved or changing household durables. The increasing incidence of "self-cleaning" ovens together with concern about eye and facial irritation from sprays are the major attributed causes.

Personal care products show a variable picture according to product. Antiperspirants, Deodorants and Shampoos show little growth prospects. However Hair Conditioners currently show an annual growth in volume terms of 7% which is said to be related to increased use by the younger segment of the population, (16 - 25 years). This growth is predicted to cease in 1983 when the products will have reached saturation in this age category and because they are considered to be unlikely to be adopted by the older members of the population.

9.3.4 Conclusions

The major part of Johnson Wax Ltd's UK consumer business is based upon Furniture care products (47% sales £'s) and Air care products (29% sales £'s). The total market for these products are worth £ 17×10^6 and £ 21×10^6 respectively (148) which is not large with respect to consumer non-durables in the UK. Any attempt to win a greater share of these and other current markets is likely to be difficult to achieve without major technical innovations or increased marketing costs and may be impossible. Further, none of the markets currently serviced by Johnson Wax Ltd is showing substantial growth in either volume or value terms.

The Personal care category has been selected by the management of Johnson Wax Ltd as the third major business category. However, although the Personal Care market in the UK is one of the largest in which Johnson Wax Ltd operate, it is very competitive with many brands and overall Johnson Wax Ltd have not been particularly successful to date.

Therefore there are two problems facing the company namely:-

(i) The need to find satisfactory product dispensing devices for possible replacement of the conventional aerosol package - anticipating its early decline and for non availability as described in Section 4.2. However even if successful, satisfactory alternatives to the aerosol will at most only guarantee the continued trading in the current business categories, most of which are declining.

(ii) The need to seek out new business opportunities, which will ensure the stability of the company and help achieve the planned growth of 4% per annum in operating profit terms. (nominal)

An early review of alternative consumer markets is therefore essential as the first step in planning for survival and desired growth.

9.4 AEROSOL ALTERNATIVES APPLICABLE TO JOHNSON WAX LTD

9.4.1 Current Activities

The alternatives to aerosols were reviewed in Chapter 8 and to date there is little evidence of their widespread adoption at Johnson Wax Ltd in order to replace existing aerosol business. Table 9.2 summarises the activity to date and the degree of success obtained.

TABLE 9.2 AEROSOL ALTERNATIVES AS SPRAYS PRODUCED BY JOHNSON WAX LTD

PRODUCT TYPE	METHOD OF OPERATION	MARKET EXPERIENCE	DEGREE OF SUCCESS (Ref. Table 9.1)
Multi Surface Polish.(Future)	Trigger pump working with plastic bottle (refills available).	One year	Moderate. Consumer research by Johnson indicates preference for aerosol.
Laundry Pre-treatment stain removal detergent. (Shout liquid)	As above.	Three years	Poor. Not well accepted - strong preferance for aerosol.

9.4.2 Applications to Specific Product Categories

Several of the product categories of current interest to Johnson Wax Ltd are already segmented into aerosol and non-aerosol product types (Table 9.1). This should tend to minimise the negative effect of a decline or ban on aerosols. However space sprays, such as aerosol air fresheners and flying insect pest control products represent a unique application which cannot be readily duplicated by aerosol alternatives due to the product atomisation constraints discussed in Chapter 8. Although insecticides are not marketed by the consumer division of the company, aerosol decline could cause major loss of annual sales to the other operating division such as 'Export' (estimated at greater than 70%), 'Industrial' (estimated at 15%) and 'Intercompany' (estimated at 10%) who have considerable trade in these products. Aerosol air fresheners, are however, important to Johnson Wax Ltd consumer division and the disappearance of the aerosol segment would equate to a loss of sales over £ 1 million per year or 6% of sales by value and 8.1% by volume (cases). Apart from the examples discussed above, it is possible that there will be further development of the aerosol alternatives in their own right, and without regard to the constraints on the aerosol package. Carpet freshener and cleaner products in powder form are an example (146). Many barriers exist, however, which include slow consumer acceptance, and relatively high component and filling costs.

Trigger or pump costs can be partially offset by marketing re-fills, but without some future packaging and product innovations, replacement non-aerosols are likely to be at a cost and performance disadvantage. The current development activities at Johnson Wax Ltd for producing a low cost trigger pump unit are described in Chapter 8 together with compressed air powered spray systems (Olozon and Mistlon Units)identified via the case study and further discussed in Chapter 12. A recently started ongoing development programme for these systems is summarised in Table 9.3

illustrating the time needed to bring such units to marketing attention. Further time will be needed to achieve production status.

9.5 SUMMARY

Johnson Wax Ltd's current UK consumer markets have been analysed both in terms of their present makeup and future potential. The effects of a ban or decline of aerosols have been examined in conjunction with the present and future programmes for aerosol alternatives.

The major conclusions that have been drawn emphasise the necessity of both innovative product and package development in order to be able to maintain the current product range when aerosols decline, as well as the more pressing need to search for new business opportunities in markets in which Johnson Wax Ltd are not currently active.

TABLE 9.3 PROGRAMME TO INVESTIGATE COMPRESSED AIR SPRAY UNITS
(Initiated September 1983)

STEP	ACTIONS	EST'D TIME REQUIRED (MONTHS)
1.	Obtain samples of components in all available materials e.g. PVC, HDPE.	1 - 2
2.	Commence selection of most suitable products for study on the basis of laboratory trials with aerosol intermediates (or trigger variants if available) - assessing spray pattern; particle size distribution; product efficiency.	2
3.	Conduct compatibility trials using formulae from 2 above with full range of available components.	6
4.	Select products which are most likely to be converted from aerosols from the results of 2 and 3 above, and reformulate to optimise performance.	3
5.	Conduct mechanical reliability trials by building test rig which pressurises the containers using the integral pump and then discharges them.	3
6.	Consumer test products.	6
7.	Present results to marketing departments.	1
	TOTAL	21

CHAPTER 10: DIVERSIFICATION ACTIVITIES AT JOHNSON WAX LTD

10.1 INTRODUCTION

This chapter is concerned with one aspect of the third option discussed in the introduction to Part II of this thesis namely the pursuance of new opportunities by diversification activities. In the case of Johnson Wax Ltd, diversification can mean the application of existing company skills to a new endeavour such as marketing new products which replace or complement the current product range (see Figure 9.1). Alternatively or additionally, it can mean the aquisition of new business interests which would be assimilated into the existing structure of Johnson Wax Ltd. In either event, it is important to establish what skills the company possesses in order to assess the difficulty associated with a particular diversification exercise. Specifically this Chapter reviews the company's previous diversification activities and experience, and lists the skills available for possible future use. Further routes to new opportunities which consider new technologies, ideas, and products are discussed in subsequent chapters.

Diversification is also an identified objective in the company corporate plan (150). Typical targets for new business are discussed more fully in Chapter 11 but can be summarised as a gross profit of 55 - 65%, operating profit in the range 15 - 20% and a return on investment 10 - 15% (Appendix IX).

10.2 DIVERSIFICATION IN THE UNITED KINGDOM

In 1965, Johnson Wax Ltd bought J Goddard & Sons of Leicester, a family business with specialist knowledge of metal polishes. This company was assimilated within Johnson Wax Ltd who still manufacture and retail many of the original product range under the Goddards label. This is the only known acquisition of a company by Johnson Wax Ltd in the UK.

Approximately ten years ago, the parent company SC Johnson & Son formed a special division in the USA to handle diversification. This company, named Johnson Wax Associates (JWA), has tended to operate independently of the marketing companies located in various countries and has direct control from the parent company in Racine, USA. The only evidence of its presence in the UK has been via the trading activities of two companies namely 'Plastimo' based in France, and 'Scubapro' based in the USA. Both these companies are concerned with the leisure industry and have offices and warehouse facilities in Southampton and London respectively. Plastimo manufacture and retail marine chandlery, with an annual turnover in the UK of approximately £ 1 million. Scubapro manufacture high quality sub-aqua equipment for the amateur diver. As yet they have not been successful in the UK, probably because of the relatively high price of the products. Their annual turnover is approximately £ 20,000 per year.

Both companies are considerably more successful elsewhere in Europe, and in other parts of the World. Plastimo is the largest supplier of marine chandlery in France with an annual turnover of £ 11 million. It supplies most of the marine outlets in France, having a market share of more than 50% in providing everything for the yachting and boating industry with the exception of the boats themselves. This particular business has a lower gross profit than Johnson usually expect in household products, averaging 40%, and yielding a 12% operating profit. These yields are, therefore, unsatisfactory.

Scubapro also has offices in the United States, Japan, France, Germany, Italy, Sweden, Switzerland and a small office in the UK. It supplies all diving equipment including aqua-lungs, wet suits and depth gauges. Most of the equipment is made either in California by the parent company "Underseas Industries" or in Italy at a subsidiary. Again gross profits average at 40% with an operating profit around 12% and can be considered unsatisfactory.

10.3 DIVERSIFICATION WITHIN THE PARENT COMPANY

As stated in the previous section, the parent company, S.C. Johnson, has made several attempts to diversify its activities over the last decade. Most of this has occurred in the United States and Canada by means of acquisitions. The companies purchased are all involved with the leisure industry, with a manufacturing company for each of the following interests:

* timber and plastic boats
* fishing reels, rods and troll motors
* tents
* outdoor clothing and back packs
* needle art and picture making kits
* special fertilisers and nutrients for house plants.

For virtually all of the time since aquisition, most of these companies have failed to be profitable. In more recent years this trend has begun to be reversed and the total pre-tax profit from all these ventures in the year 1981/1982 was £ 1.6 million. This has been achieved by closing several of the non-profitable companies and scaling down each operation. The ranking of operating profit contributions is as follows:-

fishing group of companies (20%);

camping group (15%);

marine activities of Plastimo (12%).

The boat building and plant care operations continue to lose money as do the creative arts activities.

10.4 SKILLS INVENTORY

When considering possible future diversification programmes, reference was made to corporate strategy (discussed in Section 11.1) in order to clarify the corporate requirements. However in order to identify constraints that might operate against introduction of certain types of new products, a novel approach to delineating the technical limitation of the company has been developed called a skills inventory. This procedure was used to compile an inventory of skills possessed both by Johnson Wax Ltd, and also the Johnson worldwide organisation, represented by the USA parent company, on the grounds that such skills should be readily transferable to the UK company.

This data was gathered from, and agreed with, senior management within both the UK and parent companies. Therefore the data presented for comparison in Table 10.1 represents how both Johnson Wax Ltd and the parent SC Johnson & Son in the USA see themselves. Further time has not been expended on checking this viewpoint and the assumption has been made

TABLE 10.1 INVENTORY OF SKILLS

Ranking: I : Major company strength equal to major competitors.
II : Good experience but lagging competitors.
III: Little experience in area. Could readily be concentrated to II but not I ranking.

SKILL DESCRIPTION	LOCATION AND RANKING	
	UK	USA
1. Marketing consumer and industrial especially to food multiples.	I	I
2. Sales and distribution of consumer products to food/hardware outlets.	I	I
3. Manufacturing high productivity systems for:		
Aerosols	I	I
Liquids	I	I
Gels	I	I
Powders	I	I
Suspensions	I	I
Hazardous Metals	I	I
Polymers	III	I
Plastic Moulding	I	I
4. Chemical Formulations		
Household Products	I	I
Insecticides	III	I
Toiletries	I	I
Polymer Materials	III	I
Industrial Chemicals	III	I
Non Prescription Pharmaceuticals	III	III
Food	III	II
Agricultural Chemicals	III	II
5. Aesthetic/Creative Design of Packages	I	I
6. Basic Research	III	II
7. Microbiology	III	II
8. Industrial Toxicology	III	II
9. Chemical/Mechanical/Civil Engineering	III	II
10. Leisure Industries	III	II
11. International Trading (Buying/Selling)	II	I
12. Market Intelligence Services	III	I

that corporate management should understand the strengths and weaknesses of their own business and that they will be making future aquisition decisions using this data.

10.5 DISCUSSION

Johnson Wax Ltd has made little progress to date with diversification. However by using its varied skills, perhaps supported by those transferred from the parent organisation in the USA, several new business opportunities are apparent as identified, for example in Table 10.2. This Table presents the results from applying each skill to a potential application as an example, with an assessment of the difficulty and cost. Part I is the application to the most recently stated corporate objective for new markets and Part II suggests other possibilities.

The suggested alternatives for marketing consumer products in Part I of Table 10.2 have been selected as new businesses, in the corporate plan, and appear to be relatively difficult for Johnson Wax Ltd to assimilate. Thus they may take considerable time and resources to successfully implement. However, this Table does identify several other potential opportunities which involve minimum time and resource expenditure,such as contract manufacture; import/export trading; and consultancy work in microbiology and toxicology. These suggestions are discussed below.

Perhaps the strongest attribute which can be utilised is international "marketing" across a relatively wide product range. This is because the company has built up a knowledge of both techniques and distribution patterns plus the contacts with the various research and market

TABLE 10.2 APPLYING THE SKILLS OF JOHNSON WAX LTD TO NEW MARKETS AND OPPORTUNITIES

SKILL DESCRIPTION AND REF.	SOME SUGGESTED ALTERNATIVES	ESTIMATED DIFFICULTY	
1. Marketing Consumer Products.	Non Prescription Pharmaceuticals Speciality Foods e.g.Diet Aids D.I.Y. Products	(B) (C) (B)	PART I
2. Sales Distribution	Handle products from other companies which have both products and marketing skills but lack sales effectiveness. e.g. L.P.G. for: Caravans, lighter refills, Pet care products, D.I.Y. products, household products, garden products.	(A)	PART II
3. Manufacturing	Contract filling - own label in aerosols/liquid powders	(A)	
4. Formulation	Consultancy for own label and overseas or export business	(A)	
5. Package Design	Consultancy on design and manufacturing consumer orientated packages.	(A)	
6. Basic Research	Little Scope. Perhaps contract work	(B)	
7. Microbiology	Possible consultancy on product preservation and good manufacturing practice.	(A)	
8. Industrial Toxicology	As for 7.	(A)	
9. Engineering	Possible engineering services on consultancy basis i.e. factory design. Also design/manufacturing of filling machinery.	(B) (B)	
10. Leisure Industries	Possibility of moving into this area if considered profitable.	(C)	
11. International Trading	Possible import/export business based on wide knowledge of worldwide trading restrictions etc.	(A)	
12. Marketing Intelligence	Possible service to marketing companies based on contacts and existing network.	(B)	

KEY:

		Order of Cost
(A)	= READY NOW	0 - 50,000
(B)	= SMALL INVESTIGATION REQUIRED - 3-6 MONTHS	50,000 - 200,000
(C)	= MAJOR INVESTIGATION REQUIRED - 6-18 MONTHS	200,000 - 2,000,000

intelligence agencies which allow a 'new' venture to be thoroughly investigated before risking extensive capital expenditure.

Similarly the company's sales force might be further utilised to sell other companies products to the retail outlets developed and serviced by Johnson Wax Ltd.

Johnson Wax Ltd have "manufacturing" expertise in both high volume (automated) products as well as labour intensive products. Thus contract filling could be readily achievable from a technical standpoint, assuming the business aspects proved to be worthwhile.

The utilisation of the creative skills of "Formulation" and "Package Design" to other organisations as a service is also easy to implement but may be unacceptable to senior management. Similarly undertaking basic research contracts is feasible but it is unlikely that it would prove profitable or attractive.

On the other hand, "Microbiological" and "Toxicology" services are both in demand and could be marketed without significant disruption of the current business. "Engineering" skills also come into this category.

S.C. Johnson and to a lesser extent Johnson Wax Ltd have experience of designing and building factories in various world countries. Therefore these design and engineering skills could be marketed to other organisations requiring them. In addition, considerable expertise is available on the design, fabrication and utilisation of high volume production filling machinery.

The "Leisure Industries" are generally regarded as becoming of increased importance both in the UK and in other parts of Europe (150). Therefore it should be possible to diversify in this direction by studying the failures of the past and improving future strategies. "D.I.Y." business may also be similarly reviewed.

"International trading" and "Market intelligence" activities are current but totally focused on Johnson Wax Ltd. Both these skills could be sold to (probably smaller companies) either within the UK or Europe. Once again a study is needed to assess business potential.

The marketing of skills 2 - 12 in Table 10.2 has not so far been contemplated by Johnson Wax Ltd and the more detailed evaluation of these attractive opportunities is beyond the scope of this thesis. However, the search for new ideas, technologies and products which will utilise skill number 1 i.e. marketing is developed further in Chapter 11 as this is considered to be where the major opportunities will lie.

10.6 SUMMARY

This chapter has reviewed the subject of diversification looking at previous experience of Johnson Wax Ltd and suggesting several options for future evaluation. In addition, a management aid for the assessment of future diversification and new business opportunities has been devised based on analysis and ranking of a skills inventory. This has not been fully developed as it is only one aspect of identifying new business opportunities, and attention has been directed towards development of a methodology for innovation which is discussed in subsequent chapters.

CHAPTER 11: SEARCHING AND SCREENING FUTURE OPPORTUNITIES FOR JOHNSON WAX LTD

11.1 INTRODUCTION

The importance of aerosols to Johnson Wax was described in Chapter 9 together with the potential loss of business should aerosols continue to decline. The aim of this Chapter is to develop a procedure which will identify new opportunities which might be pursued by Johnson Wax Ltd in order to secure the future growth and stability of the company.

A minimum action plan might be to ensure that the potential loss of sales due to the decline of aerosol products, estimated at £ 8.4 million a year (Section 9.3), could be replaced by new business. A more satisfactory but ambitious plan would be to not only maintain the current level of business but also to plan for a 6 - 8% per annum growth in sales. This latter objective is supported by S.C. Johnson corporate management (150).

As shown in Figure 11.1, these new opportunities can come either from company diversification or a systematic search for new opportunities. The subject of diversification has been discussed in Chapter 10, and this Chapter considers the systematic search by formulating a procedure by which new opportunities may be identified and screened. The range of skills discussed in Chapter 10 and the stated corporate objectives for new products as summarised in Table 11.1, are necessarily included in this procedure.

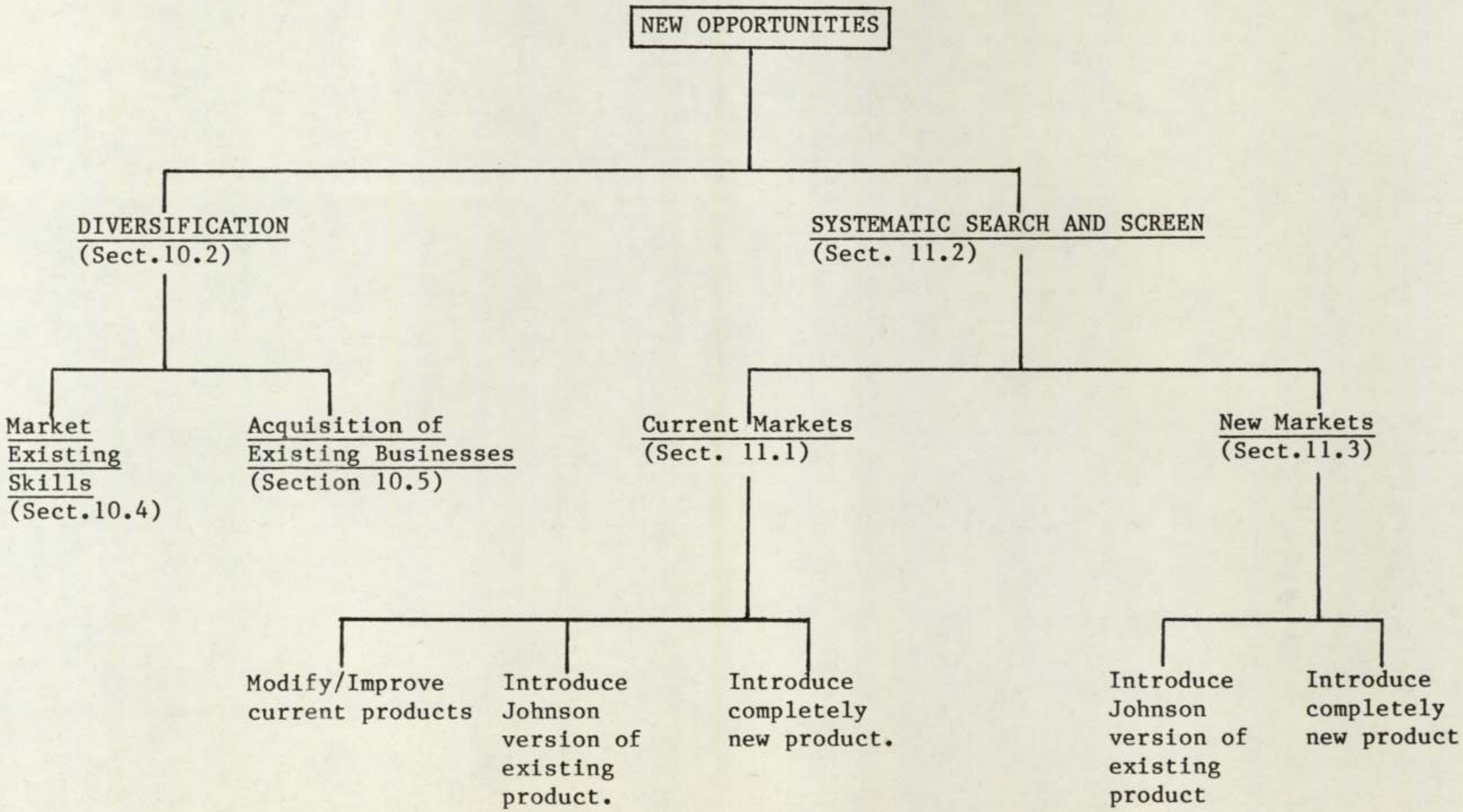


FIGURE 11.1 CLASSIFICATION OF NEW OPPORTUNITIES

TABLE 11.1 STATED CORPORATE OBJECTIVES FOR A NEW PRODUCT

1. Volume - £ 9.5×10^6 Gross Sales Minimum.
2. Gross Profit - 55%. minimum. (See Appendix IX).
3. Return on Investment - 15% (Calculated over 6 years); 18 months out-of-pocket payout. 36 months fully absorbed payout (see Appendix IX).
4. Product "Plus" - product must have a technical advantage over competition i.e. no "Fairy Dust".
5. Lack of Competition Concentration - categories should not be monopolised by a single large competitor.
6. Growth - categories should exhibit good growth or at least the potential for good growth.
7. Compatible Channels of Distribution - categories should preferably be food, drug and other mass markets if possible (but not mandatory).
8. Compatible Manufacturing Capability - products should be adaptable to current SCJ Manufacturing capability (primarily aerosol, liquid and powder filling).
9. Leadership Potential - products should have the potential for market leadership.

While ideally a new product should fullfill criteria 1 through to 9, particular emphasis tends to be placed on items 1, 2, 3, 4 and 7.

11.2 LITERATURE REVIEW

It seemed likely that the principles of identification and screening of new business opportunities must have been reviewed by other workers. Therefore it was decided to first conduct a literature review on the principles of searching and evaluating new ideas prior to preparing a procedure for Johnson Wax Ltd. This would identify the techniques used by others, and by evaluation select those considered to be most suitable for application to the company. A specific procedure could, then, be formulated in terms of actions, timings, and cost.

11.2.1 Searching for Ideas and Opportunities

The need to search for new product opportunities is a point upon which most authors appear to be unanimous and most publications positively urge this as a means of business survival (151), (152). Kotler (118) states that there are two basic ways to enter new markets i.e. via acquisition or via innovation. However little distinction is made between the search for a new business and the development of new products. This is felt to be important because it is likely that the search techniques that would be used would be different. Moreover, the methods utilised to develop new products within current markets will differ from those aimed at identifying product opportunites in new markets. This review will concentrate on new products, as the subject of acquisition was considered in Section 10.

The bulk of the literature considers new product development with noteable contributions on "do's" and "don'ts" from Booz-Allen and Hamilton (153), and by Eastlack (154). Recommendations relate to clear definition of the type of product needed in terms of concept and business parameters (profit, sales volume) and the avoidance of trying to copy the work of others without innovation. However the most useful reference was found to be a publication by White (155). This was one of the few references to make the distinction between looking for new market opportunities and looking for new products within existing markets.

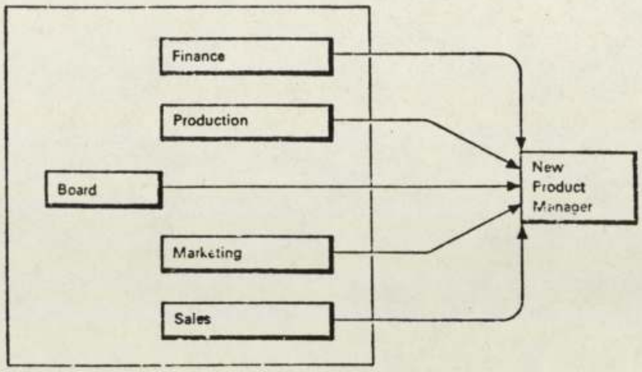
White, (155), Kotler, (118) and Heppner (156) are typical in their treatment of the subject of searching for new products in that they start with a discussion of the organisational requirements. There appears to be agreement that ideas can be found both within a firm and outside it, and

Table 11.2 shows some of the agreed sources of ideas derived from the literature (155). However this list is by no means comprehensive and a somewhat surprising conclusion is that the sourcing of new product ideas has not received sufficient attention in the literature. This subject is therefore examined further in Section 11.4 later in this Chapter.

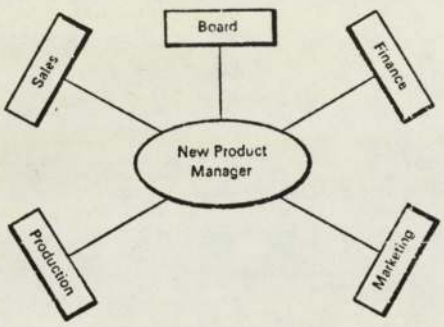
TABLE 11.2 SOURCES OF NEW PRODUCT IDEAS

IN FIRM	OUTSIDE
New Product Group	Customers-Trade
Inhouse Research & Development group	Customers-Consumers
Old Files	Inventors
Marketing/Brand Management	Competitors
Market Research	Other Companies Overseas
Production/Shop Floor	The Patent Office
Sales Force	Consultants (advertising agency/specialist)
The Chairmans Wife	Research Labs
Suggestion Scheme	

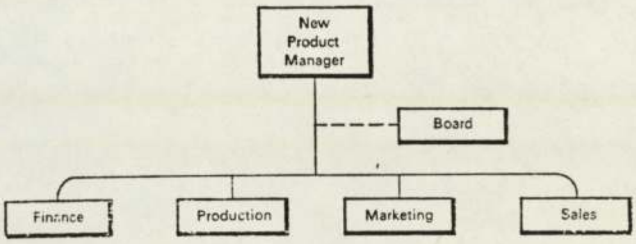
The literature is, however, in agreement that a definite effort must be made to set up a proper new ideas organisation within a company rather than depend upon R & D and marketing personnel finding the time to create new ideas, as well as perform their day to day tasks. White (155) suggests a number of ways of doing this which are illustrated in Figure 11.2 although he makes the point that the particular route used is dependent upon the type of firm and its corporate strategy. This theme is further developed by Heppner (156) and Kraushar (152), who advocate that companies should experiment in order to find the optimum new ideas organisation.



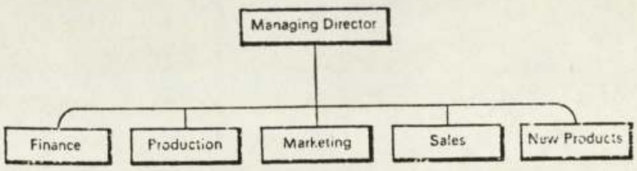
The Outcast or Scapegoat



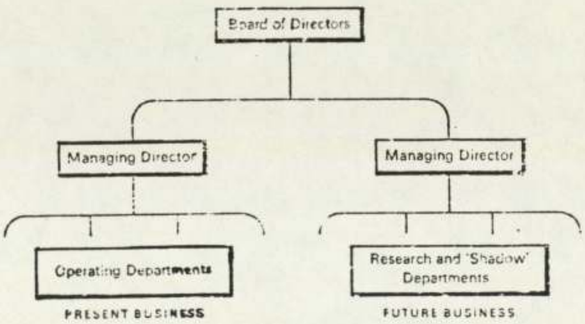
The Beleaguered Pioneer



The Megalomaniac



Equality and Acceptance



Present and Future Business in Harness

FIGURE 11.2 MODIFYING COMPANY STRUCTURE TO ASSIST THE DEVELOPMENT OF NEW IDEAS AND PRODUCTS

It is interesting to note that virtually all literature in this area originates from marketing personel and contributions from other sectors of companies are rare.

Having established the most suitable organisation coincident with corporate strategy, the next step is to select techniques for idea generation. Once again there is good agreement in the literature both regarding the techniques available and the procedures for using them. The major sources of practical information on techniques are case studies in business and management journals such as the article by Tauber (157), and Samson (158) who described morphological analysis and consumer techniques. The basic approaches can be classified under three main headings which are listed below, illustrated in Figure 11.3 and individually reviewed.

The Technical Approach: which includes laboratory experimentation, technological forecasting, value analysis, and brainstorming with technical groups.

Market Analysis Techniques: including Gap analysis, Segmentation analysis and Comparative Market Analysis.

People Techniques: involve getting ideas from people i.e. both the general public and 'experts'.

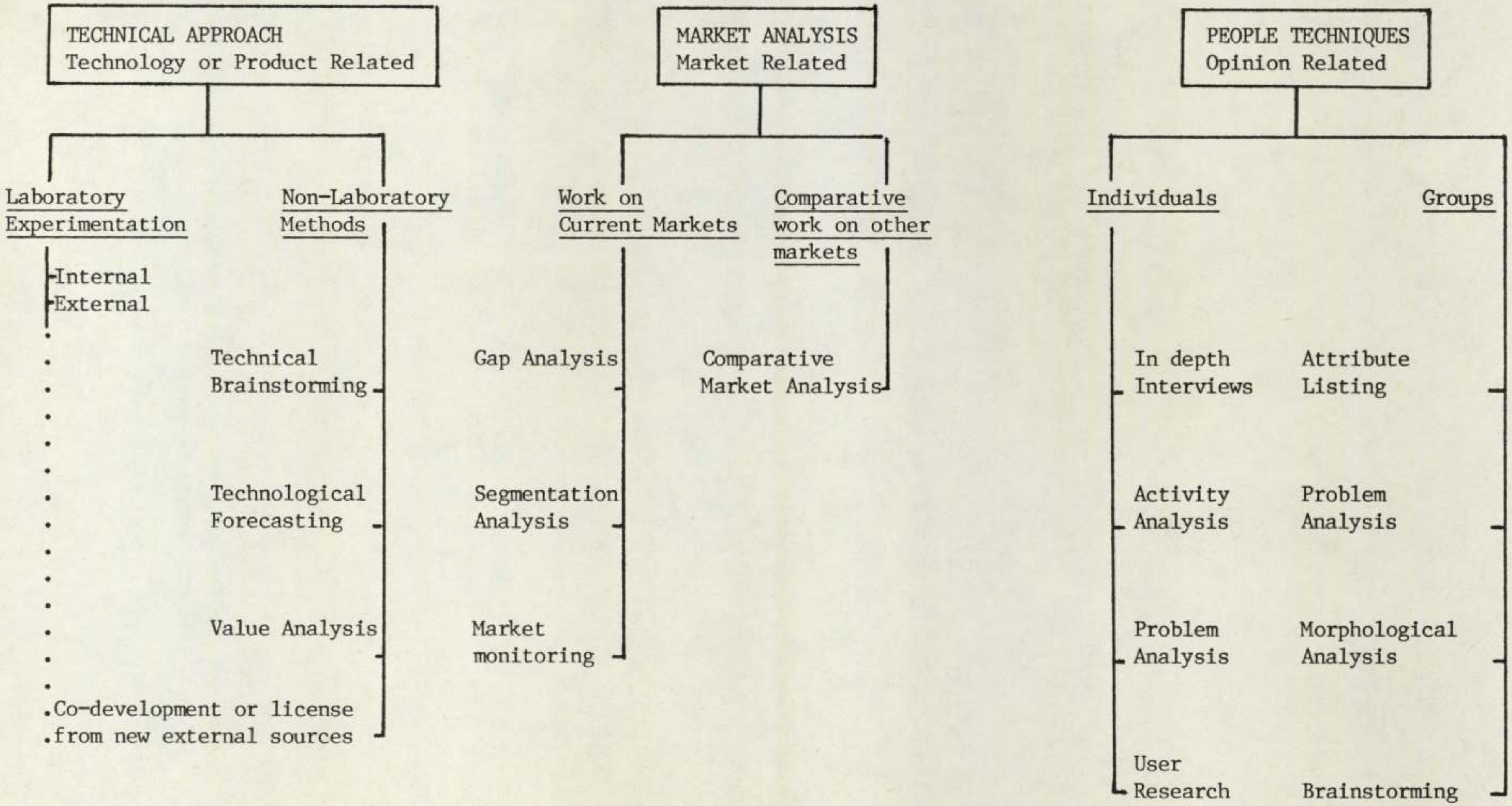


FIGURE 11.3 CLASSIFICATION OF IDEA FINDING METHODS

11.2.1.1 Technical Approach:

As shown in Figure 11.3, the technical approach relates to ideas which are concerned with technologies and products either from laboratory experimentation or using analysis methods involving technical personnel. The literature in this area is contradictory in that various authors place different degrees of confidence in the laboratory experimentation method of finding new ideas (118), (159), (160). According to Kotler (118), most R & D laboratories only carry out applied research, and often only make minor modifications to existing products. The alternative viewpoint exemplified by Lloyd (159) is that a properly organised experimental programme is the best route to new ideas and business opportunities. However only the largest companies have been successful in yielding major innovative ideas such as television, transistors, and synthetic fibres for clothing, through their basic research. The general but unsubstantiated view is that in most situations, R & D will work better if guided and assisted by marketing management.

No suggestions for exploiting external sources of ideas appear to have received attention although there is adequate material on brainstorming with technical specialists which is covered in section 11.2.1.3 later.

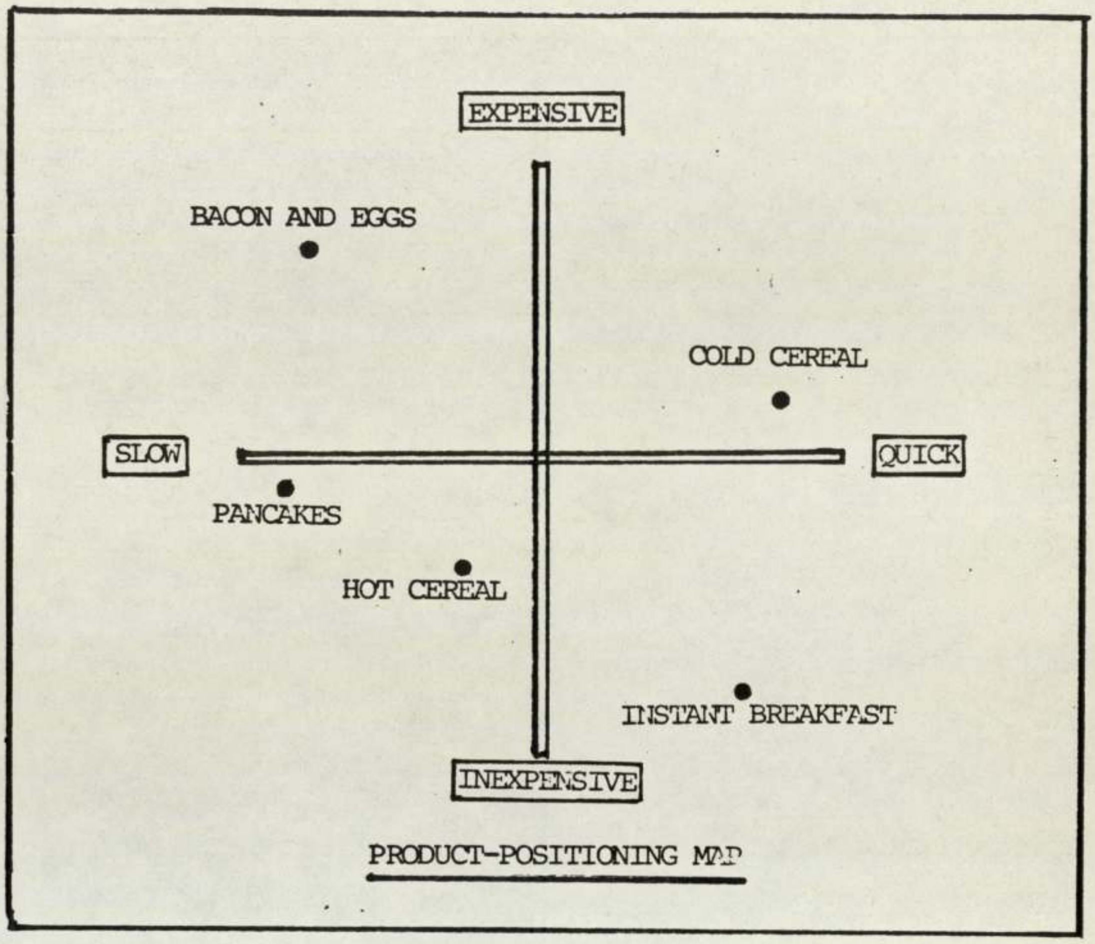
The literature on technological forecasting reflects the view that there is abundant material on how and where to use the various types of techniques available, but considerable variance on their degree of usefulness, particularly in respect of searching for new ideas (161), (162). The main techniques have already been summarised in Chapter 5, and, as indicated, their major applications are in forecasting either future technological developments or the probability or difficulty of solving a specified problem. In general, therefore, they are unlikely to be of significant interest for this thesis especially as no relevant examples were found of their use in finding new ideas. As shown later, one specific technique - Delphi - was adapted to obtain concensus judgements on new product selection.

Value analysis is a systematic approach to cost reduction. Each component of a given system is assessed from a technical viewpoint to see if cost reductions are possible. If used constructively, the technique can lead to new products. It appears to have captured the imagination of several authors e.g. Kotler (118),and White (155), and there is widespread agreement that this American approach can be very valuable to medium and large companies both in terms of cost saving and new product development. However the experience within Johnson Wax Ltd and the parent S.C. Johnson in the USA, suggests that the major end points are cost savings and that no examples of a resultant new product ideas exist. Therefore, it is likely that more fruitful results will be obtained by more direct methods such as market analysis and people techniques.

11.2.1.2 Market Analysis Techniques:

Unlike the technical approach, the literature is in good agreement over marketing analysis techniques that can be used to search for new product ideas. Gap analysis is perhaps the most widely used method, as described for example by White (155), Frost and Braine (162). This technique, illustrated in Figure 11.4, is frequently used to identify areas of product opportunity within a given market.

Segmentation Analysis is a variation of Gap Analysis, in which the aim is to identify and monopolise a significant segment of an existing market



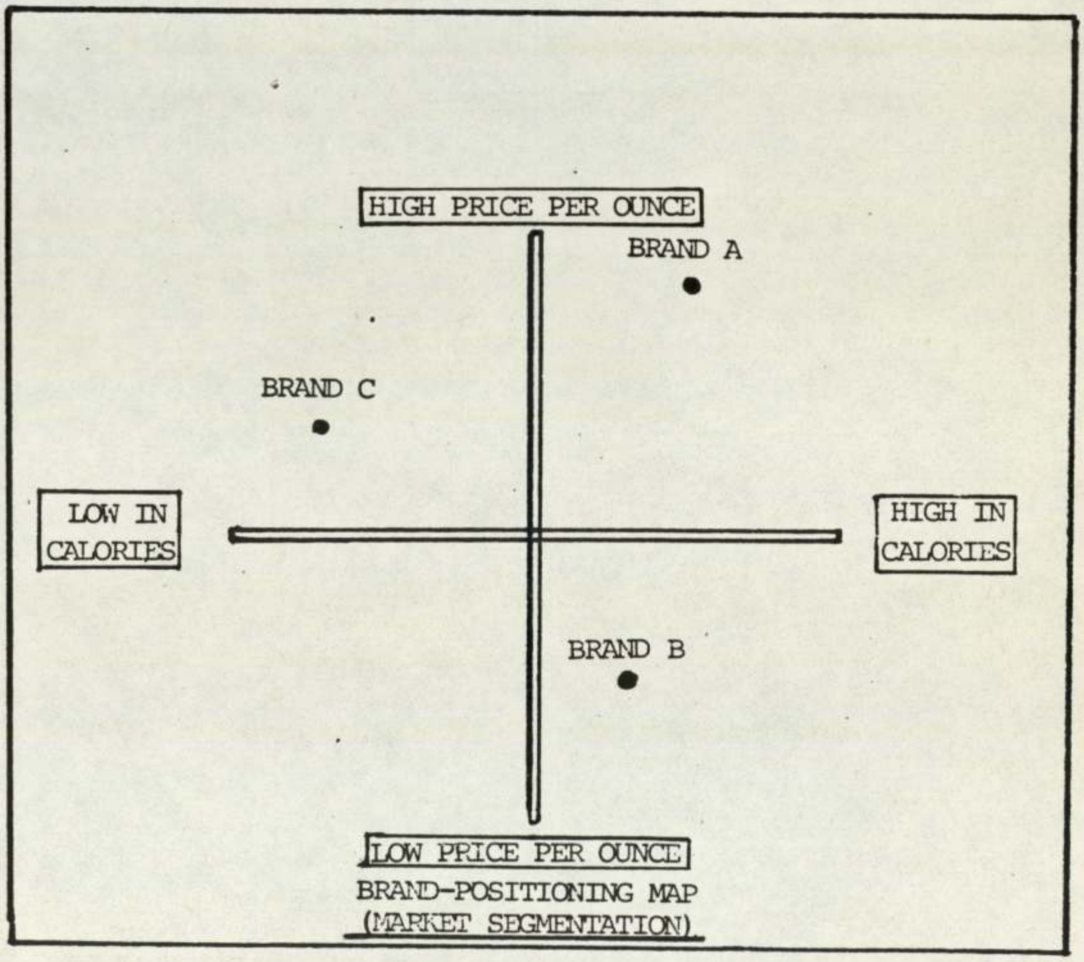


FIGURE 11.4 EXAMPLES OF GAP ANALYSIS FOR PRODUCT AND BRAND POSITIONING

which is not fully satisfied with currently available products. The main difference between this technique and Gap analysis is that attention is focused on a part of a given market rather than the market as a whole; for example the focus on nappy liners within the comparatively large Baby Care Market. Both Barnet (163) and Christopher (164) are advocates of this technique which is apparently widely used with a high degree of success.

Comparative Marketing Analysis is a further technique that appears extensively in the literature. This is particularly widely used by multi-national companies such as Johnson Wax Ltd, where comparisons are made between markets and products that are successful in the USA market and their potential opportunities in Europe. In conducting such an analysis, data is gathered on market parameters such as size, competition, growth rate, end uses, consumer viewpoints and demographic factors. Major advocates of this technique are the Booz-Allen and Hamilton Company (165), Kraushar Andrews and Eassie (166), and the Neilson Company (167), (168). There are many examples of this technique being used successfully, such as the introduction of aerosols into Europe from the United States. Door to door selling is another example, initially utilised with 'Tupperware' and now extended into cosmetics, other toiletries, leather goods and clothing.

However, the majority of the examples of comparative market analysis involve product transfer from the USA to Europe, and because of the differences in market size, consumer habits and per capita disposable income, the technique does not always work. In fact, within Johnson Wax Ltd during the last decade, there are more examples of failure than success. For these reasons and the practical difficulties of gathering sufficient information on its USA markets - it is unlikely to be of value to this case study.

11.2.1.3 People Techniques:

In the previous section, the techniques of market analysis were shown to be dependent upon data from existing markets. People techniques may need some of this background market information, but usually rely upon specialist groups and consumers to provide new ideas. A major advantage of these methods is that they can provide the opportunity to move into completely new areas. There appear to be two main viewpoints on this subject:

(i) Specialist groups are needed because consumers cannot "invent" products but merely identify areas of dissatisfaction with existing products, or unknowingly highlight the need for new products.

(ii) With suitable modifications to the various techniques utilised to get ideas from the "specialists", the general public or consumers can produce new product ideas.

These two potential sources of ideas are discussed further.

(i) Using Specialists:

The majority of authors subscribe to the view that specialists are needed, with noteable contributions by Hayhurst (169), Jewkes (170), and Kraushar (152). These authors propose that the specialised methods generally referred to as innovative/creative techniques be employed, (See Table 11.3 later), using specialist groups within a company such as scientists, marketing personnel, salesmen and top management. A particularly interesting contribution was made by Tauber (157), who described a technique he called the "Heuristic Ideation Technique" or H.I.T. system. This specific technique, although not widely used, is really a modified version of morphological analysis aimed at problem solving. For a problem of finding a new product, descriptive performance and cost parameters are used to define the problem boundaries. The more frequently used methods are listed in Table 11.3.

(ii) Using Consumers:

The minority viewpoint that consumers can be used to either create or point the way to new product ideas has been argued with some skill by Sampson (158) and more recently by Von Hippel (171). Tauber is a further supporter of the idea (157) while White (155) appears to be undecided. The advantages of such a system are claimed to be:-

* Consumers are available in substantial numbers.
* Consumers have user experience.
* Consumers are usually willing to highlight a product's shortcomings.
* Statistically, many consumers must be creative and innovative individuals.

Disadvantages, according to the literature (118), (152), relate to the consumer/manufacturer behavioural cycle which stipulates that consumers articulate "needs" and manufacturers respond with "products". However, as modern business methods have often demonstrated, the manufacturer can create a need by introducing a product e.g. airfresheners and antiperspirants. In view of the inconclusive evidence the use of consumers was investigated further and the consumer research techniques abstracted from the literature are outlined in Table 11.4 (155), (152).

TABLE 11.3 SPECIALIST (PEOPLE) TECHNIQUES FOR IDENTIFYING NEW PRODUCT IDEAS

TECHNIQUE	DESCRIPTION OF METHOD AND EXPERIENCE	COMMENTS
1. Attribute Listing (118)	The major attributes of an existing product are first listed then considered by the group who attempt collectively to make improvements such that their suggested modifications will benefit the product. Usually performed with specialists.	More relevant to improving existing products rather than searching for new ones.
2. Forced Relationships (118)	Several products are listed and then considered in combination with each other such that a revolutionary new product may result e.g. Airfreshener spray; Insecticide spray; giving the combination Insecticide spray with pleasant fragrance. Usually performed with specialists .	Although more likely to yield new products than 1. above - unlikely to effect major departures from the current product line.
3. Morphological Analysis (161)	An exercise which singles out the important dimensions of any problem (e.g finding new products or improving current ones) and then examines the relationships between them. It is also used in technological forecasting performed with specialists.	No evidence of satisfactory use in non-durable consumer product markets.
	A modified version (Heuristic Ideation Technique) has been developed by Tauber (157) to yield new product ideas.	Not widely tested. Little information available.
4. Problem Analysis (157)	This consumer technique looks at the perceived negatives associated with a specific product with the aim of constructing a framework for a new or improved product.	A further technique which will lead primarily to modifications to existing products.
5. Brainstorming (118)	This is a process for producing a wide range of ideas to solve a problem. All ideas are encouraged and criticism is ruled out until a later stage. A variation brainstorming which uses the process of analogies to aid solutions is known as Synectics (118). Both Specialists and Consumers may be used.	Directly relevant to this thesis and should be tried.

Assessment of the literature found on each aspect, only the creative thinking and consumer research techniques are in regular use.

11.2.2 Screening New Ideas

The literature is clear on the need to properly screen new ideas. Kotler (118) describes "drop errors" and "go errors": A "drop error" occurs when a company dismisses a good idea because of its lack of vision of the potentialities; a "go error" occurs when a company lets a poor idea proceed to development and commercialisation. O'Meara (172), Richman (173) and Tauber (174) emphasise the high cost of allowing a poor idea to go forward, and Richman offers a "product idea rating device" illustrated in Table 11.5.

A flow diagram proposed by White (155) is presented as Figure 11.5, which lists the steps necessary to progress an idea from its inception to national launch. Unfortunately White (155), like many other authors (165), fails to clearly specify how to generate and screen ideas in the first place.

All authors mention various criteria such as corporate plan objectives, extra profit in the forthcoming year, and ability to sell and distribute product. However, at the very early stage of a project, i.e. before much of the company's resources have been expended to develop the idea into a meaningful prototype, how is it possible to decide which idea to support and who makes the decision? Many authors such as Tauber (174) suggest that this should be done by "senior management" but fail to specify on what basis.

TABLE 11.4 CONSUMER (PEOPLE) TECHNIQUES FOR NEW PRODUCT IDEAS

TECHNIQUE	DESCRIPTION
1. CREATIVE THINKING	
1.1 Discussion Groups	This involves a group of consumers (6-10) and a moderator and the conversations are either recorded by secretary or by a tape recorder. The moderator introduces the topic e.g. "doing the laundry". The group then describe their experiences making comments on existing products regarding ease of use and satisfaction of end result.
1.2 In Depth Interviews	These are one to one interviews where a particular topic is explored in depth so as to extract all the consumers feelings and viewpoints on the subject. The conversation is recorded either manually or by tape recorder.
2. CONSUMER RESEARCH	
2.1 User Research	Here the consumer is usually given a product for 1-2 weeks and asked to record his/her comments regarding its ability to perform the task and the degree of satisfaction with the end result.
2.2 Activity Analysis	A variation of the user research technique is known as "activity analysis" or "task tracking". No specific product is given but the consumer is asked to keep a special `diary´ of daily events (e.g. in the the home).
3. PROJECTIVE TECHNIQUE	
3.1 Role Playing	This method is a variation on group discussion except that each member is given a character of role to enact within a prescribed scenario. The conversations are recorded and by subsequent analysis of the `natural´ dialogue - conclusions may be drawn regarding new ideas.
3.2 Childrens Drawings/Essays	This technique is utilised by the advertising agencies (179), (180), to create suitable TV and other media material for childrens products e.g.Toys, Food.
3.3 Future Think	A projection method similar to 3.1 also usually conducted with groups where the construction of a future scenario provides stimulus for imaginative thought and subsequently new product ideas.

TABLE 11.5 PRODUCT - IDEA RATING DEVICE (118)

PRODUCT SUCCESS REQUIREMENTS	(A) RELATIVE WEIGHT	(B) COMPANY COMPETENCE LEVEL 0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	0.10	RATING (A x B)
Company personality and goodwill	0.20							*					0.20
Marketing	0.20										*		0.180
Research and Development	0.20								*				0.140
Personnel	0.15							*					0.090
Finance	0.10										*		0.090
Production	0.05									*			0.040
Location and Facilities	0.05				*								0.015
Purchasing and supplies	0.05										*		0.045
TOTAL	1.00												0.720#

Product Rating scale: 0.00 - 0.40 Poor;
0.41 - 0.75 Fair;
0.76 - 1.00 Good.

Present minimum acceptance rate: 0.70.

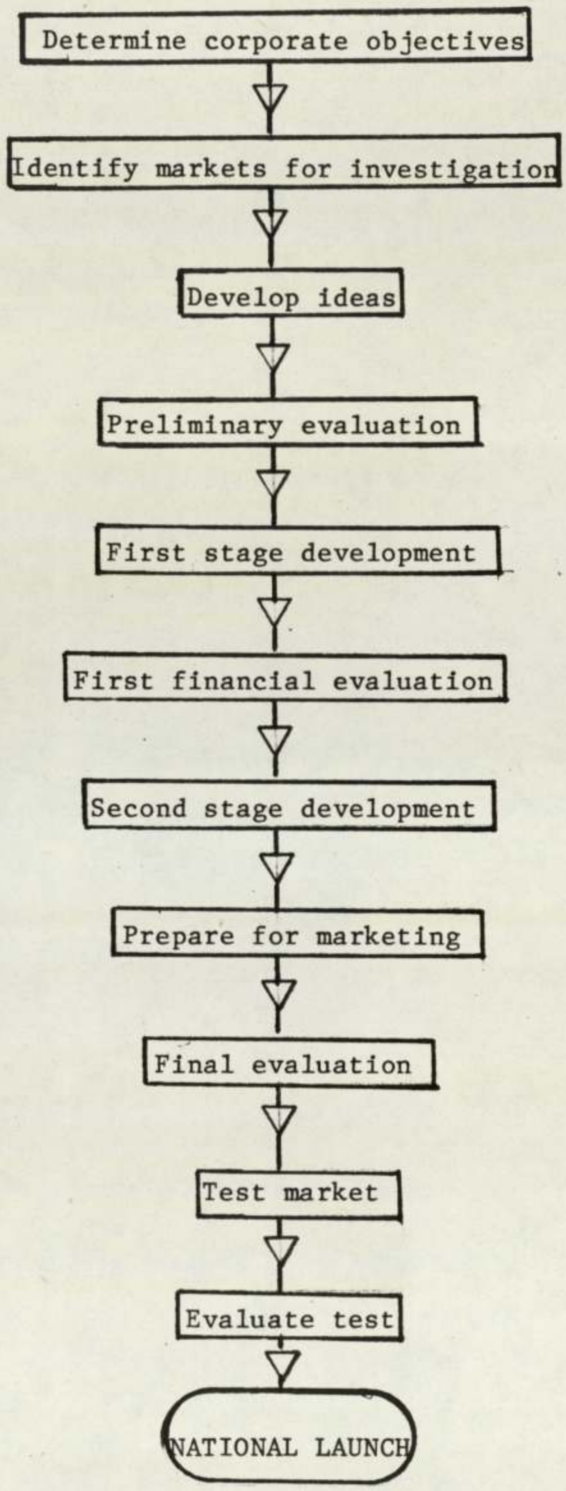


FIGURE 11.5 IDEA FLOW DIAGRAM (155)

Once the screening has resulted in a satisfactory product concept, a tentative marketing strategy and a business analysis is possible, and there are various techniques listed in the literature for performing such an analysis. For estimating sales, trend analysis and comparison with like products are usually employed, and articles by Bass (175) and Fourt and Woodlock (176), are particularly useful. For estimating costs and profits a recent article by Blattberg and Golanty (177) presents a novel simplistic approach to the discounted cash flow techniques.

However it is at the primary or early evaluation stage that there appears to have been insufficient effort in describing a method or methods for screening large numbers of ideas for action and more thorough evaluation. This aspect will therefore receive particular attention. A range of methodologies for finding and evaluating new ideas for products will be tested in order to not only solve the more immediate potential business problems facing the company, but also to generate a procedure that can be both continued and transferred to other branches of the multi-national organisation.

11.3 SELECTION OF METHODS FOR SEARCHING AND SCREENING NEW PRODUCT IDEAS TO BE USED AT JOHNSON WAX LTD

11.3.1 Aims and Scope

In the introduction to this Chapter, the reasons for initiating a plan to secure the companiy's future stability and growth were described. The resources available to pursue these activities are limited by company policy to approximately 10% of the R & D budget; equivalent to £200,000 per year. This necessitates a clear and realistic definition of the aims and scope of the plan. Ideally the search will aim to identify opportunities which are both satisfactory from a business viewpoint and also relatively easy to implement by the company (as judged by the skills inventory in Chapter 10). While this may bias the search toward technologies and products which fit within existing markets, the identification of new technologies as well as new products will ensure that new markets are also considered. In addition, corporate management have specified guidelines for new markets, summarised in Table 11.6.

TABLE 11.6 CORPORATE GUIDELINES FOR NEW PRODUCT OPPORTUNITIES (150)

(A) OVERALL OBJECTIVE

To identify new product opportunities in accordance with the specified corporate guidelines of Johnson Wax Ltd (and also those of the SC Johnson multi-national Corporation) by ultimately making available:-

New Products
New Packaging Forms
New Manufacturing and Synthesis Processes
New Technologies

(B) SPECIFIC OBJECTIVES

(i) To support existing business namely:-

Air Freshener Products
Auto Care Products
Floorcare Products
Furniture Care Products
Insecticide Products
Laundry and Fabric Care Products
Leisure Industry Products
Metal Care Products
Oven and Household Cleaner Products
Personal Care Products

(ii) To assist in the development of corporately approved new markets namely:-

Non Prescription Pharmaceuticals e.g. antacids and digestion aids.
D.I.Y. (Do-it-yourself) Products e.g. glues, sealants.
Health Care Products e.g. Diet Aids.
Convenience Foods e.g. drinks, sauces, instant meals.

These guidelines are wide ranging and it was anticipated that the time available for the pilot study would not permit full assessment of all product areas. Therefore the search was focused mostly on ideas, technologies and product prototypes which would support existing markets or could be readily implemented using existing company skills, however more radical ideas were not excluded. In addition, this pilot search process was confined to the UK in order to simplify the administration and reduce costs. The subject of diversification as discussed in Chapter 10 was excluded from this particular programme. Similarly the screening methods must take account of corporate strategies and direction, yet be rapid and easy to apply to large numbers of items.

11.3.2 Current Situation

The literature review in Section 11.2 identified three basic classifications of idea finding techniques namely:-

1. Technical Methods.
2. Market Research Methods.
3. People Methods.

A study of the current situation within Johnson Wax Ltd indicates that specific techniques from each of the above classifications are being utilised at the present time by the marketing department, and details of these activities are summarised in Table 11.7.

TABLE 11.7 THE CURRENT NEW PRODUCT IDENTIFICATION ACTIVITIES USED BY THE MARKETING DEPARTMENT OF JOHNSON WAX LTD

TECHNIQUE	SPECIFIC METHODS USED	COMMENTS
Technical	New product development by means of R & D brief to Johnson Wax Ltd R & D centre.	Usually modifications to existing products or formulation of a new product within current markets. Little opportunity to break away from current business categories.
Market Research	(i) Gap analysis - carried out on behalf of Johnson Wax Ltd by creative agencies. (ii) Segmentation - as in (i) above but also via market research agencies and consumer concept techniques e.g. group discussions.	The "new" products which have traditionally resulted from these activities have usually been already launched by competotors i.e. are already on sale in the major outlets in the UK or the USA.
	(iii) Market monitoring of product categories of interest by specialist agencies e.g.Nielsen (178)	
People	(i) Used in respect of gaining responses to a product concept (which is illustrated via slides or story boards) or a prototype product. (ii) Used in the so called product `Assessor´ Test (150), to measure purchase intention and effect of advertising with a special mock store and retail display facility. In this test the fully identified product is displayed alongside the competition, and after viewing advertising consumers are invited to `buy´ the product of their choice. (iii) Used to assess the impact of intended advertising.	These measurements are valuable in assessing the potential of a given product prototype or idea. They make no real contribution to the identification of new ideas.

However the systems described in Table 11.7 have not proved to be particularly successful for Johnson Wax Ltd over the last decade in that few new products have been launched and none appear to meet the corporate guidelines listed in Table 11.1. A chronological summary of new product activity by category and idea source is presented in Table 11.8 from which it may be concluded that two of the sources warrant further attention namely:-

(i) Ideas from the R & D group.

(ii) Investigation of competitive activity.

Changes only in product colour, fragrance or pack size have been excluded and the annual sales of each product in a typical recent year have already been presented in Table 9.1.

There is little evidence of either the marketing or R & D departments actively following up any of the 'other' sources of ideas already listed in Table 11.2 and Figure 11.3 including the possibility of using consumers as "inventors" or "direction finders". Equally, there is no evidence of sourcing ideas from outside the organisation.

The research and development department currently expend more than 90% of their total resources servicing product development briefs from the marketing department as shown in Table 11.7. Prior to this pilot study, few R & D resources were directed at finding or developing new ideas, technologies or products outside those requested by the marketing department. Typical activity relates to product formulation and development in response to a request (product brief) from the marketing department usually either one of the existing categories e.g. Floor Care, Air Care. The diversity and quantity of such marketing initiated work has tended to leave little time or resources for exploratory studies.

TABLE 11.8 JOHNSON WAX LTD - NEW PRODUCT ACTIVITY 1970 - 1980

CATEGORY	PRODUCT DESCRIPTION	SOURCE OF IDEA	YEAR
Furniture Care	SPARKLE - Aerosol multi surface polish.	R & D	1972
" "	TEAK WOOD Aerosol	Marketing	1975
Air Care	GLADE (gel) solid airfreshener	R & D	1973
" "	SECRETS - paper impregnated stickup	Competitor	1979
" "	type airfreshener		
" "	GLADE FLO THRU: variable paper impregnated airfreshener	Competitor	1980
" "	GLADE SHAKE N'VAC carpet and room powdered airfreshener	Competitor	1981
Floor Care	KLEAR - dry bright clear polymer floor polish	R & D	1973
Fabric Care	SHOUT - concentrated spray on detergent/ stain remover	R & D	1980
" "	FINAL TOUCH - Spray ironing aid - not starch based	Competitor	1980
Personal Care	US ANTIPERSPIRANT - Aerosol	Competitor	1971
" "	US ANTIPERSPIRANT - Roller	"	1972
" "	SPRAY TALC - Aerosol	"	1972
" "	HAIRSPRAY - Aerosol	"	1973
" "	TABLET SOAP	"	1973
" "	AGREE HAIR CONDITIONER	"	1981
" "	AGREE HAIR SHAMPOO	"	1982

SOURCES:	COMPETITORS	- 11
	R & D	- 4
	CREATIVE MARKETING ACTIVITIES	- 1 (as listed in Table 11.7)

11.3.3 Selection of Idea Finding Methods for the Case Study

The use of Johnson Wax Ltd as a pilot study to investigate the approach of finding and evaluating new opportunities was described in Chapter 9. This section selects suitable methods to carry out this study.

11.3.3.1 Technical Methods

The limited success of R & D as a new product idea source to the company was described in the previous section using historical data. The literature review in Section 11.2 further suggested that there may be several technical idea sources which had not as yet been investigated by Johnson Wax Ltd. It therefore seemed appropriate to concentrate on technical methods to be used by the R & D group to improve their performance as a new product source. This was seen to be best achieved first by a study of the activities in the R & D centre with the objectives of improving motivation, innovation and creativity (M.I.C.).

The investigation of 'other' technical sources of ideas, technologies and products such as Universities, was selected as a second technical route also to be undertaken by R & D personnel, as this appears to have been ignored by all other researchers and by Johnson Wax Ltd as a potential valuable source of ideas.

11.3.3.2 Market Research Methods

A further conclusion from Section 11.3.2 was that in the last decade, competitors apparently provided the best source of new product ideas for Johnson Wax Ltd. Market monitoring activities initiated by the marketing department do not produce any new ideas, merely serving to providing a watching brief. While these are likely to continue, and fulfill a useful function, such activities are essentially passive, and there are interesting possibilities for a more active involvement which might lead to useable product ideas. Such a venture should initiated by R & D to raise the level of awareness regarding the company's consumer markets. A procedure needs to be developed whereby R & D and marketing department become equal partners in all new product activity instead of the present response only mode of the R & D department. Unfortunately the literature reviewed in Section 11.2 does not offer a proven technique and one needs to be developed for the pilot study.

11.3.3.3 People Methods

The literature review in Section 11.2 identified the possibility of using consumers as a source of new product ideas. Table 11.7 showed that such procedures do not form part of the current or planned activities of the marketing department, and therefore this method was selected for inclusion the pilot study.

11.3.4 Selection of Idea Screening Methods for the Pilot Study

Unfortunately the literature yielded little information on idea screening techniques which would be likely to comply with the aims and scope of the pilot programme detailed in Section 11.3.1. Therefore special methods had to be developed which utilised available resources.

Table 11.9 summarises the search and screening methods selected and used in a pilot study programme the procedures for which are described in the next section with results in Chapter 12.

TABLE 11.9 SEARCH AND SCREEN METHODS SELECTED FOR PILOT STUDY

ACTIVITY	SELECTED METHODS	SECTION REFERENCE
A. SEARCHING		11.4.1
(i) Technical	Review creativity and innovation at R & D centre.	11.4.1.1
	Investigate exterior sources e.g. universities.	11.4.1.2
(ii) Market Research	Devise a new method of using competitor activity as source of ideas for Johnson Wax Ltd.	11.4.1.3
(iii) People	Investigate the use of consumers as inventors.	11.4.1.4
B. SCREENING	Devise an efficient and easy to use procedure which includes corporate strategies and plans.	11.4.2

11.4 PROCEDURES UTILISED

The following procedures were selected and/or devised for the pilot study which not only tested the methodologies for searching out then screening new ideas, but also produced new products for Johnson Wax Ltd to exploit in order to achieve the objectives described in Tables 11.1 and 11.6. The overall procedure is designated E.S.M.E. (External Search and Multistage Evaluation) and is described in Figure 11.7 later.

11.4.1 Search Procedures

11.4.1.1 Review of Innovation and Creativity at the R & D Centre

A study was made of the activities at the R & D centre in order to identify constraints and thereby improve productivity. This was carried out by examining past performance from the point of view of new product development, and any constraints on creativity and innovation. Such a study was achieved by first establishing the definition of innovation and its relationship to creativity and and motivation (193), i.e.

$$\text{Motivation} + \text{Creativity} = \text{Innovation}$$

With the overall objective of increasing R & D creativity in the sense of raising the output of high quality ideas, technologies and product prototypes; each of the terms in the above relationship was examined in the context of the R & D centre by comparing the current situation to ideality.

Motivation was examined first using the conceptual relationship:-

$$\text{Motivation} = K.M.^{m}R.^{r}P.^{p}A.^{a}$$

Where

M = Money (pay and benefits)

R = Recognition factor

P = Promotion or career development factor

A = Achievement factor (technical, scientific or otherwise i.e. "inner satisfaction").

K = Personal constant of the individual

m,r,p,a are exponents dependant on the mental set of the individual.

Each factor was then studied with respect to R & D staff on an individual basis since most R & D activity is carried out by individually assigned projects.

In order to carry out this work, it is helpful to appreciate the definition and meaning of the terms employed.

Creativity was defined as follows:-

"Creativity is that thinking which results in the production of ideas that are both novel and worthwhile" (193). Worthwhile was interpreted here as those activities which resulted directly or indirectly in a successful new product for the company or the corporation, and a measure of rate of success, i.e. productivity, is therefore necessary. In the R & D context two definitions emerged:

(a) Annual productivity can be set at the number of successful new products launched per £ 100,000 of R & D expenditure; or (b) Productivity can be set at the number of new product prototypes which achieve the objectives specified by the marketing department per £ 100,000 of R & D resources. In this latter case, however, some of these products may not actually get launched. No information has been found in the literature or from within the company on typical values or ranges.

A study of creativity was then initiated with reference to its detection, measurement and assessment in R & D staff. This in turn led to considerations regarding the correct or optimum R & D staffing for Johnson Wax Ltd. A check list of factors likely to influence creativity was compiled some of which were found to be similar to those discovered during motivational studies.

Innovation was studied in collaboration with an external consultant who was briefed to look at ways of improving it within R & D. He was given access to the results of the work described above on resource management, motivation and creativity together with the productivity objectives. The results are presented in Chapter 12 with recommendations in Appendix VII and in Chapter 14.

11.4.1.2 Investigation and Use of New Technical Sources

A comprehensive literature review of new potential sources of ideas technologies and products was described in Section 11.2.1.1, from which it was concluded that external sources have been largely ignored. A comprehensive list of these sources has been compiled and is presented as Table 11.10, in descending order of their anticipated success rate (based on discussion with Johnson Wax Ltd marketing personnel and previous experience within the company). In order to assist the search at universities and research institutions, a listing of likely departments of interest was compiled based on the findings of Chapter 10, Table 11.6 and previous experience at Johnson Wax Ltd. This information is presented as Table 11.11.

For sources 1, 2, 4, 5, 6, 7, in Table 11.10, initial contact was made by a letter which explained the objectives of the programme and invited interested parties to make contact with the writer outlining the areas of expertise for possible co-development or sale. Samples of these letters (which had to be approved by the Johnson Wax Ltd legal department to ensure no breach of confidentiality occurred) are included in Appendix VI.

Having identified the new sources, a list of contacts was drawn up from research directories (181), (182), and company files. The full list included universities, key raw material suppliers, government and private research institutes, technology traders and external product developers and is presented as Appendix VI. In addition, a list of publications dealing specifically with new ideas, technologies and products was compiled and is presented in Table 11.12.

TABLE 11.10 IDENTIFIED SOURCES

RANKING	SOURCE	INTENDED ACTIONS
1.	University based research.	Pilot in UK then extend to Europe via technical manager at Johnson subsidiaries.
2.	Fragrance suppliers and key suppliers e.g. I.C.I., Esso, Marchon.	Run in UK only as all multi-national companies
3.	Survey of goods in market place i.e. store audits.	Run pilot 4 x/year in each TV advertising area of UK. If succesful extend to Europe as in 1. above.
4.	UK government research.	Pilot UK - if succesful proceed in 1.above.
5.	UK Private Research Institutes.	Pilot UK - if successful proceed as in 1. above.
6.	Sponsored consumer research via external agency.	Pilot in UK via University of Surrey Home Economics Dept. If successful exctend as in 1. above.
7.	Technology Traders.	Pilot in UK - if successful proceed as in 1. above.
8.	Product (Idea) Developers.	
	(a) Inhouse - own marketing)	No action already underway.
	- R & D ideation seminars	Pilot in UK - if successful proceed as in 1 above.
	External - Consultants	Evaluate cost before proceeding further.
9.	Literature Review.	
	(a) New Product publication	Evaluate by monthly scan for half year.
	(b) Patents	Use subscribed online computer searches such as "Dialogue"(188) or "Blaise" (183).Evaluate over six month period.
10.	Competitions.	
	(a) Inhouse	)Check historical information
	(i) Own salesmen	)at Johnson Wax Ltd.
	(ii)General employees	)Evaluate practical difficulties
	(b) National advertising	)and cost. Endeavour to gain
	(i) Identified	)Management approval.
	(ii)Non-identified	)

The review of the literature was conducted by subscribing or ordering copies of the journals listed in Table 11.12 for a twelve month period, and by utilising online computer abstracting services such as "Dialogue" and "Blaise". The initial cost of these journals were small as many were already obtained by the company, some without charge. However the abstracting services were found to be expensive particularly when used for patent searching.

The possibility of running competitions both inside the company using sales or general employees, and outside the company by advertising in the media, was reviewed with senior management and considered to be unacceptable due to previous inhouse experience where poor results had been obtained at high cost.

TABLE 11.11 SEARCH SUBJECT AREAS

Biochemistry
Biological Science including Microbiology and Toxicology
Building Science and Architecture
Business and Marketing
Chemical Engineering
Chemistry
Civil Engineering
Computing Science
Home Economics
Industrial Design
Mechanical Engineering
Production Engineering
Social Science including Behavioural Studies

TABLE 11.12 JOURNALS DEALING WITH THE SEARCH FOR NEW PRODUCTS AND INNOVATION

NAME OF PUBLICATION	PUBLISHER
Inside R & D - weekly	Technical Insights Inc, Fort Lee, USA
Innovation - Bi-yearly	Technology Review Inc,Alumni Centre, New York, USA
Dialogue Computer Search	Dialogue Information Services, Inc, Palo Alto, USA
Chemtec - monthly	American Chemical Society, NY, USA
Aerosol Age - monthly	Industry Publications, NJ, USA
Cosmetics & Toiletries - monthly	Allurid Co, USA
Soap, Cosmetics & Chemical Specialities - monthly	MacNair-Dorland Co, NY, USA
Household & Personal Products Industry - monthly	Rodman Corp, NJ, USA
New Products International-monthly	World Business Publishers, London
European New Products Report-monthly	LLS Ltd, Haywards Heath, Sussex
British Business - weekly	UK Government
New Scientist - weekly	New Science Publications, UK
Manufacturing Chemist - monthly	Morgan Grampian Ltd, UK
Soap, Perfumery & Cosmetics - monthly	United Trade Press, London
Blaise Computer Search	The British Library, London

11.4.1.3 New Market Research Sources - Gaining Ideas from Competitors

The significance of improving competitors products as new ideas source was demonstrated in Table 11.8 and a method had to be devised to identify competitors products at an early stage for evaluation. The study of Johnson Wax Ltd historical data indicated that the market monitoring agencies commissioned by the marketing department tended to be too slow in gathering their data to gain a competitive edge.

The adopted procedure involved auditing and buying selected products from grocery and relevant multiple stores in areas of the UK known to be test market sites (148) for competitor's products. This procedure was named the 'Store Audit' and planned to be conducted in Newcastle, Birmingham, and Southampton approximately six times per year.

Having obtained samples of a new product, it would be subject to performance trials and full analysis.

11.4.1.4 Using Consumers as Inventors

The consumer (people) research by the "activity analysis" method (Table 11.4) was conducted jointly with Surrey university who were contracted to progress the interviews and distribute and collect the questionnaires. The respondents were drawn from Guildford, Surrey, and the data gathered by group discussions, questionnaires and in depth interviews. The questionnaire utilised for activity analysis (reproduced in Figure 11.6) was left in the home together with use instructions and agreed action and collection dates.

In addition to the questionnaire, personal contact for idea evaluation was actioned in two ways:

(a) Discussion groups were formed by the university based project supervisors from respondent housewifes of various age groups and discussion was conducted under the heading "Quality of Life" in order to stimulate interest.

(b) In depth interviews were conducted, again by the university supervisors, on a one to one basis using the more articulate members of the respondents who had completed activity analysis, and the discussion groups. During these final interviews, each of the tasks listed in the activity analysis, was discussed in depth.

ACTIVITY	Time start AM/PM	Time ended AM/PM	Would you call this particular activity.. **W.** Work? **L.** Leisure? **B.** Both? **N.** Neither?	Do you feel this household activity is..... **P.** Pleasant **T.** Tiring **B.** Boring **S.** Satisfying **D.** Difficult **U.** Unpleasant **F.** Frustrating **NOF.** No feeling one way or another	Who, if anyone is helping you with this..... **NO.** No one **H.** Husband **SO.** Son **D.** Daughter **DH.** Daily Help **R.** Relative **N.** Neighbour **F.** Friend **CHF.** Child's friend **DN.** Does not apply	YOUR COMMENTS
			CIRCLE	LETTERS THAT	APPLY	
GOT UP	7:15	7:16	W L B N	P T B S D U N NOF	NO H SO D DH R N F CHF DN	
MADE COFFEE	7:16	7:20	W L B N	P T B S D U N NOF	NO H SO D DH R N F CHF DN	
SET BREAKFAST TABLE	7:20	7:23	W L B N	P T B S D U N NOF	NO H SO D DH R N F CHF DN	
GOT DRESSED	7:23	7:35	W L B N	P T B S D U N NOF	NO H SO D DH R N F CHF DN	
MADE BED	7:35	7:36	W L B N	P T B S D U N NOF	NO H SO D DH R N F CHF DN	
TIDIED BEDROOM	7:36	7:40	W L B N	P T B S D U N NOF	NO H SO D DH R N F CHF DN	
WOKE CHILDREN	7:40	7:42	W L B N	P T B S D U N NOF	NO H SO D DH R N F CHF DN	
LOADED WASHING MACHINE	7:42	7:45	W L B N	P T B S D U N NOF	NO H SO D DH R N F CHF DN	
HELPED DAUGHTER DRESS	7:45	7:47	W L B N	P T B S D U N NOF	NO H SO D DH R N F CHF DN	
MADE BREAKFAST	7:47	8:00	W L B N	P T B S D U N NOF	NO H SO D DH R N F CHF DN	

FIGURE 11.6 QUESTIONNAIRE FOR ACTIVITY ANALYSIS

The data gathered was coded, and by means of a computer programme, cross tabulations were run which ensured maximum utilisation of the information.

11.4.2 Screening Procedures (E.S.M.E.)

The proposed overall procedure to be used, designated E.S.M.E. (External Searching and Multistage Evaluation) in searching and screening new business opportunities is shown in Figure 11.7.

After finding new ideas, technologies and products using the sources described in Tables 11.10 and 11.11, a multistage screening procedure was established of which the first stage was the panel reviewing each idea individually. The panel was formed of senior management from Johnson Wax Ltd and consisted of the following personnel:-

European Region R & D Director (Technical)

European Region Area Director (Marketing)

European Region Acquisition and Diversification Manager (Business/Financial)

European Product Research Manager (Technical)

European Marketing/Sales Training Manager (Personnel/Marketing)

Due to the time period that the pilot study covered - 8 months - it was believed necessary for this panel to convene at approximately monthly intervals to avoid an excessive committment and to avoid saturation with too many varied ideas coming forward at one time. Those products that were felt to be of likely interest by consensus or majority view were passed to the 2nd stage for interactive judgemental assessment which was run as a Delphi exercise.

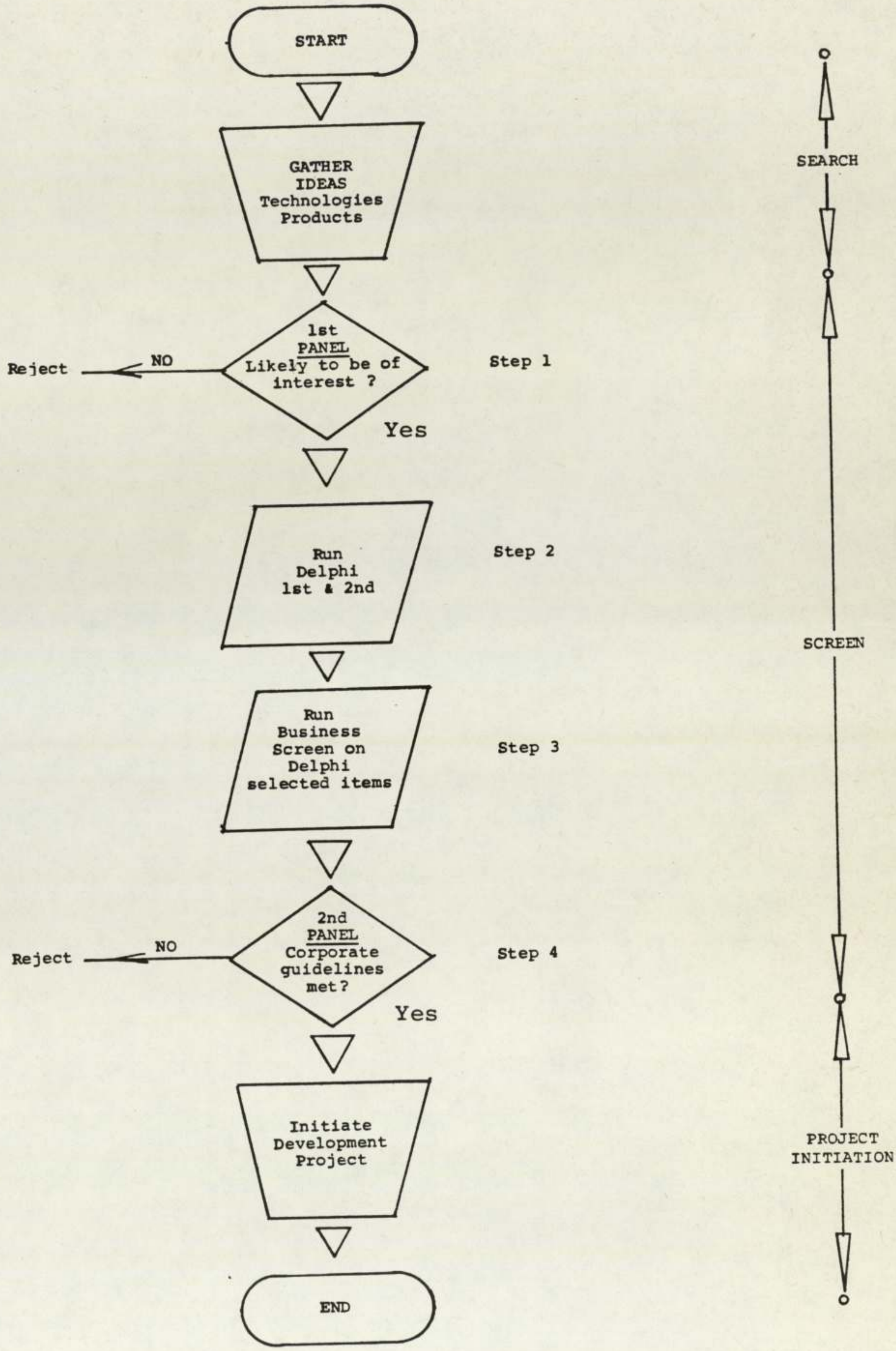


FIGURE 11.7 E.S.M.E. PROCESS

The Delphi exercise was organised to involve a broad cross section of European interests (in order to provide a widespread viewpoint and committment) for judging the likely success of the results of the first panel screen. An essential feature of this stage of the evaluation procedure is the involvement of Europe from a technical and marketing viewpoint. In particular this represents the major marketing input to the procedure, whose committment as explained in Section 11.4.2, is an essential feature of any new product development.

The Delphi technique adopted follows the conventional procedures described in Chapter 5 but was modified to permit a more rapid and concise response from those involved in the exercise. Communication was carried out by telex in order to satisfy both objectives and the technique is therefore designated Telex Delphi Analysis. The justification for this approach is for two main reasons:

(a) Past experience has showed that in order to obtain an assured and rapid response from marketing personnel, the minimum of business data and detail should be requested.

(b) The use of the telex system makes word economies necessary because of cost (187).

The round 1 Delphi questionnaire is exemplified in Figure 11.8. The results of the second round questionnaire are included in Chapter 12. A typical example of the 1st and 2nd round Delphi results showing the developments that occurred is given as Figure 11.9.

NEW TECHNOLOGY SEARCH   PART I
==============================

TO : MARKETING MANGERS U.K., FRANCE, GERMANY, ITALY, SPAIN

THE NEW TECHNOLOGY/PRODUCT IDEA DESCRIBED IS SUBMITTED FOR YOUR COMMENTS :-

DESCRIPTION (SERIAL NO) _______________ DATE ___________________
POSSIBLE APPLICATION

PLEASE CONSIDER A) WHETHER THE TECHNOLOGY WOULD HAVE A POSSIBLE APPLICATION IN YOUR MARKET.

B) TO WHAT OTHER IDEAS/APPLICATIONS MIGHT THIS TECHNOLOGY BE EXTENDED.

COMMENTS

RETURN TO JMC ROBERTS, MILTON PARK

FIGURE 11.8 DELPHI ANALYSIS FIRST STAGE

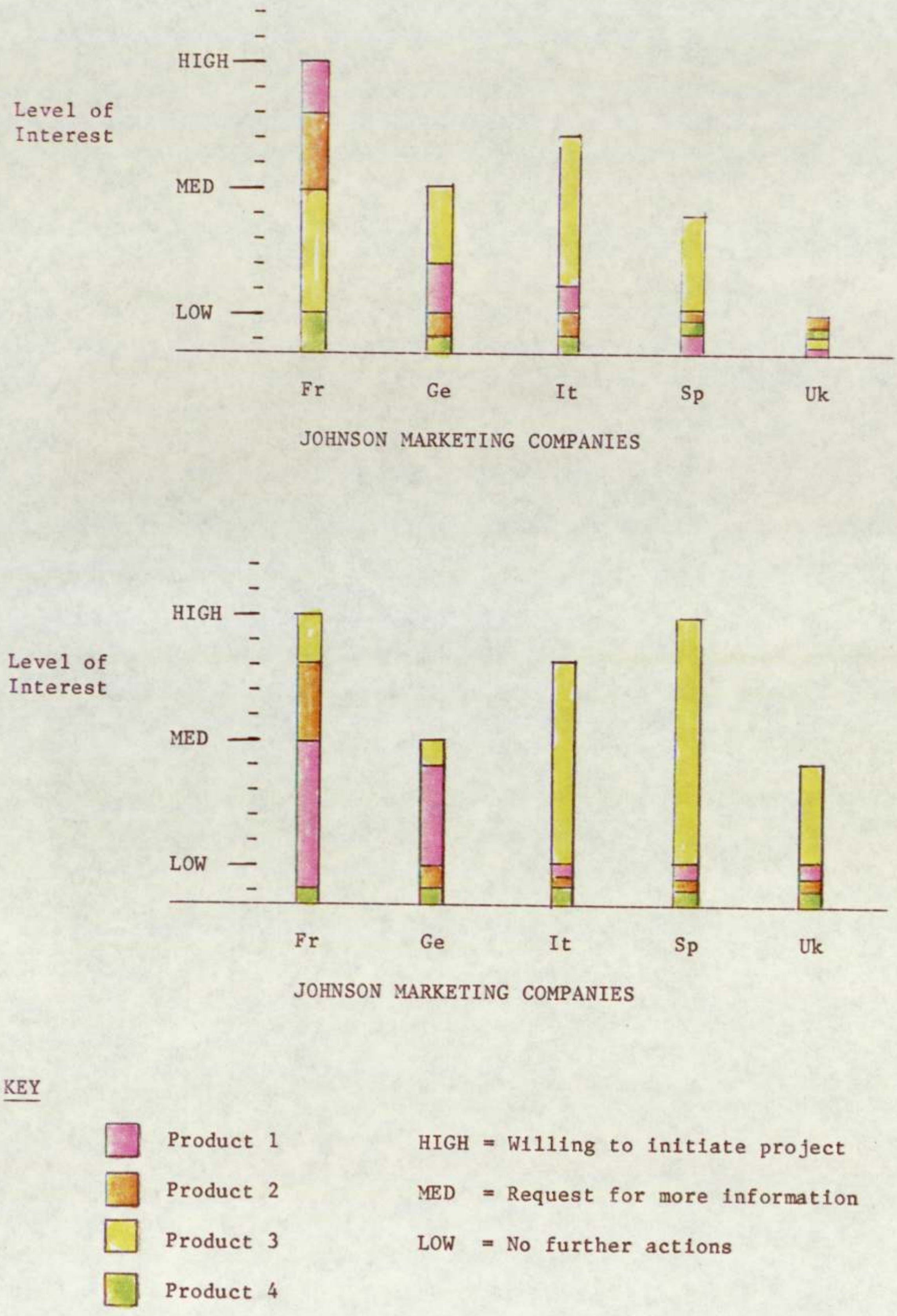


FIGURE 11.9 EXAMPLE OF 1ST AND 2ND STAGE DELPHI ANALYSIS

The positive results from the second round Delphi analysis were then subjected to a business analysis to measure potential and profitability and re-appraisal by a second panel. This consisted of the same members as the first panel but with a different objective which was to examine the business analysis resulsts and other technical and marketing factors in order to select a limited number of ideas for R & D development projects.

11.5 ACTION PLAN AND TIMETABLE

The proposed action plan with estimated timings and resource needs is shown in Table 11.13. This summary represents the data initially presented to the management of Johnson Wax Ltd in order to gain their approval to proceed. The proposed timetable is shown in Figure 11.10.

11.6 SUMMARY

This Chapter first reviewed the literature concerning techniques by which new product opportunities may be identified, screened and developed. The search methods were classified into three categories, (Technical, Market Research, and People methods) and by examination of these and current new product procedures used at Johnson Wax Ltd, it was concluded that additional and alternative methods would need to be initiated by R & D if company stability and growth objectives were to be achieved.

Both selected and novel search and screen procedures were then formulated into an action plan and timetable for an 8 month pilot study aimed at both verifying the proposed new methodologies and finding new products. The results of this exercise are presented with discussion in Chapter 12.

TABLE 11.13 ACTION PLAN - CONTACTS/TIMING AND ESTIMATED COST

SOURCE	TYPE OF CONTACT (S)	EST'D NO CONTACTS	EST'D TIME NEEDED IN MAN MONTHS	BUDGET COST £ '000
1) University	Letter followed by visits on selected basis.	150; 50 (1) (v)	3 - 6	5
2) Suppliers	Letter/phone, visit initially to Johnson Wax Ltd selectively to their site.	50; 20 (1) (v)	2	1
3) Store Audits	Visit to stores - 6x/year in three locations	50; 100 (1) (v)	0.5 - 1	2.5
4) UK Government Research Laboratories	Letter followed by visit	5	0.5	0.2
5) Private R & D Institute	Letter followed by visits	3	0.2	0.5
6) Consumer Research	Visits to homes.	100	)	)
	Group discussions in central locations.	30	)3-6	) 3,500
	In depth discussions in central locations.	10	)	)
7) Technology Trader	Letter/Telephone - visit to Milton Park.	10	1 unless we buy package then 10	0.5
8) Product Idea Developers				
a) In house				
(i) Marketing	Hold Discussions with GPM & PM	5	0.5	1
(ii) Ideation	Seminars at Johnson Wax Ltd	6x4	0.5	1
b) Consultants	Letter/Phone - visit to J.Wax	10	1	Nil unless we buy. If yes 10
9) Literature Review	Subscribe to various journals Follow USA developments Use 'Dialogue' and other computer information services (Blaise)	15	on going 1.5	1
10) Competitions				
a) In House	Sales Manager and staff via sales meeting and letter	6	0.2	1
b) National Advertising	Place advertisment in magazine via agency	$1\text{-}1\text{x}10^6$	0.2	2
TOTAL				< 1% R & D BUDGET

KEY 1 = letter GPM = Group Product Manager) Marketing
v = visit PM = Product Manager)

Notes Time estimates = time to gain information on ideas.
Costs = cost of obtaining information i.e. travel, research costs.

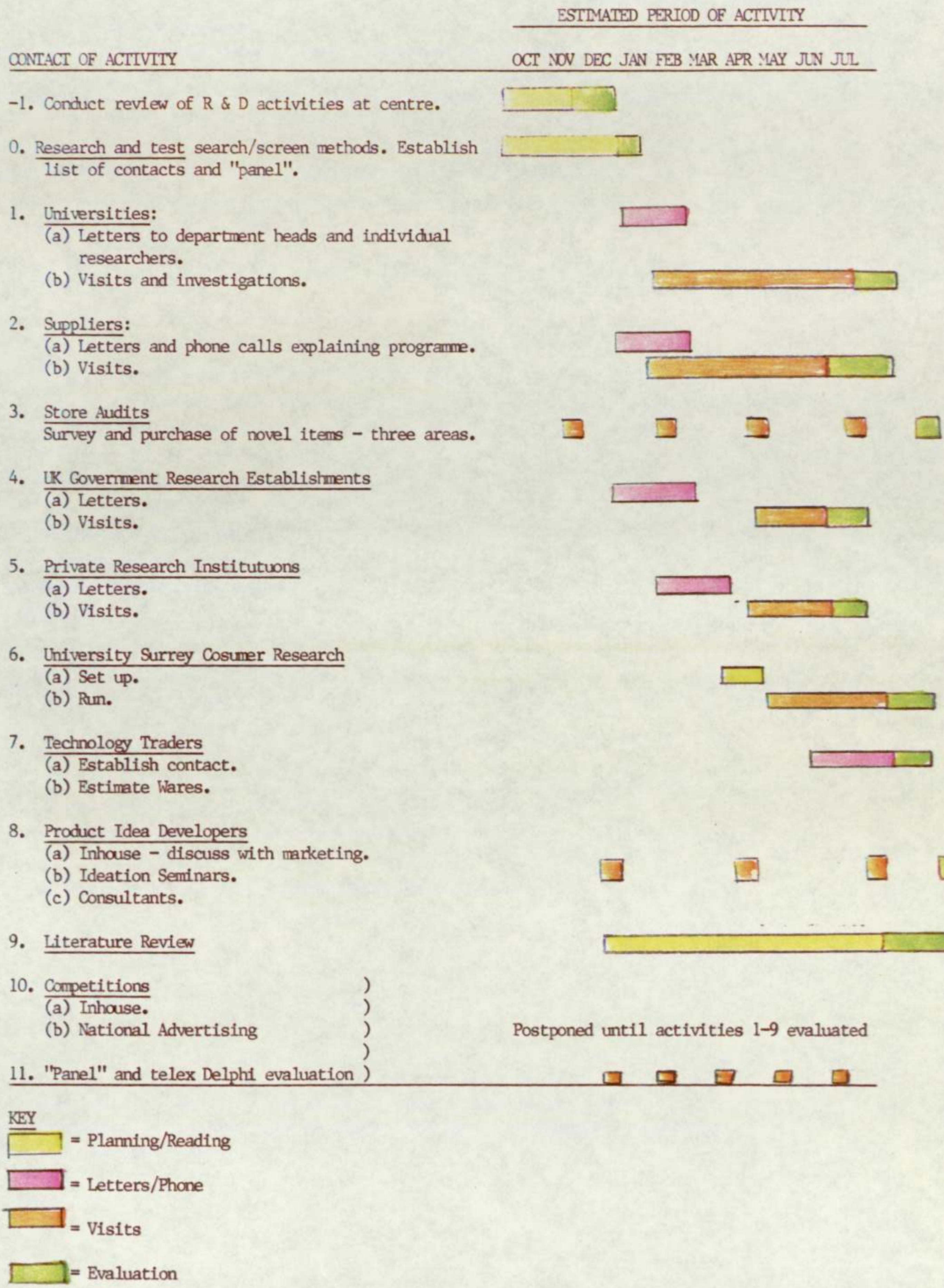


FIGURE 11.10 SEARCH FOR NEW PRODUCT OPPORTUNITIES PROPOSED TIMETABLE

CHAPTER 12: RESULTS AND DISCUSSION

12.1 INTRODUCTION

The results of the pilot study, planned and described in Chapter 11 are presented and discussed in this chapter, presented in a similar layout to maintain continuity with the previous chapter and facilitate cross referencing. The pilot study was initiated in October 1982 and the results up to and including August 1983 are included.

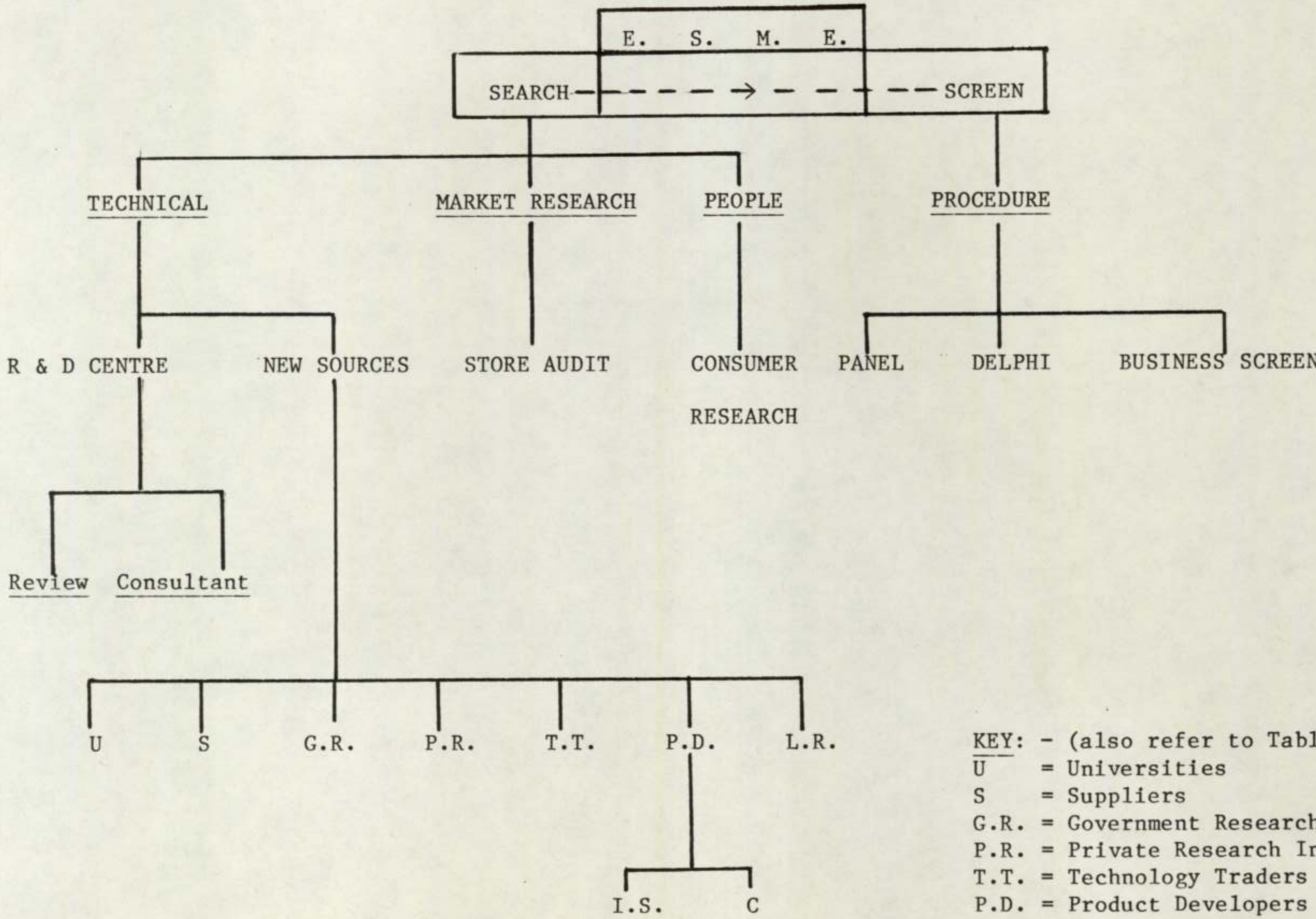
12.2 SEARCH AND SCREEN METHODOLOGIES (E.S.M.E.)

The layout of these results is illustrated in Figure 12.0.

12.2.1 Search Procedures

12.2.1.1 Review of Innovation and Creativity at the R & D Centre

Productivity was defined in two ways in Section 11.4.1.1 and was illustrated in Table 11.8. The first definition (number of new products launched/ £10^5 R & D expenditure) gave a result of £ 200,000 per product (new products as defined in Section 11.3.2). The second definition (number of approved prototypes/ £10^5 R & D expenditure) gave a figure of £100,000 per product. However this data included all new products launched by Johnson Wax Ltd irrespective of idea source and if the measurement is made on the basis of new products originating from R & D (Table 11.8) the figures are much higher i.e. £1 million per product. It was not established if these figures are typical of the company or industry in general but if this productivity is considered low with reference to product sales (Table 9.1), it is concluded that most of the



KEY: - (also refer to Table 11.10)
U = Universities
S = Suppliers
G.R. = Government Research Institutes
P.R. = Private Research Institutes
T.T. = Technology Traders
P.D. = Product Developers
L.R. = Literature Review
I.S. = Ideation Seminars
C = Consultants
N.A. = Non applicable

FIGURE 12.0 - RESULTS FROM ESME: THE SEARCH AND SCREEN METHODOLOGY

R & D resources must be expended on colour/fragrance or pack changes to existing products, or on speculative/investigative activities that are ultimately terminated without yielding a viable product. It appears that the responsibility for this situation lies outside of the R & D department who have become accustomed to operating only in response mode as discussed in Section 11.3.2.

The study of creativity revealed the complexity of the subject and that while considerable research had been completed and was underway (193), (194), there appeared to be no universally accepted technique of assessing this attribute other than by the rate of achievement of required results e.g. successful new products. However it was clear that the R & D centre needed the optimum combination of creative and product assembly personnel. If the number of sucessful new products originating from the R & D department is to increase, it was concluded either that there will need to be a rise in the numbers of creative people and/or the time available for creative activities. However as shown in Table 11.8, if the number of new products launched per year was controlled by financial constraints rather than new product availability, then perhaps the present level of effort was satisfactory.

On the assumption that more and/or better new products are required i.e. that productivity as already defined should rise, the factors likely to influence creativity were established as listed below. Those factors considered to be important with respect to the R & D centre are marked *.

* Time for creative activity

Freedom from restrictions

Freedom of choice - (research projects)

* Reception of new ideas - (by R & D/marketing management)

* Attitude of supervisor - (encouragement/assessment)

Attitude of organisation

* Recognition of creativity - (rewards/encouragement)

Physical environment - (at R & D centre)

Inter-action with others - (marketing/production personnel)

* Composition of staff - (creative/product assembly)

Method of problem solving - (techniques and support available)

Contact with project - (degree of involvement)

Type of project - (extent of challenge)

A joint examination of all aspects of innovation at the R & D centre with a consultant [M.I.C. in Appendix VII] yielded the series of recommendations shown in Table 12.1. The main emphasis is on improving motivation by concentrating on `recognition´ and `achievment´ factors.

12.2.1.2 Investigation and Use of New Technical Sources

Virtually all external contacts with potential sources of ideas/technologies/products, were initially made by letter and although more than fifty letters per week were possible, a practical limit of ten was used which anticipated the rate of reply and permitted a rapid response. Each initial communication contained a booklet describing Johnson Wax Ltd in terms of diversity of interests, level of business, size, structure and location. The responses obtained varied considerably according to source and the overall picture in terms of time taken, quantity and quality of ideas/technologies/products is shown in Figures

TABLE 12.1 MAIN RECOMMENDATIONS FOR IMPROVEMENT OF INNOVATION AT THE R & D CENTRE

1. Establish a large commitment to innovation process development throughout the company, with clear support from the top executives.

2. Provide opportunities for everyone to learn about the innovation process, e.g. why needed how it works and the benefits.

3. A nominal innovation budget should be set aside for long term work allocated by senior management.

4. Set up a small working group to develop an incentive scheme aimed at increasing innovation.

5. Publication of articles at conferences and in journals should be encouraged.

6. Organise in-house conferences/seminars for training, dissemination of information and explaining the operations of different parts of the company.

7. Develop maximum confidence between all levels of staff by greater interaction on social and professional levels. This is only likely to be effective in a relatively small organisation like Milton Park.

8. Develop an in-house publication to draw more attention to new ideas and products with personality profiles and prize-winners.

9. Set up a working group to examine the feasibility and "modus operandi" of mobility between research, manufacturing and administrative centres. This should ideally include one representative from each centre in each country, although costs may impose restrictions such as geographical constraints.

10. Redeploy creative and innovative talent into areas which can benefit most from such talents [see also 7. above].

11. Use idea generation sessions sparingly and to best effect by careful planning to maximise interest, enthusiasm and opportunity. Provide follow-up sessions for feedback.

12. Traditional "rights" may need to be sacrificed, at least in part, but with some compensation. An example is marketing where, apparently, much of the kudos is laid unjustifyably for the successful launch of a new product.

13. Encourage informal creativity/innovation by group activities. Exploit good personal and working relationships and discourage fruitless activities.

14. Involve outside but sympathetic individuals/organisations to occasionally assess research programmes and current activities. An independant objective judgement can often prove invaluable

15. Establish a formal idea screening/assessment procedure.

12.1, 12.2 and 12.3. The quality of ideas in this analysis were taken to be those which were screened favourably in via the E.S.M.E. process shown in Figure 11.7. Further specific information is presented below and in Table 12.2.

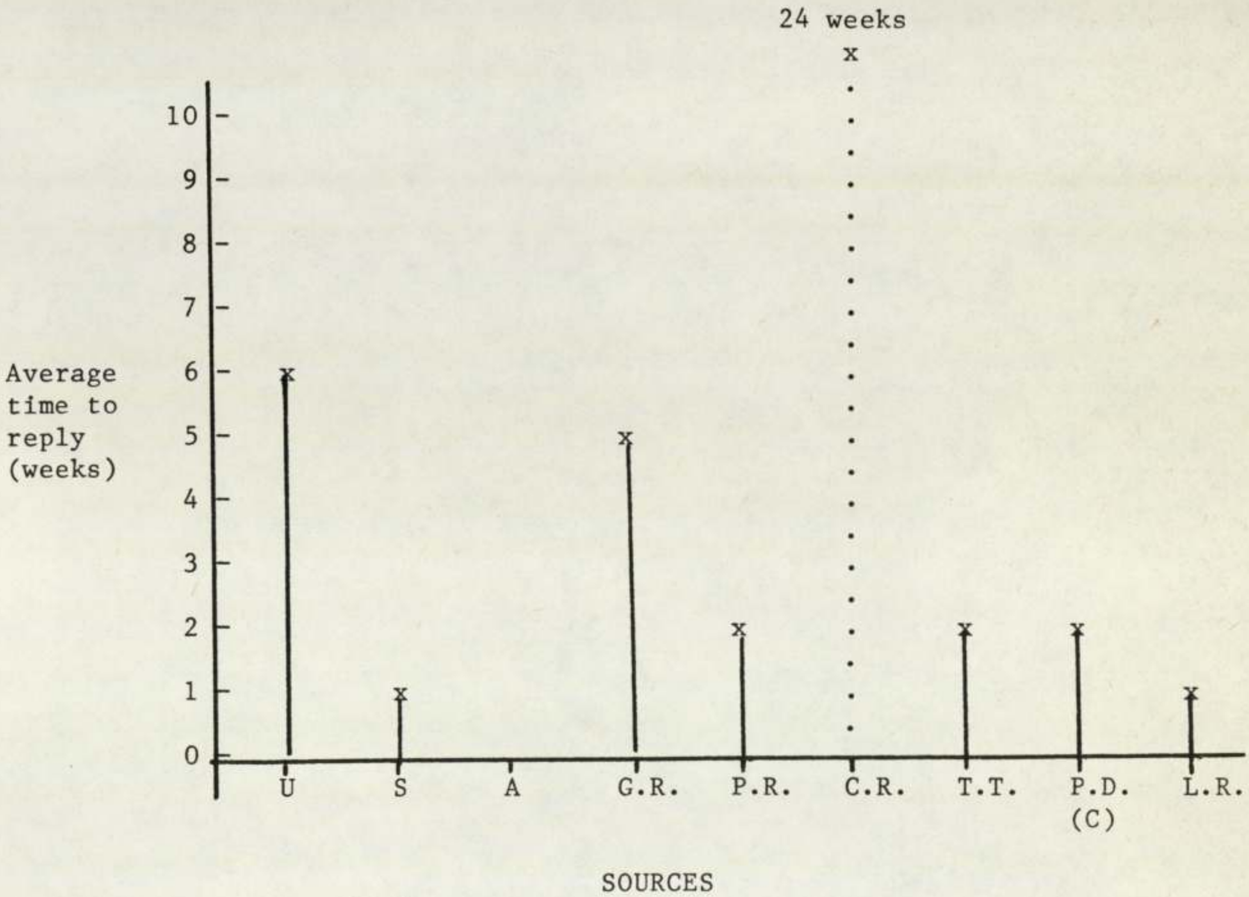
Universities (U): Using the directories of research at UK universities (181), (182) a contact listing of 261 addressee's was compiled of which 100 were actually approached as shown in Table 12.2. This selected list and the people contacted are presented in Appendix VI of this thesis. In general, slow responses were obtained from universities for a variety of reasons namely:-

* Incomplete, inaccurate and outdated university research directories.
* Availability of academic personnel.
* Large numbers of academic personnel involved.
* General lack of motivation to work with industry.
* General failure to appreciate the potential value to industry of academic research.

Regretfully it was found to be impossible to pre-screen information from university contacts on the basis of the their written or telephoned responses and also due to a general unwillingness by the contacts to divulge any detailed information except on a face to face basis. The ideas resulting from this exercise are described later in Section 12.3 and the type and percentage of response to the contacts by letter in Table 12.2.

As a source of ideas they ranked fourth in terms of quantity and third qualitatively (See Figure 12.2, 12.3 and Table 12.6) and two product ideas have been progressed to the prototype stage (see Table 12.17). In addition an Interdisciplinary Higher Degree (I.H.D.) project is underway. Figure 12.4 indicates the success rate by source showing universities ranked equal second with the store audit.

Suppliers (S): All 31 industrial companies contacted responded with speed and enthusiasm, telephoning their replies within one week and arranging a meeting within two weeks. This source proved the most fruitful both quantitatively and qualitatively.



Symbols as in Figure 12.0

FIGURE 12.1 RESPONSE TIMES

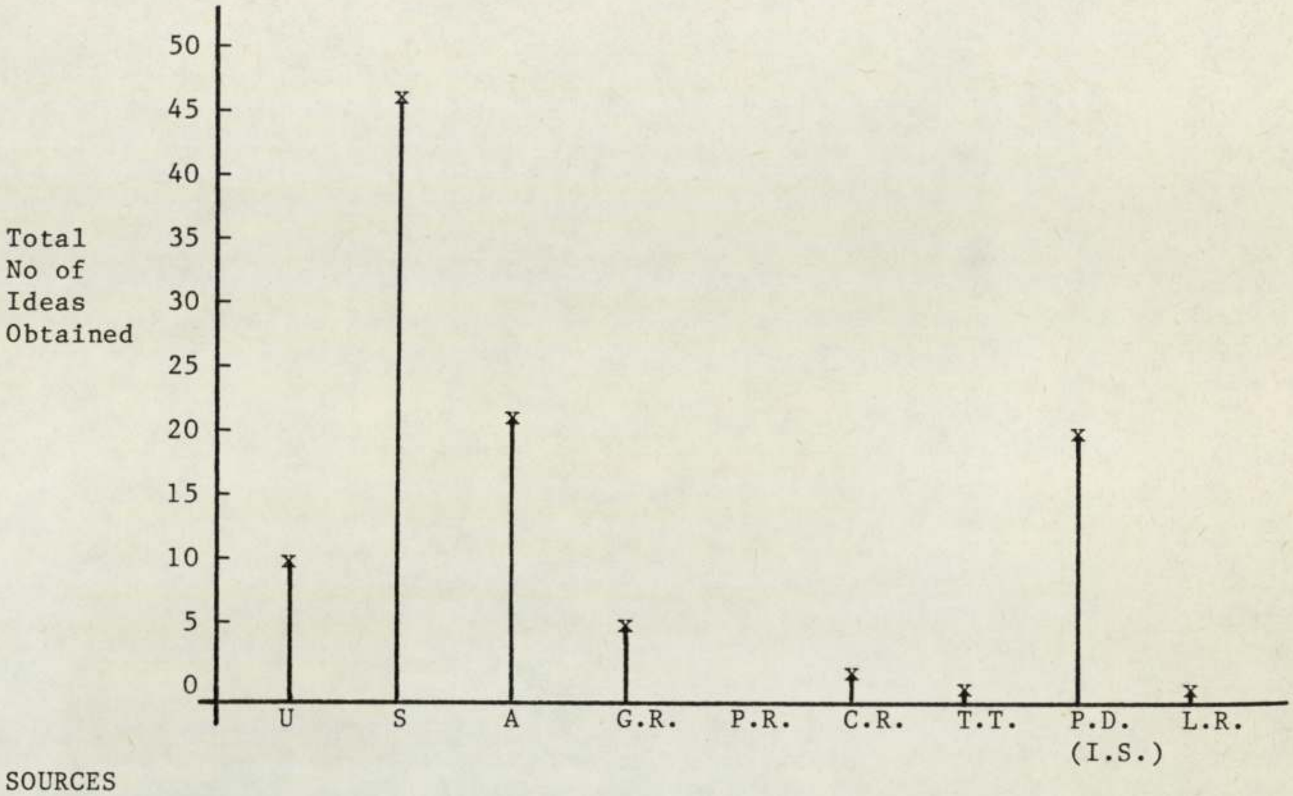


FIGURE 12.2 NUMBERS OF IDEAS BY SOURCE

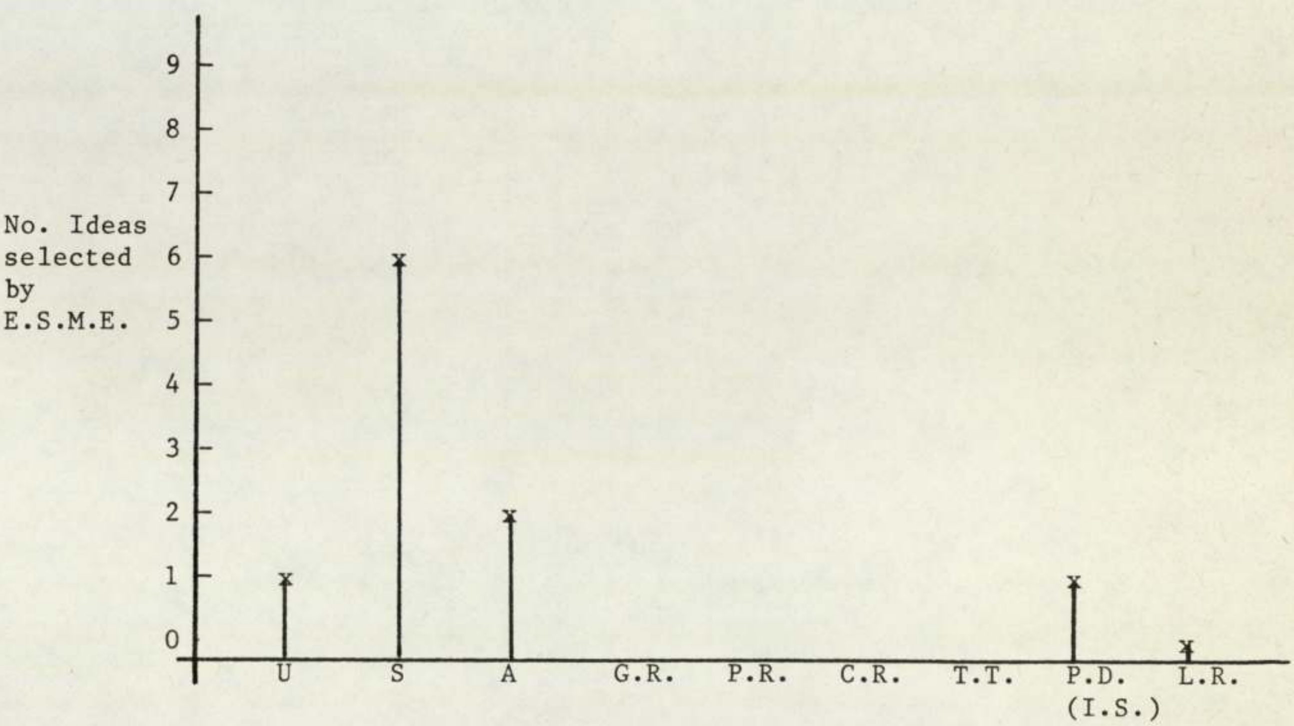


FIGURE 12.3 QUALITY OF IDEAS BY SOURCE

	U	S	A	G.R.	P.R.	C.R.	T.T.	P.D.	L.R.
"Success Rate"	1/11	6/45	2/23	0	0	0	0	1/18	0
=	0.09	0.13	0.08	0	0	0	0	0.06	0

FIGURE 12.4 "SUCCESS RATE BY SOURCE E.S.M.E.

TABLE 12.2 UNIVERSITY/POLYTECHNIC CONTACTS AND RESPONSE

University Department	Type Contact	No.of Contacts	No.Responses	% RESPONSE Of Contacts	% RESPONSE Of Total
Agriculture	Dept. Head	2	0	0	0
Biochemistry	Dept. Head	2	0	0	0
Biology	Dept. Head	6	1	17	1
Business Studies	Dept. Head	3	3	100	3
Chemical Engineering	Individuals	4	2	50	2
Chemistry	Dept. Head	10	3	30	3
Computing Science	Dept. Head	3	3	100	3
Corrosion Science	Dept. Head	1	1	100	1
Electrical Engineering and Electronics	Dept. Head	3	0	0	0
Fibre Science and Textile Industries	Dept. Head	2	1	50	1
Food Science	Dept. Head	2	0	0	0
Graphic Design	Dept. Head	2	1	50	1
Home Economics	Dept. Head	2	1	50	1
I.H.D. Scheme	Dept. Head	1	1	100	1
Industrial Design	Dept. Head	2	0	0	0
Innovation Centre for Management Science	Dept. Head	1	1	100	1
Mathematics	Dept. Head	4	0	0	0
Materials Science	Dept. Head	2	0	0	0
Mechanical Engineering	Dept. Head	3	1	33	1
Medical Engineering	Dept. Head	2	0	0	0
Metallurgy	Dept. Head	3	0	0	0
Pharmacy	Dept. Head	5	0	0	0
Physics	Dept. Head	4	0	0	0
Powder Technology	Dept. Head	1	1	100	1
Printing Technology	Dept. Head	1	1	100	1
Safety and Hygiene	Dept. Head		0	0	0
University Industrial Liaison Services	Liaison Officer	25	25	100	25
	TOTALS	100	48		

UK Government Research Institutes (GR): The selected list is shown in Appendix VI which totals 14 establishements all of which were contacted. Although a 100% response was obtained over time, the type of response pattern from these institutes was comparable to that from universities probably for the same reasons that is lack of motivation. During the course of the pilot study no results were obtained which could be of future use to Johnson Wax Ltd. However, bearing in mind the wide range of activities often controlled via the British Technology group (182), it is likely that further effort will yield results. A starting point might be to gain accurate information on the content of the research at the various institutes and the persons conducting it as the publications (181) currently available have proved to be inadequate in this respect.

Private Research Institutes (P.R.): Seventeen institutes were contacted and although the 100% responses from the above institutes were rapid, no useful material has been found to date. In fact most of the institutes contacted (See Appendix VI) were either engaged on long term research work which they could talk about and invite a Johnson Wax Ltd subscription; and short term private work which was confidential. In general their activities were outside the interests of Johnson Wax Ltd or were available to so many competitors that there seemed to be little chance of gaining a competitive edge. They nevertheless represented a potentially useful means of solving specific problems particularly connected with testing long term effects of Johnson Wax Ltd products in the home e.g. the effect of carpet cleaners on wool carpets. This is considered further in Chapter 14.

Technology Traders (TT): Although all of the nine companies contacted (see Appendix VI) responded quickly, they were primarily interested in selling technologies and products acquired from international sources usually at a considerable mark up. Only one contact dealing in non-prescription pharmaceuticals had products which came close to meeting the programmes objectives but during a preliminary discussion it became apparent that much of the offered technology was at best a marginal improvement over that already marketed by others. No products were subsequently obtained but this is an area where further work would be needed to complete the evaluation.

Product Idea Developers (P.D.): The inhouse ideation seminars (I.S.) involving both R & D and marketing staff occasionally supplemented with advertising agency personnel, proved to be effective. Due to time resource constraints, only the laundry and household cleaner categories were progressed within the pilot project. The results are presented in Section 12.3 together with other new product ideas derived from inhouse ideation (I.H.) at the R & D centre.

Although a list of 7 consultant "product developers" was compiled, contact with two of them revealed the high cost of consultations (minimum £10,000) which prevented this source being studied further during the pilot programme. The terms for co-operation were however established and are summarised in Table 12.3 together with an estimation of external and internal costs.

Literature Review (L.R.): Literature reviews were conducted both via the new product publications listed in Tables 11.12 and for patents via the online computer search systems, Dialogue and Blaise. To date the results have been discouraging for the following reasons:-

TABLE 12.3 METHOD OF WORKING WITH CONSULTANT PRODUCT IDEA DEVELOPERS

STEP	Time Req´d (months)	ACTIONS
1.	1/4	Brief Product Developer on consumer market of interest as well as the experience and skill of Johnson Wax Ltd.
2.	1	Product Developer writes up his understanding of the brief then presents it together with a cost estimate to Johnson Wax Ltd.
3.	2	On receiving approval to proceed, the Product Developer surveys the market of interest and presents findings.
4.	6	Creative sessions commence with Product Developers personnel as leaders and Johnson Wax Ltd personnel (marketing/R & D/Designers) as initiators.
5.	2	Concept established and tested with consumers via storyboards; animatics.
6.	3	Prototype samples prepared and consumer tested for efficacy, and intention to purchase.
7.	1	Advertising strategy developed often in conjunction with an advertising agency.
8.	6	Test market product (via limited sales in part of UK). If successful it is extended to a national basis and Product Developers work is done. If not the process returns to Step 4, theoretically until the product is successful or Johnson Wax Ltd lose confidence in the Product Developer.
TOTAL> 21 MONTHS		COSTS: external £10 - 20,000; internal £10,000

(a) New product literature: most information is outside the Johnson Wax Ltd sphere of interest or already known. This is not an effective search method.

(b) Patent searching: searching by "Dialogue" or "Blaise" is very time consuming because it is difficult to give the computer precise search co-ordinates such that large numbers of patents have to be read and discarded. In addition considerable difficulty was encountered in understanding the purpose of many patents which probably needed a professional appraisal. Therefore this route was considered to be ineffective with the resources available.

Competitions: After estimating both the out of pocket and administration costs, reviewing previous company experience and making comparisons with other search methods, it was decided to exclude the competitions search method from the pilot study i.e. until all other methods had been evaluated.

12.2.1.3 Market Research - Store Audits

The store audit programme was found to be easy to conduct yet fruitful in terms of identifying new opportunities for Johnson Wax Ltd in existing product categories and approved new ones. A frequency of six times per year per area (5 were completed in 11 months) was found to be practical and capable of continually yielding new product ideas. This source ranked second both in terms of number and quality of ideas as shown in Figures 12.2 and 12.3.

12.2.1.4 People Techniques - Consumer Research

This study proved to be of more value in establishing the direction of new product development rather than as a source of new products. It was completed over a six month period and the major findings are summarised in Tables 12.4 and 12.5.

As a quantitative source of new ideas it ranked fifth i.e. near the lowest

TABLE 12.4 CONSUMER RESEARCH - ACTIVITY ANALYSIS

ACTIVITY	% WORKING DAY	LEVEL OF INTEREST #	PERCEIVED IMPORTANCE #	AREAS OF JWL PRODUCT
Food Preparation	40	L - M	H	NO
Child Minding	35	M	H	NO
Laundry Process	15	L	H	NO
Cleaning *	5	L	H	YES
Polishing	2	L	M	YES
Leisure Time	2	H	M - H	NO
Personal Care	1	M - H	H	NO

Notes

The above results were derived from the activity analysis diaries described in Figure 11.6.

Consumers made no mention of Air care products and this is believed to be significant in terms of their perceived importance and contradictory to the amount of effort currently devoted to this category by Johnson Wax Ltd.

* Most cleaning tasks involved consumer products not currently marketed by Johnson Wax Ltd namely:-

Disinfectants
Dishwashing Detergents
Floor Cleaners
WC cleaners
Window Cleaners

Key:

H	=	High
M	=	Medium
L	=	Low
JWL	=	Johnson Wax Ltd

TABLE 12.5 CONSUMER RESEARCH IN DEPTH INTERVIEW RESULTS

RESULT	PRODUCT CATEGORY	COMMENTS
1. Bath cleaner product which prevents scum.	Cleaners	Already exists
2. Improved dispenser for dish wash liquid.	Cleaners	Already exists
3. Cream cleaner which does not leave powder residues.	Cleaners	Current R & D project at Johnson Wax Ltd.
4. Less foamy cream cleaner	Cleaners	Feasible
5. Non clog lids for cream cleaners.	Cleaners	Already exist.
6. More effective oven cleaners especially on glass doors.	Cleaners	Difficult to achieve without increasing toxicity.
7. Non-rust "Brillo" pads	Cleaners	Already exist - via plastic pan scrubbers
8. More effective smear free window cleaner	Cleaners	Current R & D project at Johnson Wax Ltd.
9. Non silicone cleaners for video/micro computers/games.	Cleaners	Feasible idea - also obtained from a supplier with prototypes.
10.Special duster which attracts dust from sensitive surfaces.	Furniture	Current R &D project at Johnson Wax Ltd.
11.Water resistant packaging for soap powders.	Laundry	A matter of cost
12.Freezer deicer spray with scraper in lid	New	New product idea.
13.Dish drying cabinet.	New	Already investigated. Problems of space in kitchen, also dish-washers can do this.
14.Indoor plant nutrient products.	New	Current R & D project at Johnson Wax Ltd.
15.Pet repellant sprays.	New	Already exist.

and none of the ideas were selected by E.S.M.E. However, it is regarded as being important in terms of presenting a picture of household consumer behaviour and the relative importance assigned to home tasks. Table 12.5 shows that the current range of products provided by Johnson Wax Ltd do not relate to tasks which account for a major part of the housewife's day nor are they ranked with particular importance. In addition, household tasks which are considered to be important and command much of the housewife's time and buying power involve products as yet unexplored by the company. The overall results by source, category and ranking are shown in Table 12.6.

12.2.2 Screening Methodology

12.2.2.1 1st Screen by Panel

This panel evaluated all the ideas from the search programme, making majority acceptance decisions when necessary on the basis of business performance; novelty; market interest; difficulty of implementation (judged by the company skills inventory listed in Table 10.1); and level of accord with declared corporate strategy. The results of the panel selection are reviewed in Section 12.3 and the only problem encountered with this first screen was the difficulty of regularly assembling the panel members for a meeting and ensuring that they had previously read the material for consideration. Meetings were held at six week intervals because of this logistic problem, which was partly overcome by arranging future meetings at the end of a current meeting and by circulating the material one week in advance of a panel session. Six meetings in total were held with all members present during which 102 ideas were reviewed. Each meeting lasted less than two hours and it was found to be relatively easy to reach a majority decision.

TABLE 12.6 SEARCH RESULTS BY SOURCE ANALYSIS
INCORPORATING ALL IDEAS

	% OF IDEAS BY SOURCE IN CATEGORY									
BUSINESS CATEGORY	U	S	A	G.R.	P.R.	C.R.	T.T.	P.D.	L.R.	TOTALS
Air Care	8	69	15					8		100
Cleaners	6	25	19					50		100
Furniture Care	17	17	50					16		100
Insecticides	22	56	11					11		100
Laundry Care			37					63		100
Metal Care	20	20	60							100
Miscellaneous	14	55	22			9				100
Personal Care	8	62	23				7			100
Pharmaceuticals	40	60								100
Overall	11	45	23			2	1	18		100
Original Ranking: (Table 11.10)	1	2	3	4	5	6	7	8	9	
Pilot Study: Ranking-Nos ideas	4	1	2	-	-	5	6	3	-	
Pilot Study: Ranking via E.S.M.E.	3	1	2					4		
"Success rate" Ranking	2 =	1	2 =					3		

12.2.2.2 2nd Stage - Delphi Analysis

The Delphi analysis was slow to get started due to an early misunderstanding of the type of replies required: some respondents spent too much time at first in the preparation of their answers, sometimes actually commissioning preliminary market research work. This had the overall effect of delaying the first round and losing the interest of those respondents who had replied promptly. After several Delphi rounds however, the system seemed to operate more smoothly and settled down to a frequency of 5 items being evaluated each month. It was found that the choice of product mix had to be carefully selected by the panel prior to the first round, in order that each participating Johnson company would be likely to find a product of interest otherwise the level of interest would fall to the point of failing to respond.

Initially summarised written results from the first round were presented to the respondents by telex and at four pages this proved to be too lengthy a document. It was thus replaced by a simplified histogram method which reported assessments by country, grading them according to interest e.g. High, Medium or Low. Typical results are shown in Figure 12.5.

12.2.2.3 3rd Stage - Business Assessment and 2nd Panel

The selected ideas from the Delphi excercise were then subjected to a business analysis, which is described in detail in Appendix VIII. This was run on the selected items prior to re-convening the 2nd panel for the third stage of the evaluation. During this session the panel discussed the compatibility of the selected items with corporate objectives and then by concensus viewpoint initiated R & D development projects. In practice it was found that the majority of products selected by Delphi also gave a satisfactory result during the business screen.

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NEW TECHNOLOGY - DELPHI PART ONE HISTOGRAMS
--------------------------------------------

DEFINITIONS : HIGH = E.C.P. I LEVEL
              MEDIUM = REQUEST FOR MORE INFORMATION
              LOW = NO FURTHER ACTIVITIES


WATER SOLUBLE FRAGRANCES
========================                                   4/5

HIGH        :
            :
            :
            :
MEDIUM      :     X
            :     X
            :     X
            :     X
LOW         :     X        X         X        X        X
         ------------------------------------------------------
              FRANCE    GERMANY    ITALY    SPAIN    U.K.
```

FIGURE 12.5 TELEX DELPHI RESULTS

12.3 NEW IDEAS AND SELECTED PRODUCTS

12.3.1 1st Panel Screen

All of the ideas technologies and products generated by the search procedures detailed in Chapter 11 are shown in Tables 12.7 to 12.15, reported in the format in which they were presented to the panel i.e. by product category and source. The results of the 1st panel screen indicating those items selected for the second stage (Delphi analysis) are reported in column 1 - Table 12.17. As shown this reduced the product ideas from 102 to 24.

12.3.2 Delphi Analysis Screen

The ideas/technologies/products selected by the Delphi analysis screen are also presented, in column 2 - Table 12.17. There is a further reduction of ideas from 24 to 18, with the 18 items shown representing the material subjected to the business screen and presented to the second panel. The significant feature of this stage of the exercise is the involvment of an international marketing forum which represents the major marketing input to the evaluation procedure. While the reduction in number of ideas being considered is not significant in this case study, this is seen more as validation of the first stage screening. Future exercises may produce somewhat different results, but this stage of evaluation is seen as an essential step in the screening procedure by involving marketing personnel whose committment to development of new ideas is a prerequisite to successful product evolutions.

12.3.3 Business Screen

The 18 items from the Delphi analysis were processed via the business screen assessment software described in Appendix VIII with results presented in Table 12.16. Maximum operating profit and the corresponding advertising/promotional spend is shown expressed as a percentage of anticipated gross sales value. Selected items are listed in column 3 - Table 12.17.

12.3.4 2nd Panel

Here the 18 items were reconsidered by reviewing the result of the business screen and approved material was then passed to the R & D centre as a development project. The ideas reaching this status are shown in the final column of Table 12.17 together with their source of origin showing that the E.S.M.E. procedure has found and screened 102 items down to 11 projects.

TABLE 12.7 NEW OPPORTUNITIES SEARCH - AIRCARE

DESCRIPTION	SOURCE	STATUS
1. Humidifier/Air Freshener: adds moisture and fragrance to living rooms via basket on radiator.	Inhouse Ideation	Prototypes available
2. Double action aerosol: equipped with absorbent cap giving lasting action.	Supplier	Prototypes available
3. Aerosol airfreshener with soluble fragrance components in overcap, mixing valve and soluble aqueous base in conventional can. Multiple fragrance options.	Supplier	Drawings available
4. Mood fragrances for home use	Supplier	Awaiting prototypes
5. Telephone air freshener/sanitiser.	Audit	Prototypes available
6. Vac fresh - perfume impregnated paper pads for insertion into vacuum cleaner bags.	Supplier	Prototypes available
7. In bowl WC cleaner/air freshener - twin compartment pad and block.	Supplier	Drawings only
8. Binfresh - airfreshener/deodoriser/insecticide for use in garbage bins.	Audit	Prototypes available
9. Perfume impregnated plastics:)plain)hydrophilic polymer)	)Supplier	Prototypes available
10. Electret polarised polymeric fibres/cloths: air cleaning.	University	Already adapted by competitor.
11. Colour change useage indicator based on enzymes starts green - - -> red - suggested as use up cue for non aerosol airfresheners.	Supplier	Prototypes available

TABLE 12.8 NEW OPPORTUNITIES SEARCH - CLEANERS

DESCRIPTION	SOURCE	STATUS
12. 2 phase liquid bleach containing fragrance in immiscible upper layer.	Supplier	Prototype available
13. Effervescent bleach cleaning tablets.	Supplier	Prototype available
14. New form of stable bleach - chlorine donor.	University	Received preliminary information
15. Kitchen carpet care product	Inhouse Ideation	Idea Only
16. General Carpet protector product	Inhouse Ideation	Idea Only
17. Wool carpet care product	Inhouse Ideation	Idea only
18. Self heating cleaners for carpets	Inhouse Ideation	Concept details available
19. Protective resins for ceramic or hard surfaces based on hydrocarbons e.g. "Bathshine";	Supplier	Prototype bath version available
20. Silicone protective/non stick ceramic coating for new WC cleaner system.	Inhouse Ideation	Prototypes available
21. Self heating aggressive cleaners for drains and heavy duty applications (metabisulphate/ peroxide.	Inhouse Ideation	Prototype available
22. Enzyme drain cleaner-long lasting; highly effective.	Inhouse ideation	Prototype available
23. Crushed Hypol (Urea/Formaldehyde foam powder): high water loadings posible.	Supplier	Materials available
24. `Hypol´ foam sponge: impregnated surface cleaner, just add water.	Supplier	Prototype WC cleaners available
25. Fungicidal paint and wallpaper cleaner.	Audit	Prototype available
26. Washing up liquid - rinse free, bactericidal.	Inhouse ideation	Idea only
27. Electric iron "sole plate" cleaner .	Audit	Prototype available
28. Steam iron cleaner/descaler.	Audit	Prototype available
29. Colour change `use up´ cue indicator for cleaners based on pH.	Supplier	Prototype available

TABLE 12.9 NEW OPPORTUNITIES SEARCH - FURNITURE CARE

DESCRIPTION	SOURCE	STATUS
30. Electret cloth impregnated with polish	University	Preliminary information available
31. Compressed Air propelled furniture spray	Inhouse Ideation	Prototypes available
32. Mild abrasive polish - restores finish	Inhouse Ideation	Idea only
33. Heat and water mark remover "polish"	Audit	Prototype available
34. Scratch remover "polish"	Audit	Prototype available
35. Furniture maintenance product - makes loose joints tight.	Audit	Prototype available

TABLE 12.10 NEW OPPORTUNITIES SEARCH -INSECTICIDES

DESCRIPTION	SOURCE	STATUS
36. F.I.K. spray using low toxicity/low flammability ingredients.	Supplier	Awaiting information
37. Encapsulated insecticides giving residual or slow residual release effect.	Inhouse Ideation	Idea only
38. Insect growth regulator (hormone) for fleas; possible use on carpets/furnishings, pets.	Supplier	Prototype available
39. Aerodynamic trap for roaches and possibly house fleas and wasps.	University	Prototype available
40. Insect lures based on food and sex attractants (pheromones)	University	Prototype available
41. New synthetic pyrethroid compounds for flying insects	Supplier	Prototype available
42. New carbamate toxicant mixture for crawling insects	Supplier	Prototype available
Head lice shampoo	Supplier	Prototype available

TABLE 12.11 NEW OPPORTUNITIES SEARCH - LAUNDRY PRODUCTS

DESCRIPTION	SOURCE	STATUS
44. Bleach containing self dissolving polymer sheets for addition to washing machine.	Inhouse Ideation	Prototype available
45. Drying aid for upgrading performance of spin drier such that clothes can be ironed directly	Inhouse Ideation	Prototype available
46. Concentrated liquid laundry detergent in mini pack for holiday travel	Audit	Rejected for Europe
47. Fabric conditioning foam discs for addition to tumble drier	Inhouse Ideation	Prototypes available
48. Fabric softner and iron ease additive for washing machine.	Inhouse Ideation	Prototypes available
49. Silky finish additive - "as new feel" for washing machine.	Inhouse Ideation	Prototypes available
50. Dye for use in washing machine	Audit	Rejected for Europe
51. Steam iron additive for scale prevention/ironing ease/freshness.	Inhouse Ideation	Prototypes available
52. Iron mould remover	Audit	Prototype Available

TABLE 12.12 NEW OPPORTUNITIES SEARCH - METAL CARE

DESCRIPTION	SOURCE	STATUS
53. \`Instant´ metal polishes: Brass/Copper/Silver Sweden	Supplier	Prototype available
54. Metal cleaner based on chlorine donor compounds.	University	Preliminary information
55. Steam iron cleaner (internals).	Audit	Prototype available
56. Iron sole plate cleaner.	Audit	Prototype available
57. Tea and coffee stain remover for metal kettles and cooking utensils.	Audit	Prototype available

TABLE 12.13 NEW OPPORTUNITIES SEARCH - PERSONAL CARE

DESCRIPTION	SOURCE	STATUS
58. Foam Bath Oil in self dissolving packs	Supplier	Samples available
59. New source mild surfactants for soaps etc.	Supplier	Samples available
60. Laser flowmeter - monitoring efficacy and mildness of skin care products.	University	Prototype available
61. Roller-ball shaving lubricant (Rollashave).	Supplier	Prototype available
62. Professional strength hand soap with abrasive	Audit	Samples available
63. Skin scrub with abrasive	Audit	Samples available
64. Nail buffing sticks - clean varnished appearance without varnish - non-peel.	Supplier	Samples available
65. Impregnated toilet tissues - cleansing - antisceptic - special treatments e.g. haemorrhoids - soap	Supplier	Samples available
66. Various tissues e.g. freshen up/baby with lanolin/dry soap.	Audit	Samples available
67. Selective bacteriostatic agent for deodorant formulations - normal skin flora not affected	Supplier	Samples available
68. Anti-inflammatory agent for skin products to be used on sensitive skins e.g. after shave, after sun.	Supplier	Samples available
69. Novel three compartment aerosol - dispenser/ deodorant/cologne; fragrances etc.	Supplier	Samples available

TABLE 12.14 NEW OPPORTUNITIES SEARCH - NON PRESCRIPTION PHARMACEUTICALS (O.T.C'S)

DESCRIPTION	SOURCE	STATUS
70. Fibre bread - weight control and health food	University	Samples available
71. "Son Vital" wheat bran wafer - fibre food supplement for gastro-entestinal disorders and weight loss.	Supplier	Samples available
72. Artificial sweetener (Sulpham K) without metallic after taste.	Supplier	Samples available
73. Thermogenic drugs as slimming aids.	University	Samples available
74. Therapeutic heat pad - for arthritis relief.	Audit	Samples available

TABLE 12.15 NEW OPPORTUNITIES SEARCH - RESULTS TO DATE - MISCELLANEOUS

DESCRIPTION	SOURCE	STATUS
75. Thick bleach technology and products .	Supplier	Prototypes available
76. In tank toilet blocks with self dissolving packaging.	Supplier	Prototype available
77. Disposable WC brushes	Supplier	Prototype available
78. Washing up liquid with germicide	Audit	Samples available
79. Various paper products e.g toilet rolls/kitchen towels.	Supplier	Samples available
80. Auto product - easy grip tyres in snow	Audit	Prototype available
81. Freezer de-icer spray	Consumer research	Idea only
82. De-ionised water generator.	Audit	Prototype available
83. Antifungal wallpaper and paint cleaners (liquid)	Audit	Prototype available
84. Pet care technology (shampoo, flea treatments).	Supplier	Information available
85. Pet repellant sprays	Consumer research	Prototype available
86. Plastic wood filler in tube	Audit	Samples available
87. Self open/closing bottle	Supplier	Prototype available
88. Temperature indicator strips	University	Samples available
89. Kaufman Valve - bulk liquid dispenser ideation	Supplier/Inhouse	Prototype available
90. Dehumidifier/deodoriser unit equipped with colour cue.	Supplier	Samples available
91. `Mistlon´ - rechargeable metal compressed air spray unit.	Supplier	Prototypes available
92. `Olozon´ - Air Spray rechargeable compressed air plastic spray unit.	Supplier	Prototypes available
93. `Tissot´constant pressure discharge valve for compressed air spray units.	Supplier	Prototypes available
94. Plastic aerosol containers	Supplier	Drawings only available
95. Electrostatic spray unit for household products.	Supplier	Prototypes available

TABLE 12.15 CONTINUED

96.	Computer care products (cleaners lubricants.)	Supplier	Prototypes available
97.	Anti-glare spray for V.D.U. screens and cleaning aids for micro computers	Supplier	Samples available
98.	Special toothpaste for children with colour	Technology Trader	Prototypes available
99.	Use of micro encapsulation for deodorants, carpet cleaners, pet care products.	Inhouse Ideation	Prototypes available
100.	Glass cleaner spray - non smear, water repellent.	Supplier	Prototypes available
101.	Dry bright shoe polish with lanolin to feed leather.	Supplier	Samples available
102.	Use of I.H.D. scheme to fund basic research.	University	Application in to S.E.R.C.

TABLE 12.16 BUSINESS SCREEN RESULTS

PRODUCT & REFERENCE		MAX^M O.P. % SALES VALUE	ADVERTISING/PROMOTIONAL SPEND % SALES VALUE	ACTION
3.	Aerosol Air freshener with multiple fragrance option.	7	3	Reject
13.	Effervescent Bleach tablets	19	8	Accept
15.	Kitchen carpet care product	16	11	Accept
18.	Self heating carpet cleaner	4	10	Reject
29.	Colour change W.C. cleaners	20	9	Accept
44.	Bleach Sheets	8	5	Reject
58.	Foam Bath self dissolving pack	6	4	Reject
61.	Roller-ball shaving lubricant	18	11	Accept
62.	Hand soap with abrasive	9	3	Reject
74.	Heat pads	20	12	Accept
91.	Mistlon spray unit	3	2	Reject
92.	Olozon spray unit	15	11	Accept
93.	Tissot Valve	< Used in 92 above and 94 below >		Accept
94.	Plastic Aerosol	18	14	Accept
95.	Electrostatic Spray	5	1	Reject
99.	Microencapsulation	12	9	Accept

TABLE 12.17 IDEA SELECTION BY E.S.M.E.
(Numbers refer to ideas in Tables 12.7.- 12.15)
(Letters as in Figure 12.0)

1ST PANEL SELECTIONS FOR DELPHI	DELPHI SELECTIONS	2ND PANEL BUSINESS SCREEN SELECTIONS	SOURCE	ADOPTED
Air Care				
1	-			
3	3	-		
5	-			
Cleaners				
13	13	13	S	
15	15	15	A	
18	18	-		
29	29	29	S	
Furniture Care				
NIL				
Insecticides				
39	-			
Laundry				
44	44	-		
Personal Care				
58	58	-		
60	60	60	U	60
61	61	61	S	
62	62	-		
Pharmaceuticals				
71	-			
74	74	74	A	74
Miscellaneous				
82	-			
91	91	-		
92	92	92	S	
93	93	93	S	
94	94	94	S	
95	95	-		
96	-			
99	99	99	I.S.	
102	102	102	U	102

* Adopted by Johnson Wax Ltd at completion of this thesis (November 1983).

12.4 DISCUSSION OF E.S.M.E.

12.4.1 The Search Programme and Sources

Table 12.17 demonstrates the effectiveness of the programme showing that in under one year it has yielded eighteen new product prototypes which have the confirmed interest of regional marketing management via Delphi. Three of these products have been adopted by Johnson Wax Ltd at present (November 1983), which is viewed as encouraging particularly as these had to compete against items already in the corporate plan. The total direct cost of the pilot study was £ 9,000 broken down as follows:-

	£ ´s
Consumer research	3,500
Travel	2,500
Purchase of products and material	1,500
R & D man hours to develop prototypes	1,500
	9,000

While the above costs exclude the writers time, they are roughly equivalent to 0.5% of the current R & D budget and amount to £3000 per item. This should be directly compared with the cost of using an external Product Development Consultant of at least £ 10,000 per product. As discussed in Table 12.4, R & D support time for formulation and pack development will also need to be considered, making the comparable external Product Developer cost in the area of £20,000. In addition, it is possible that the final results from the pilot study will produce more than three items for Johnson Wax Ltd as some products are still under consideration.

The final ranking of sources must be on the basis of numbers of acceptable items (as judged by E.S.M.E. in column 3 - Table 12.17), and this ranking is:

1 Suppliers; 2 Store Audit; 3 Universities; 4 Inhouse Ideation.

All other sources failed to yield any acceptable products.

Suppliers ranked first probably because they were already associated with Johnson Wax Ltd and wished to expand their opportunities. The store audit procedure yielded the second largest number of acceptable ideas for little outlay of resources. In comparison, the impression gained from many university based contacts was that they either did not percieve benefit from collaboration with the company or did not need funding for their work at the time of contact. However bearing in mind the potential of this source (see Appendix VI) and the relatively limited number of contacts made it should be considered worthy of further effort. It is doubtful if there is any merit in continuing with further consumer research but government and private research institutes and technology traders need further investigation at least to build up a comprehensive picture of their activities.

Therefore for practical purposes - only the first four rankings are probably worth pursuing on a regular basis. Suggested procedures for improving the success rate of four sources are
listed in Table 12.18.

12.4.2 The Screening Programme

Panel: The panel system seems to work well in that large numbers of ideas can be conveniently handled with consensus being readily achieved. The present members seem to be happy to continue to serve on it yet the introduction of new members on a rotational basis is probably worthwhile, some of which might be external such as consultants and university specialists in order to reduce company bias.

Delphi: The ability to effectively screen ideas/technologies/products or opportunities in accordance with the perceived needs of marketing has been demonstrated. The process can be rapid if organised as presented in Section 12.3. with results obtained each month which encompass a total European viewpoint giving greater confidence on idea value. This also permits greater possibilities of satisfying local requirements.

TABLE 12.18 WAYS TO IMPROVE THE SUCCESS RATES FROM PREFERRED SOURCES

SOURCE	MODIFICATION
Suppliers	Establish jointly owned projects with key suppliers thus excluding competitors.
Store Audit	Largely satisfactory. Extend to D.I.Y. outlets
University	Work with University industrial liason officers.
Inhouse Product Development	(a) Increase frequency of marketing/R & D ideation seminars.
	(b) Implement recommendations from consultant regarding M.I.C. at R & D centre (Table 12.1).

Business Screen: This software has been shown to provide quality information regarding a new products future commercial potential if marketed by Johnson Wax Ltd given that the market size and proposed retail selling price can be identified (or estimated). This commercial potential is reported via operating profit versus advertising spend with an optional project accept/reject loop using parameters agreed with Johnson Wax Ltd. Recommendation for its further development are presented in Chapter 14.

12.5 SUMMARY

The pilot programme has demonstrated that new products which are `on strategy´ can be obtained efficiently and at reasonable cost by the techniques devised by this study. The recommendations for modification and continuation of this programme are discussed in Chapter 14.

CHAPTER 13: CONCLUSIONS

13.1 INTRODUCTION

This chapter deals with the overall conclusions from the work presented in this thesis. For convenience they have been classified under the following headings and will be presented in this way:-

Methodologies - Searching for New Ideas.
- Screening New Ideas.

Products - Current Aerosols.
- Safe Aerosols.
- Non-Aerosols.
- Completely New Products.

Effects on Corporate Plan of Johnson Wax Ltd.

13.2 METHODOLOGY

13.2.1 Search Methods

1. The search programme piloted in the case study has proved to be both workable and practicable. The most profitable sources of ideas were found to be Suppliers> Audit> Universities> Inhouse Ideation.

The search process at universities, UK government and private research institutes is considerably hampered by the lack of reliable directories describing both the type of work and the researchers involved.

2. A more efficient way to work with universities appears to be via the Industrial Liaison Officers who have both current information on research activities by departments and individuals as well as the motivation to work with industry.

3. Suppliers represent the most fruitful source of new products in the pilot study and joint development projects should be sought in order to exclude competitors.

4. Store audits have also shown to be an effective source of new ideas/products/technologies especially when conducted in regions of the UK known to be used for new product launches e.g. Newcastle; Birmingham and Southampton.

5. The opportunity to use consumers as "inventors" has been concluded to be not worth pursuing further as shown in Table 12.17. However the possibility to use consumers in behavioural and attitudinal studies on household tasks is considered to be worth periodically repeating e.g. every two years.

6. Inhouse Ideation (both seminars and individually) were also concluded to be a worth while source of new ideas, provided that the guidelines in Table 12.1 are followed.

7. More time will be needed to properly evaluate the sources utilised during the case study (e.g. Government and Private Research; Technology Traders) and to further consider those that were not tried e.g. Diversification; Competitions; External Product Developers.

8. The maintenance of an updated company Skills Inventory as devised for this thesis will greatly assist the screening processes aimed at new ideas/technologies/products for Johnson Wax Ltd.

13.2.2 Screening Methods

9. Stage 1 - 1st Panel: The use of a panel as the first stage in the screening of new ideas/technologies/products proved to be an efficient way of selecting items for judgemental assessment by marketing personnel. This process works well with a panel of five senior managers from the technical, marketing and financial disciplines and inorder to obtain best results, it is desirable that the panel have had the opportunity to preview the material. Given this opportunity there appears to be no limit to the number of ideas that can be handled other than time available for the task.

10. Stage 2 - Delphi: The telexed Delphi analysis represents a convenient and rapid means of gaining a widespread European marketing assessment of a new idea/technology/product. It also allows a rationalised approach to project selection offering both a qualitative and quantitative level of committment. A maximum of five items (i.e. 1 orientated to each respondent) appears to be optimum.

11. Stage 3 - Business Screen and 2nd Panel: The third stage i.e. the final selection of new projects for project activity at the R & D centre by a second meeting of the panel was enhanced considerably by the availability of business screen data. While this information mostly agreed with the Delphi selections, it provided quantitative information to aid the panels decision.

12. Both the first panel screen and the Delphi analysis are made easier with additional information besides the basic new product description e.g. prototypes, models drawings; or examples of similar products already marketed by others.

13.3 PRODUCTS

13.3.1 Current Aerosols

13. There is a high probability of aerosols as a general product group going into decline over the next 5 to 10 years. The probability of this decline to half current levels is estimated at 70% over a time period which may be as short as two to five years or as long as ten to twenty years, dependent on politics and attitudes of both government and the general public as described in the following conclusions.

14. The extent and rapidity of aerosol decline will vary by geographical location being the highest in the USA, Western Europe, Japan and Australia and least in developing and third world areas.

15. Aerosol decline will also vary according to product category. In economically strong countries, Hair sprays and Personal Care aerosols are likely to show greatest decline almost everywhere. Household and Insecticide products will decline more slowly or maintain a static position, while Miscellaneous aerosols will generally maintain slow growth. In developing countries there is likely to be little variation by product over the present position but some modest growth followed by decline within 5 years from now. A summary of these conclusions is presented as Table 13.1.

TABLE 13.1 SUMMARY OF WORLDWIDE AEROSOL FORECASTS

AEROSOL CONSUMPTION PICTURE (1983 - 1993)

AREA OR COUNTRY	AV. EARNINGS /CAPITA	TOTAL AEROSOLS	HAIRSPRAYS	PERSONAL CARE	HOUSEHOLD	INSECTICIDES	MISCELLANEOUS
Total World	1,662	D.S.	D.R.	D.R.	M	M	G
USA	7,700	D.R.	D.R.	D.R.	M	G - M	G
Rest of World	1,000	G-M-D.S.	G - D.S.	G - D.S.	G - M	G - M	G
Canada	7,485	D.R.	D.R.	D.R.	M	M	G
W. Europe	5,000	G - D.S.	D.S.	D.S.	G - M	M	G
Austria	7,300	M	D.S.	D.S.	M	M	M
Belgium	7,500	D.S.	D.S.	D.R.	D.R.	M	D.S.
Denmark	8,200	D.S.	D.S.	D.S.	D.S.	D.S.	M
Finland	5,660	D.S.	D.S.	D.S.	D.S.	D.S.	M
France	6,380	D.R.	D.R.	D.S.	D.S.	D.S.	G
W. Germany	7,465	M - D.S.	M - D.S.	M - D.S.	D.S.	D.S.	G - M
Greece	2,701	G	D.S.	G	M	G	G
Holland	7,000	M	D.S.	M	G - M	D.S.	G
Italy	2,725	G - M	M	G - M	G	G	G
Norway	7,253	D.R.	D.R.	D.R.	D.S.	M	D.R.
Portugal	1,503	G - M	D.S.	D.S.	M	G	M
Spain	2,896	G - M	D.S.	D.S.	G - M	G	M
Sweden	8,369	D.R.	D.R.	D.R.	D.S.	M	M
Switzerland	8,918	D.R.	D.R.	D.R.	D.S.	M	G
UK	3,896	D.S.	D.R.	D.R.	M	D.S.	G
Eastern Europe	2,578	G - M	G - M	M	G - M	M	G
Asia	421	G - M	G	G	G	G	G
Africa	608	G - M	M	G - M	M	G - M	M
South America	1,353	G	G	G	G	G	G
Oceania	5,260	M	D.S.	D.S.	D.S.	D.S.	G

KEY: G = Growth; M = Mature; D.S. = Slow decline; D.R. = Rapid decline

16. The decline of aerosols is primarily the result of safety concerns inducing national legislation and/or insurance controls. The same concerns are causing a marked change in consumer attitudes turning them against aerosols.

17. The trend regarding constraints on the manufacture and storage of aerosols is being established primarily in the USA but also in the UK. These trends indicate that the use of hydrocarbon propellents will warrant a "hazardous location" rating at the site of manufacture plus the possibility of similar ratings for finished goods in retail outlets.

13.3.2 Development of a `Safe Aerosol´

18. The development of a safe and efficient aerosol propellent is considered unlikely in view of the high costs involved, the toxicological nature and high price of currently viewed options and falling interest in the product.

19. Assuming that the propellent problems could be overcome by a major breakthrough, the problems of inhalation toxicity, pressurised containers and, in many cases, product flammability are likely to remain. Even if these problems could be surmounted the cost is likely to be prohibitive (estimated at 2 - 3 times current propellent cost). Further, while no firm evidence exists which indicates a high level of risk to the consumer, aerosol safety is an emotive subject which is likely to induce government control on the basis of a `fail safe´ philosophy.

20. Aerosol misuse as discussed in Chapter 4 is a further and growing difficulty which is largely specific to the aerosol package and therefore argues against their continued presence in the market place.

21. Further interest has recently developed in a Poly Ester Tubing (P.E.T.) plastic aerosol which might reduce some of the chemically induced failures (corrosion) but will not overcome conclusions 18 through 20 above.

13.3.3 Non Aerosols - Alternative Packaging

22. For those products which do not require fine atomisation i.e. are surface sprays such as furniture polish, surface cleaners and laundry sprays, there are several alternative delivery systems such as compressed air powered `aerosols´, trigger pumps, finger pumps and squeeze packs.

23. To date (1983), Trigger pumps have shown the most commercial promise limited by their high unit price and relatively slow filling speeds compared to aerosols. However higher volume production might produce the necessary economics of scale for viable production.

24. Although aerosol alternatives may represent viable replacement for surface sprays, they have not, so far, gained acceptance with the consumer anywhere. This is largely due to relatively poor performance and lack of user convenience compared to the conventional aerosol package.

25. For space sprays e.g. rapid action insecticides for flying insects and heavy duty airfresheners, the aerosol represents the only mechanism to deliver the active ingredients at the desired level and in an efficacious manner.

26. A switch from aerosols to the alternatives is likely to involve aerosol producers in major capital expenditure due to the fact that the

aerosol package is already highly optimised from a manufacturing production and cost viewpoint. These investment costs are estimated to be in the range, £100,000 - several £million depending upon the size of the production facility.

27. The most promising new alternatives are the compressed air self priming Olozon or Air Spray unit (plastic) and the Mistlon spray unit (metal), which are similar in function and appearance to conventional aerosols . The latter unit can probably be filled on conventional aerosol production lines but is reported to be expensive (1.5 - 3 times conventional aerosol).

28. As discussed in Chapter 12 and in section 13.3.4 below, there is a high probability that a satisfactory compressed air powered `aerosol´ product will be developed as a direct result of the pilot study. This will be achieved by optimising both the active product´s physical characteristics and the aerosol valve component, coupled with the use of the Tissot constant pressure actuator unit.

13.3.4 <u>Completely New Products</u>

The conclusions listed in this section should be regarded as confidential to Johnson Wax Ltd for commercial reasons.

29. Wholly new ideas/technologies/products can be identified and screened at relatively low cost by an R & D initiated programme designated E.S.M.E.

30. For existing markets - several new products have been selected to progress to consumer tested prototypes namely:-

* Effervescent bleach cleaning tablets.
* Kitchen carpet care product.
* Colour change WC cleaner.
* Roller ball type shaving lubricant.
* Olozon compressed air spray unit.
* Compressed air powered spray unit comprising plastic container, constant pressure valve and active product.
* Use of microencapsulating techniques for novel personal deodorants, carpet cleaners and pet care products.

In addition the following new products have been adopted by Johnson Wax Ltd.

* Laser flowmeter for skin care.
* Therapeutic heat pad.
* In addition an IHD funded research project has been initiated as a direct result of the pilot study.

31. For new markets - which according to company policy are to be evaluated by S.C. Johnson - interest has so far been shown by the parent company in the following:-

Diet aid biscuits.
Saccharin substitutes.
Computer care products.

13.4 EFFECT ON CORPORATE PLANS

32. Johnson Wax Ltd still plan to rely quite heavily on aerosol products for at least 3 years for both turnover and profit and any ban or rapid decline in aerosol sales could be serious for them.

33. The current business of Johnson Wax Ltd is built on too narrow a base relying heavily on Furniture Care aerosols and Air Care products - some of which are aerosols.

34. Although an alternative to the aerosol (the trigger pump) has been tried in the Furniture Care category, it has not so far, been successful. Other attempts to offer aerosol alternatives e.g. in Personal Care and Laundry Care have met with similar results. The future corporate plans should recognise this apparent failure, analyse the cause and take appropriate actions.

35. The markets currently serviced by Johnson Wax Ltd are virtually all mature with the exception of Hair conditioners, which is showing slow growth and from which they have recently withdrawn.

36. As shown by the consumer research results in Tables 12.4 and 12.5, the largest and most important household consumer markets have not yet been entered by Johnson Wax Ltd. Moreover one of the major objectives of the current corporate plan is to develop Air Care products which do not appear to be important.

37. Attempts at increasing sales and profits of existing products by gaining an increased market share at the expense of their competitors are considered to be both unlikely and very costly to achieve.

38. From consideration of conclusions 32 to 37 above, it is concluded that in order to guarantee survival in the event of the failure of aerosols, new opportunities should be explored via the pursuance of new products and markets as described above, and studies into possible company diversification.

39. Diversification could represent an alternative way to pursue new opportunities by either or both of the following routes:-

(a) - by marketing existing skills to others as described in Section 10.4.

(b) - by purchasing other companies and assimilating them into the structure of Johnson Wax Ltd.

40. The first of these [route (a)] in 39 above, has been analysed, and the following are considered to be the most commercially attractive.

Sales and Distribution.

Manufacture of consumer or industrial speciality chemicals in Aerosols; Liquids and Powder form.

Formulation and development of consumer or industrial speciality chemical products.

Package design.

Industrial Microbiology.

International trading (import/export).

41. The second - route (b) in 39, concerns acquisitions and this has not been analysed in detail as part of this thesis but is discussed in the next Chapter.

CHAPTER 14: RECOMMENDATIONS FOR FUTURE WORK

14.1 METHODOLOGY

14.1.1 Search Methods

1. The search programme piloted in this thesis should be continued by concentrating mainly on the following sources:-

Suppliers

Store Audits

Universities

Inhouse Ideation seminars

2. Suppliers (S): Little needs to be done to improve the liaison that exists between Johnson Wax Ltd, the fragrance houses and their key suppliers other than to formalise the meetings, to perhaps twice per year, and to share with them the corporate and local future objectives. In this way selective projects could be pursued on a joint basis i.e. to the exclusion of competitors. As all suppliers listed in Appendix VI are international companies there is no need to consider extending this programme outside the UK.

3. Store audits (A): These should be continued at least four to six times per year (throughout the main television advertising areas.) However, while the UK has proved to be an excellent source of new products, there are other countries which also have an good reputation in this respect, and therefore, it would also be beneficial to extend this activity to other locations. It is recommended that initially the same procedure is utilised, but that the results from the first exercise be carefully monitored so that future procedures can be orientated towards local circumstances.

4. Universities (U): The search programme should be continued and extended to include all the UK universities by having regular meetings with the industrial liaison officer or their equivalent at each university. In this way a comprehensive survey can be made of departments and individuals active in areas of interest and the searching can become a "technology transfer" programme. These meetings might be held 1 - 2 times per year per university and the possibility to simplify the process further by working with the Society of University Industrial Liaison Officers should be evaluated. That is a "Technology Transfer" programme might be arranged via an annual conference.

As with the store audits, the use of this source should be extended to other countries providing coverage by using technical personnel from Johnson subsidiaries in each country. Once again it is advisable to proceed via the industrial liaison bureau or its equivalent as it is unlikely that the directories (194) describing research overseas are any more reliable than their UK counterparts.

5. Future searching for ideas technologies or products from UK government or private research establishments should be planned on the same basis as universities i.e. work through the information or industrial lisison person rather than contact individuals.

6. Technology Traders (T.T.): These are most likely to be helpful in pursuing new markets such as pharmaceuticals and a comprehensive survey of them should be conducted listing sources and their range of products.This should be done first in the UK and fully evaluated prior to extending overseas.

7. It would also be advisable to investigate the remaining sources of ideas/technologies/products listed in Table 11.10 (but as yet not used as part of the pilot programme) e.g.

* Product Developers (Consultants).
* Competitors.

8. Although an analysis of the pilot study has been carried out, future programmes should re-assess the success rates of the various sources used, in terms of numbers of opportunities offered and the quality and acceptability to Johnson Wax Ltd marketing department. This analysis would provide guidance in planning the future search programme in terms of resource useage.

9. Since the corporate R & D group in the USA has a similar interest in such a new opportunities programme, it is recommended that they should adapt the procedure to North and South America, Asia and Oceania. The Johnson Wax R & D centre in the UK should concentrate on Europe, Africa and the Near East. This is likely to be best achieved by working with the technical and marketing managers for each country.

10. Computerisation of relevant data on a centralised data base at the Johnson Wax Ltd R & D centre with links to the European and USA communication networks will greatly faciliate information exchange and rapid response. In fact, it may also be possible to access external date basis e.g. at universities by this means given compatability of equipment. Having achieved this degree of sophistication, the administration and

operation of the programme should become less time consuming allowing human resources to be best utilised in searching and screening of new opportunities both from within the European region and via the USA group, from elsewhere.

14.1.2 Screening Methods

11. The Pilot Study: This has provided evidence and experience that the E.S.M.E. procedure is both a practical and efficient way of finding and screening new ideas, technologies and products. It is recommended that it continues to be used but with the modifications detailed in 12, to 15 below.

12. Stage 1 - Panel review: The panel plays an important role in the overall evaluation process and it might be beneficial to reconstitute the membership periodically in order to apply the most up to date relevant experience and judgement to the ideas being reviewed. It is also important that the panel members continue to reflect the company´s serious committment to the projects and that panel selected ideas are seriously evaluated by the marketing department. Increased objectivity might result from inclusion of members external to Johnson Wax Ltd e.g. consultants, and while such a radical plan may create inhibitions for the company members, the potential advantages are believed to outweigh the difficulties.

13. Stage 2 - Delphi: In order to maintain marketing interest and stimulate enthusiasm, at least one item believed to be of potential interest to each marketing company respondent should be included. Experience may prove that additional information would be desirable to optimise this type of analysis ,such as diagrams, models, and drawings of

potential new product applications. The logistics for providing this information,should it be necessary, would have to be planned in some detail. Play back of results in the second round should be by histogram which proved in the pilot study to be the most acceptable method.

14. Stage 3 - Business Screen and 2nd Panel: The use of the novel business analysis computational software developed during this thesis and described in Appendix VIII has been found to be both rapid and convenient. It also seems to present a realistic picture of a products future performance and further refinements to this programme will be possible as it is used to build up data on typical product costs over a wider range of products.

The 2nd Panel is also important, being the decision point at which a committment to utilise R & D resources is made. While it might be argued that the 2nd Panel is unneccessary, it should continue to be used because it allows an overall review of all aspects of a potential project prior to committment e.g. changes in company policy; availability of funding and resources.

15. Marketing Follow Up: As mentioned in Chapter 9, previous experience shows that an early involvement of the marketing department is often vital off in terms of committment and `follow up´ with a product. The operation of a "New Ventures" group as described by White (155), would seem to be a way of ensuring that a promising new product opportunity gains both adequate attention and resources to ensure the realisation of its potential. The temporary secondment of an R & D specialist to such a group for the duration of the project might enhance the benefits from such a scheme and increase the speed with which the project can be brought to fruition. There are also benefits in motivation of R & D staff to have a

closer involvement in the commercial and marketing aspect of a project as discussed in Appendix VII - MIC.

14.2 PRODUCTS

14.2.1 Current Aerosols

16. With reference to the forecasted decline in aerosol consumption, little can be done by Johnson Wax Ltd to economically prevent this as discussed in Chapters 4 and 6. It is, however, recommended that the aerosol industry continues to work with government and organisations concerned with the safety of aerosols endeavouring, where possible, to reflect the positive attributes of these products. This is likely to be best achieved by working through the trade association (B.A.M.A.) such that the industry pools its resources and focuses its communications with authoritative bodies via its official spokespersons. Such a policy would be consistent with the recent past concerning other restraints on the aerosol industry e.g. The Prescribed Qualities Directive - January 1980 - successfully negotiated by B.A.M.A.

17. If further aerosol product development is to be undertaken, it is recommended that the Miscellaneous category be re-examined first as it appears to be the only one with some possibility for growth. The development of new aerosol applications i.e. the establishment of new product categories is considered unlikely in view of the emotive safety considerations discussed in Chapter 4.

14.2.2 Development of a `Safe´ Aerosol

18. No resources should be committed internally to the general development of the `safe´ conventional aerosol as this is likely to prove highly costly with a poor chance of success. However the new opportunities search can take account of this route and perhaps identify more specifically novel and useful work in this area (conducted by others).

19. Interest in the P.E.T. aerosol container deserves maintenance on the grounds of possible cost savings and reduced container failures due to chemical attack. This is not likely to affect the outcome of aerosol decline.

14.2.3 Non-Aerosols - Alternative Packages

20. Johnson Wax Ltd should pursue the development of a low cost trigger spray system as discussed in Chapter 8.

21. The compressed propelled systems such as the Mistlon and Olozon units should also be further developed and consumer tested both as surface and space sprays.

22. For bulk liquid delivery systems, several of the squeeze and pump packages listed in Chapter 8, should be subject to value analysis techniques in order to make a selection with the emphasis on reduced unit and manufactured cost. However, the numerous "off the shelf" developments should be investigated prior to investing in an inhouse system.

23. The "Sepro" packaging system should be re-examined in terms of optimising its performance while reducing unit cost, because it reduces the safety and ecological concerns and offers the scope to market novel and high performance products such as self heating or post foaming shaving gels. The simplification of the filling process should be an additional objective.

24. By following recommendations 20 through 23 above, the company should develop within two years a range of packaging which could immediately replace aerosols should a ban become effective.

14.2.4 Completely New Products

25. It is recommended that the following new products be consumer tested by Johnson Wax Ltd with the objective of future launch in the UK:-

* Effervescent bleach cleaning tablets.
* Kitchen carpet care product.
* Colour change W.C. cleaner.
* Roller ball type shaving lubricant.
* Olozon rechargeable compressed air spray unit.
* Compressed air powered spray unit comprising plastic container, constant pressure valve and optimised active product.
* Use of microencapsulation techniques for novel personal deodorants, carpet cleaners and pet care products.

26. The following products which represent ventures into new markets are recommended to the USA based parent company, SC Johnson and Son for consumer testing there.

Diet aid biscuits.

Saccharin substitute free from `metallic´ taste.

Computer care products.

14.3 EFFECTS ON CORPORATE PLAN

27. With reference to the narrow profit base of Johnson Wax Ltd, the company should carefully select, then develop, at least a third major product line and preferably additional lines to spread the commercial risks. This is unlikely to be achieved with the Personal care category but the pursuance of other new opportunities is discussed in Chapters 9, 10 and 11.

28. As shown in Chapter 9, some of the current products generate little operating profit and it is recommended that these products be reviewed as to their viability, selecting on the basis of a minimum profit contribution. For example this minimum level might be £100,000 per annum and at least 10% operating profit such that any product failing to meet these criteria would be discontinued.

29. The data from the consumer research summarised in Table 12.8 should be used as a starting point for new opportunities searches such that the products judged to be important by the consumer are investigated as possible future product lines for Johnson Wax Ltd.

30. Diversification is a recommended further route for achieving the third and additional `legs´ to the business as discussed in Chapter 10. To

pursue this route, a task force should be formed of senior managers from the marketing and financial departments of both Johnson Wax Ltd in the UK and the American parent company. Clear directions and objectives will be needed on the amount of funds available for this purpose and on the timing and specific areas of corporate interest.

31. Future diversification plans should include both the consideration of marketing existing skills to other organisations and potential acquisitions. In this latter case, likely candidates will be within corporately approved new areas such as non-prescription pharmaceuticals, health care products as well as companies with unique technology which would assist the development of existing markets.

32. In order to assist the diversification plans, the novel skills inventory developed during this thesis in Chapter 10 should be developed. It could then be included in each years corporate plan showing areas of strength and weakness.

33. With reference to the search for new product and business opportunities in general, more effort should be placed behind these activities than is currently reflected in the corporate plan. This is important from the viewpoint of survival, stability and growth and should be directed as detailed in Chapters 10 and 11.

34. In order to give the investigation of new opportunities (i.e. products/markets) the best chance of success, a similar level of committment should be devoted as that outlined in 30 above.

35. The corporate plan will need to go further in creating a better environment for the identification and development of new opportunities. Specific recommendations are listed below.

36. Although broad corporate guidelines were described in Chapter 11, this case study has highlighted the recommendations for better focus in respect of what can, and needs, to be achieved by Johnson Wax Ltd. For the new and large scale opportunities, it would be advantageous to determine the level of interest and capability in other SC Johnson European subsidiaries. This is because a particular project may be too big or small for Johnson Wax Ltd alone but justified on a total European basis.

37. According to the recommendations of this case study, the identification of new idea/technologies/products should be mainly an R & D led action followed by an evaluation by the marketing department, (first judgementally and then by consumer research). Therefore in order to maintain a high level of motivation, in both departments, both searchers and evaluators must be fully aware of the process parameters i.e.

- the type of ideas/technologies/products which are of interest.
- the realistic mortality rate on new ideas of sixty per chosen product.
- the number of new products likely to be launched in the next fiscal year and hence the number of ideas/technologies/products needed for that period.

The proper establishement and communication of the above parameters should avoid wasted effort or the demotivation of those involved.

38. The business screen software developed during this thesis should be developed further to take more precise account of manufactured cost, advertising expense and other parameters under the control of Johnson Wax Ltd. Results from these analyses might be included in future corporate plan documents to justify selected new products.

39. The environment at the R & D centre also needs attention in respect of removing some of the constraints on innovation - specifically

- more time to innovate
- recognition and reward of creativity by the staff.
- carefully structured seminars with marketing in order to accelerate inhouse ideation.

APPENDIX I: AEROSOL PRODUCTION/CONSUMPTION DATA BY COUNTRY

TABLE A3.1. COUNTRY - AUSTRIA

YEAR	HAIRSPRAY		PERSONAL CARE		HOUSEHOLD		INSECTS		MISCELLANEOUS		TOTALS FOR YEAR	
	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N
1963	0.5											3
1964	2											4
1965	4.5											7
1966	5.5											11
1967	8.5											16
1968	7.5	8	4	2.2	2	2.1						14
1969	8	11	5	3.7	2.2	2.2	0.2	0.2				16
1970	10.5	11.5	6.5	5.2	2.4	2.4	0.6	0.6	0.1	0.1	20.1	19.8
1971	13.5	11.9	7.5	7.5	2.5	3.1	1	1	0.2	0.2	24.7	23.7
1972	14.5	14.8	8	7.3	2.6	3.3	1.5	1.4	0.3	0.2	26.9	27
1973	15.5	15	9.5	8.7	2.8	4.1	1.6	1.5	0.3	0.3	29.7	29.6
1974	15.5	16.3	9.5	8.2	2.8	3.2	1.7	1.8	0.3	0.3	29.8	29.8
1975	16.5	16.4	9.8	9.8	3.0	3	1.8	1.7	0.3	0.4	31.4	31.3
1976	17.5	17.5	10.8	10.8	3.2	3.2	1.5	2	0.4	0.4	33.4	33.9
1977	18	18.8	11.3	11.3	3.4	3.5	2	2	0.4	0.4	35.1	36.1
1978	18.5	18.3	11	11.0	3.3	3.3	2	1.9	0.4	0.4	35.2	34.9
1979	18	17.8	10	10.5	3	3	1.5	1.8	0.4	0.4	32.9	33.5
1980	17.5	16	9.5	10	3	3.1	1.5	1.5	0.4	0.3	31.9	30.9

NOTE : ALL CONSUMPTION (CONS'N) AND PRODUCTION (PROD'N) FIGURES IN UNITS x 10^6

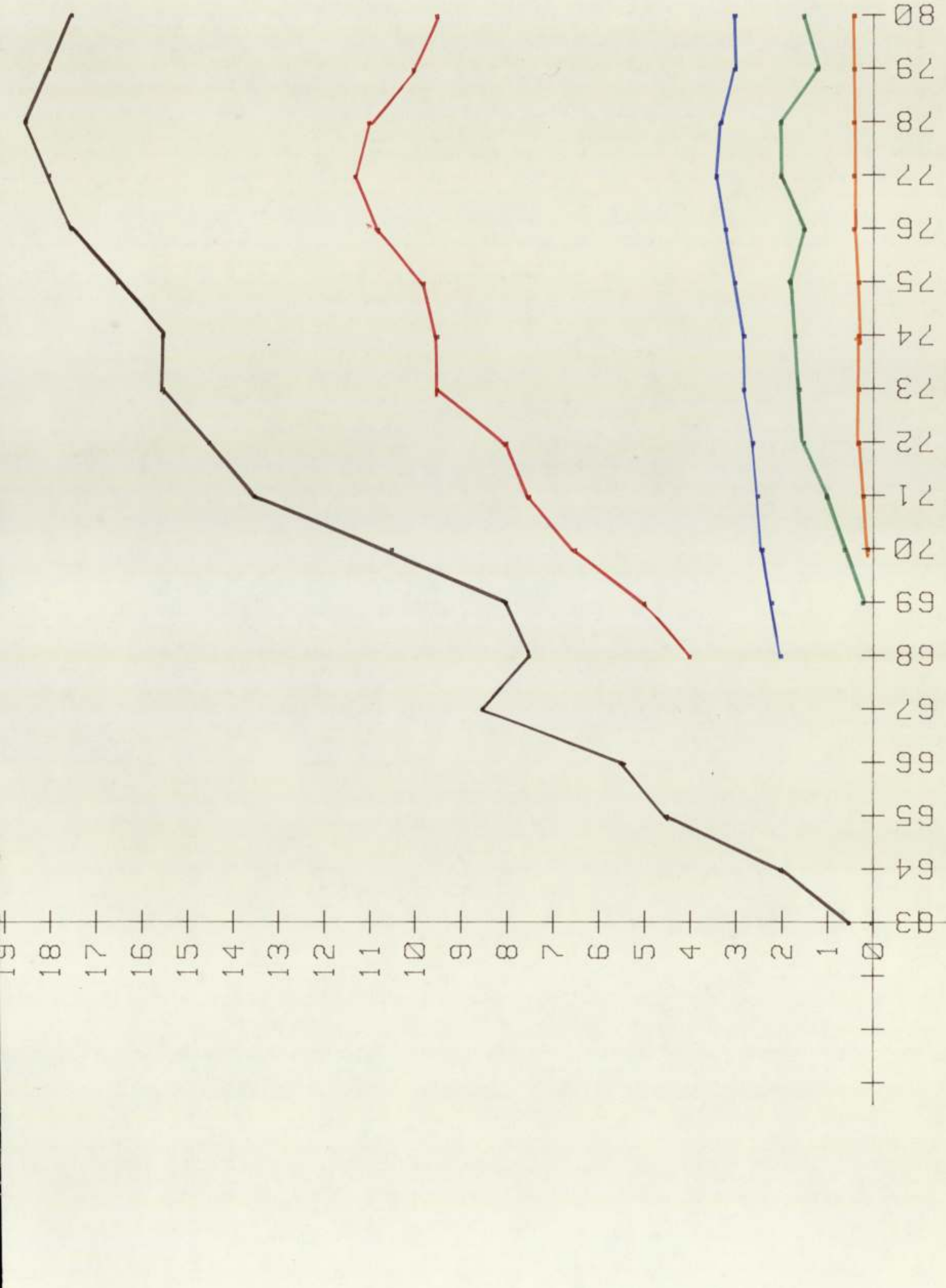


FIGURE A 3.1: AUSTRIA CONSUMPTION

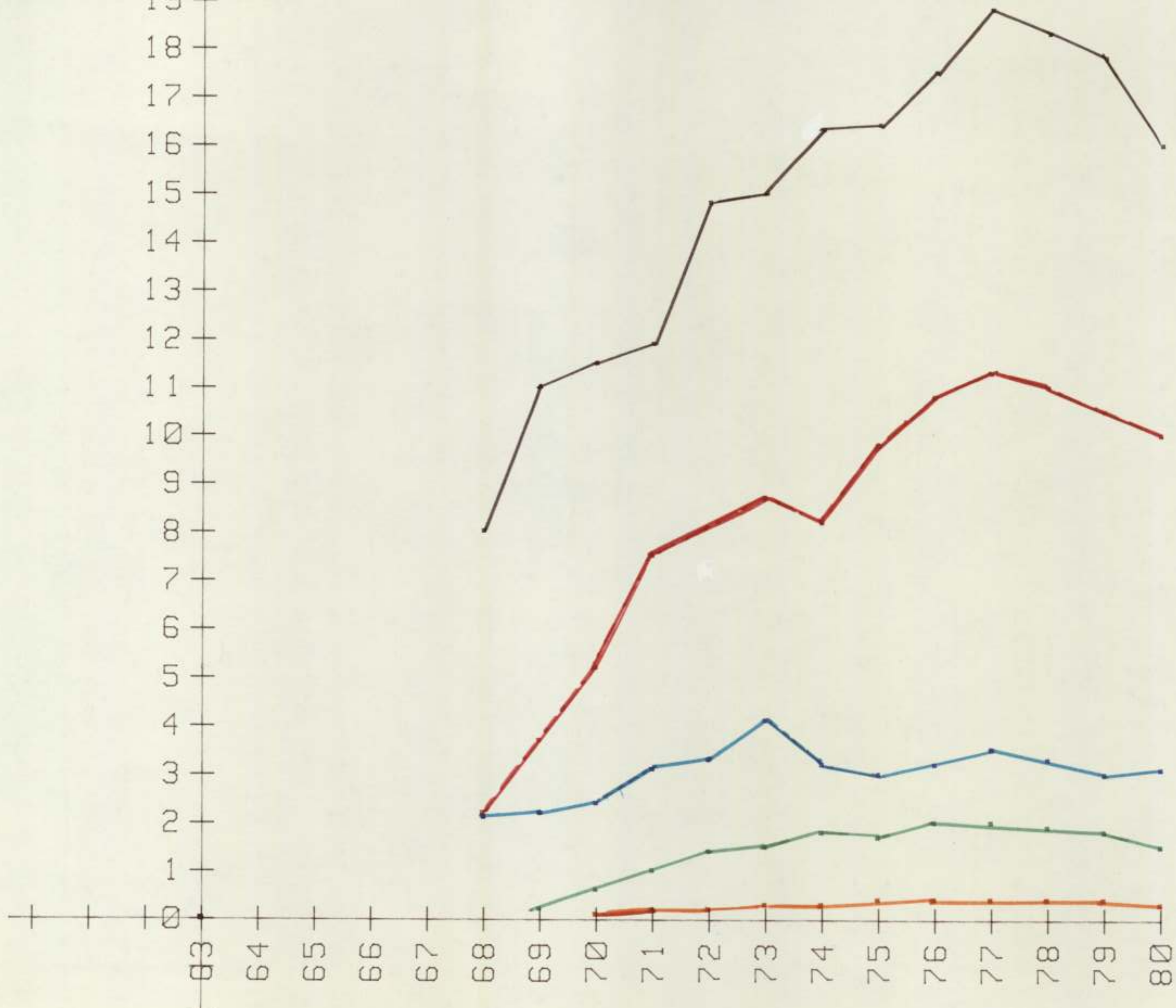


FIGURE A 3.1: AUSTRIA PRODUCTION

TABLE A3.2 COUNTRY - BELGIUM

YEAR	HAIRSPRAY		PERSONAL CARE		HOUSEHOLD		INSECTS		MISCELLANEOUS		TOTALS FOR YEAR	
	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N
1963	2.7											
1964	4.5											
1965	5											
1966	6											
1967	6.5											
1968	8			3								
1969	10			5								
1970	14.6	11.5	1.9	10	3.5	5	1.3	4	1.7	8.5	23	39
1971	11.5	15.6	2.2	14	5.7	6	2.5	3.5	1.7	6.5	27.7	41.5
1972	14	16.2	2	19	7.4	6.5	2.4	3	1.7	4.5	29.7	47
1973	14.5	16.9	4.1	20.5	5.2	6.5	4.5	3	1.8	4	32.5	48.5
1974	15	17.6	4.1	17	5.9	6.5	4.1	2.5	1.9	4	33.6	45
1975	18.5	18.4	5	13.5	6.7	7	6.1	3	2	5	38.2	47
1976	16	15.9	4.7	22	6.2	6.5	5.3	2.5	1.9	4.5	34	51.5
1977	16	14.8	4.8	21	14.5	8	6.1	3.5	2	5	42.2	53.5
1978	16	13.8	4.9	19	22.6	9	6.9	4	1.9	5	50.1	53
1979	16.5	12	5	18	15	10	7	3.5	2	5.5	41	53.5
1980	16	11	4.5	22	16	21	7.5	3	1.5	10	40.5	72

NOTE : ALL CONSUMPTION (CONS'N) AND PRODUCTION (PROD'N) FIGURES IN UNITS x 10^6

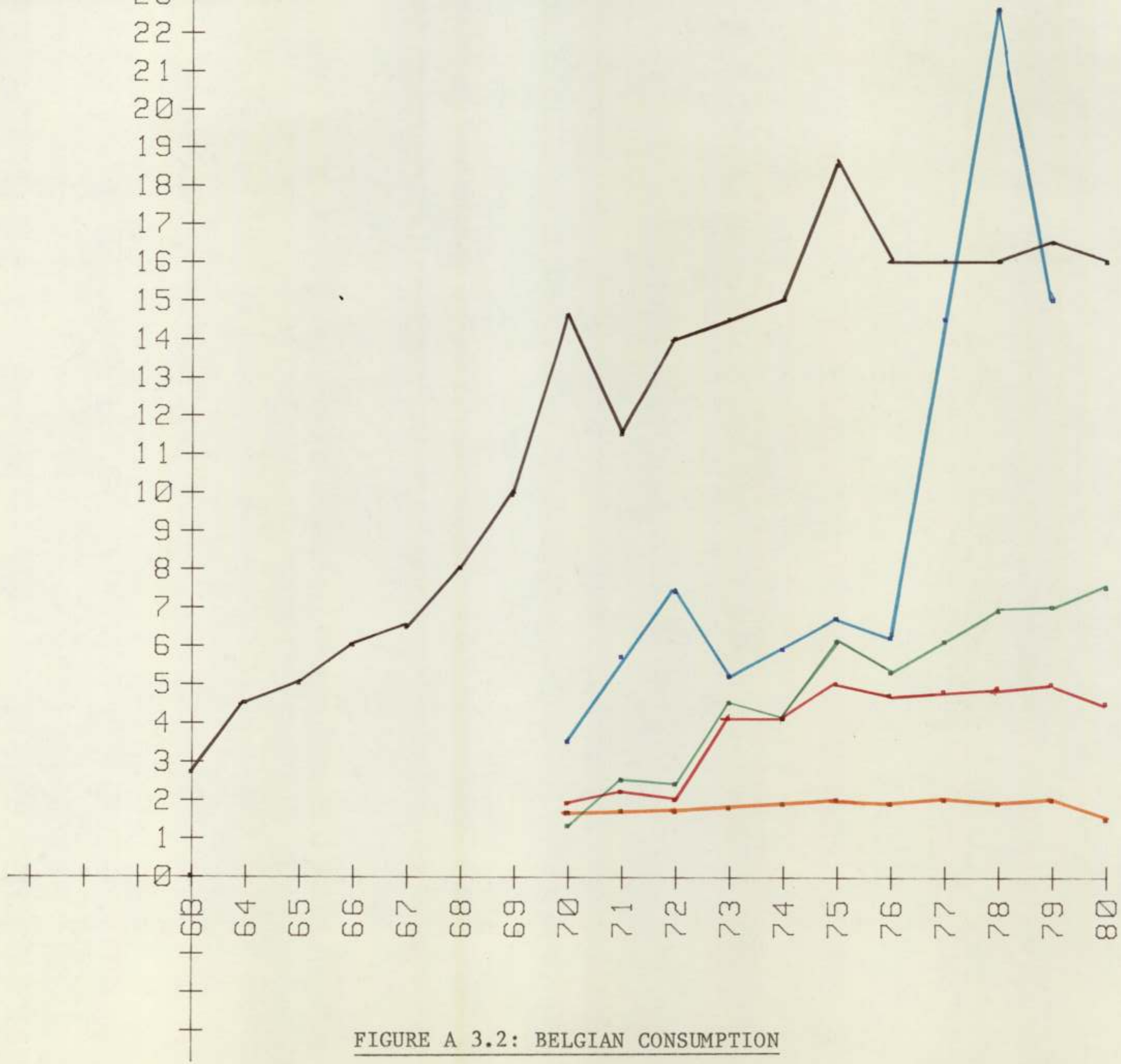


FIGURE A 3.2: BELGIAN CONSUMPTION

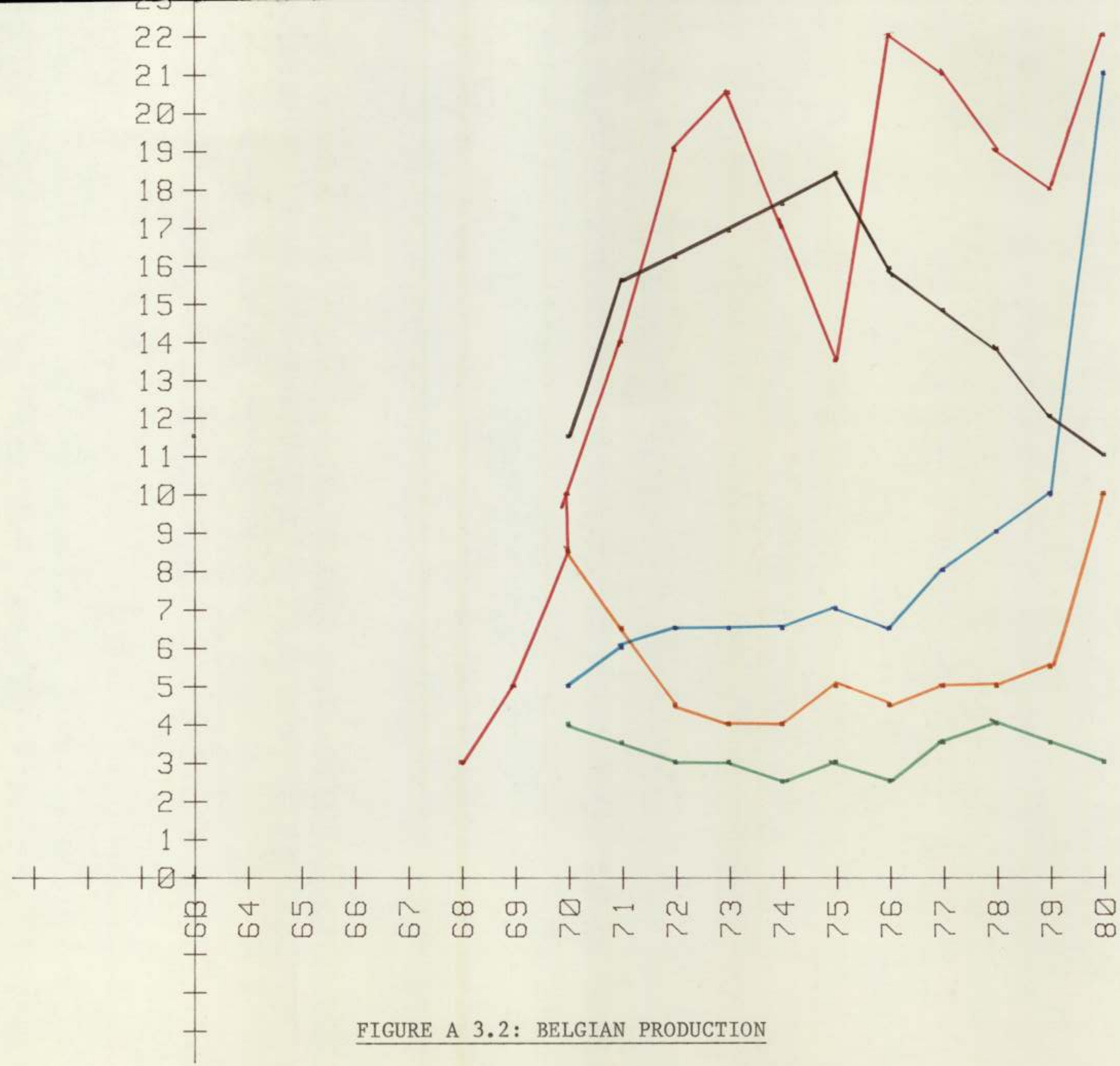


FIGURE A 3.2: BELGIAN PRODUCTION

TABLE A3.3. COUNTRY - DENMARK

YEAR	HAIRSPRAY		PERSONAL CARE		HOUSEHOLD		INSECTS		MISCELLANEOUS		TOTALS FOR YEAR	
	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N
1963												
1964												
1965												
1966												
1967												
1968	4.6	3	3	2.5	1.8	1.6	1.7	1.5	0.5	0.5	11.6	9.1
1969	4.8	3.5	3.6	2.8	1.9	1.8	1.7	1.7	1	1	13	10.8
1970	6.4	4	4.3	3.5	2	2	1.5	1.1	1.5	1.5	15.7	12.1
1971	5	5	4	4	1.7	1.6	0.9	1	1.2	1.2	12.8	12.8
1972	5.1	5.5	4	4	1.7	1.7	0.9	1.2	1.7	1.8	13.4	14.2
1973	5.2	5.5	4.8	4.5	1.5	1.5	0.9	0.9	1.7	1.6	14.1	14
1974	5.3	5.5	4.9	4.5	1.2	1.2	0.9	0.9	1.5	1.9	13.8	14
1975	4.5	4.5	5.2	5	1	1	0.9	0.9	2.4	2.5	14	13.9
1976	3.8	3.5	4.6	4.5	1	0.9	0.8	0.8	2.9	3.9	13.1	13.6
1977	2.6	2	4.1	4	1.[illegible]	1	0.6	0.8	3.2	3.1	11.5	10.9
1978	1.5	1.5	3.3	2.5	0.8	0.8	0.6	0.5	2.9	2.9	9.1	8.2
1979	1.5	1.5	2.8	2	0.8	0.8	0.5	0.5	2.8	2.8	8.4	7.6
1980	1.5	3.5	2.5	4	0.8	1.2	0.4	0.4	2.6	3.9	7.8	13

NOTE : ALL CONSUMPTION (CONS'N) AND PRODUCTION (PROD'N) FIGURES IN UNITS x 10^6

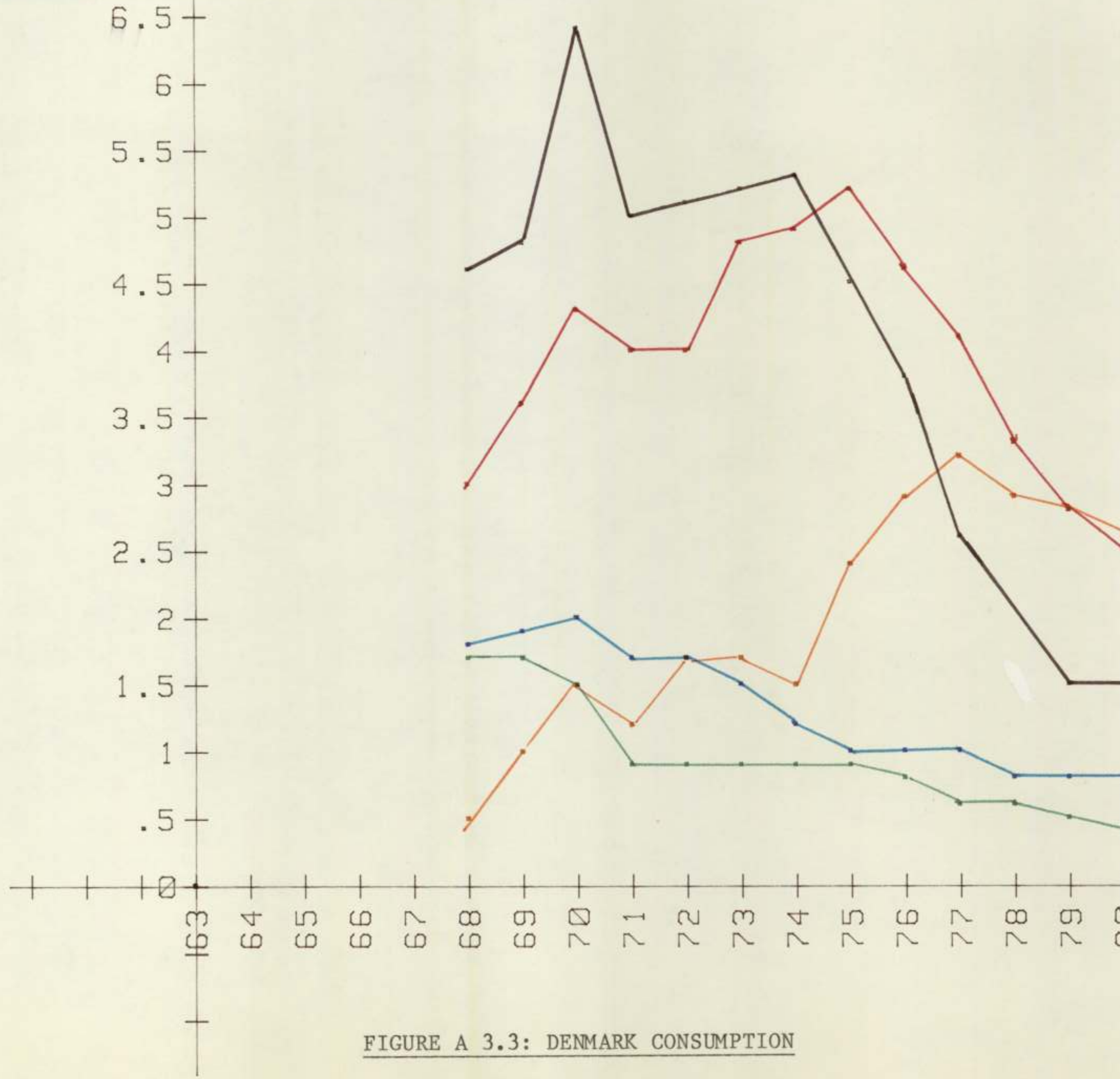


FIGURE A 3.3: DENMARK CONSUMPTION

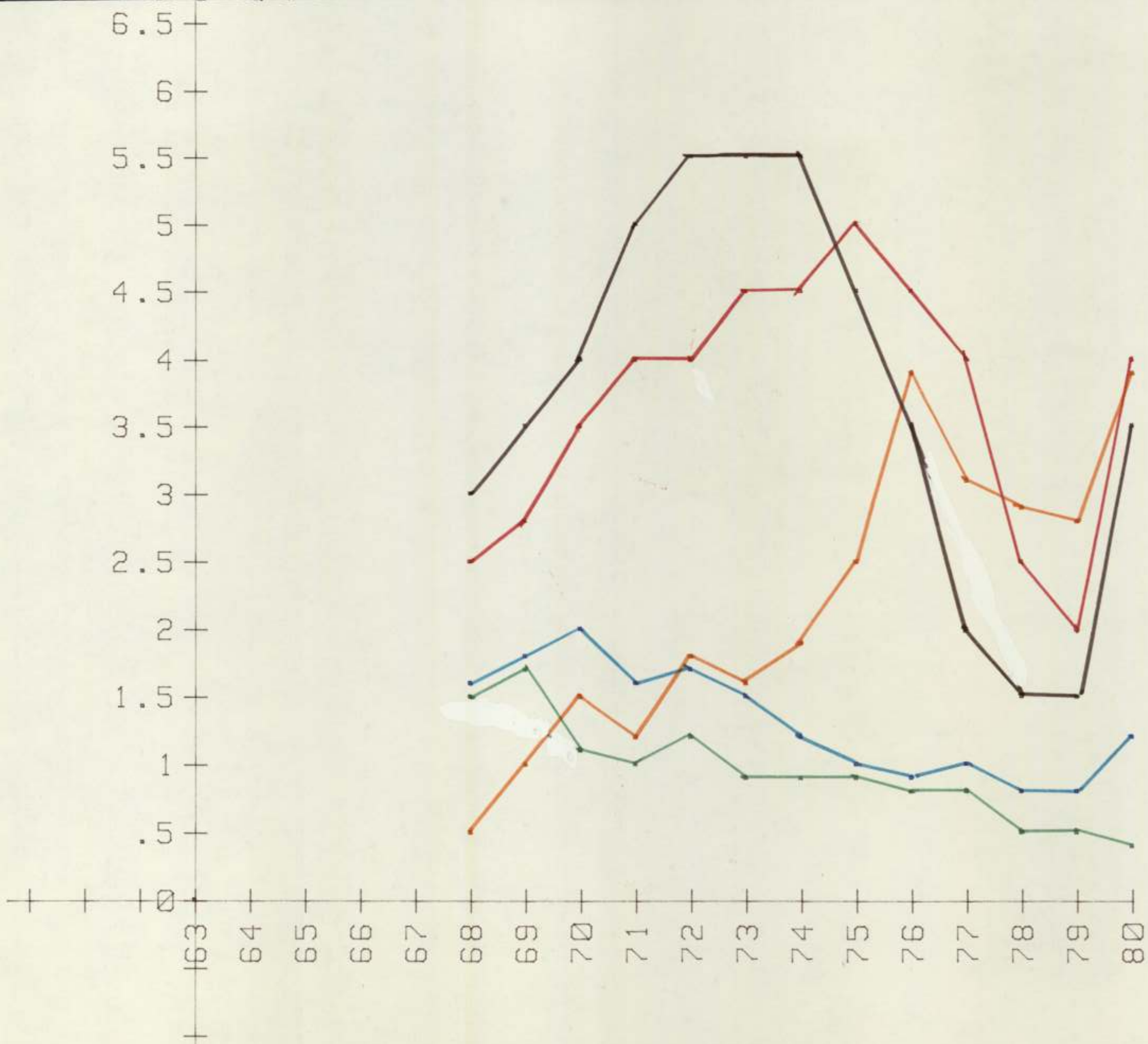


FIGURE A 3.3: DENMARK PRODUCTION

TABLE A3.4. COUNTRY - FINLAND

YEAR	HAIRSPRAY		PERSONAL CARE		HOUSEHOLD		INSECTS		MISCELLANEOUS		TOTALS FOR YEAR	
	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N
1963												
1964												
1965												
1966	4.1	2.3	4.1	4	0.4	0.7	0.5	1.3	0.5	0.9	9.6	9.2
1967	4.6	3.2	5.4	6	0.4	1.3	0.5	1.4	0.8	1.1	11.7	13
1968	5.4	3.3	5.4	8	0.5	0.9	0.7	1.1	0.9	1.3	12.9	14.6
1969	7.1	4	7.1	9	0.7	1.2	0.8	1.7	1	1.3	16.7	17.2
1970	6.9	4.5	6.9	12	0.8	1.3	0.9	1.[illegible]	1.1	1.3	16.6	20.7
1971	7.6	5.5	7.6	14	0.9	1.3	1.1	1.3	1.2	1.3	18.4	23.4
1972	7.9	4	7.9	18.5	1	1.4	1.2	1.2	2	1.3	20	26.4
1973	8.5	4.5	8.5	19	0.8	1.7	1.9	1.9	2.5	1.1	22.2	28.2
1974	9.4	5.5	9.4	15	1	1.5	1.8	2.0	3.3	4.4	24.9	28.4
1975	9	5	9	11	0.6	1.3	0.9	1.3	1.1	3.5	20.6	22.1
1976	8.5	4.5	9	10	0.7	1.4	0.6	1.3	1.1	4	19.9	21.2
1977	4.6	2.5	4.6	5.5	0.8	1.3	0.5	1.1	1	4.2	11.5	14.6
1978	4.2	2	4.2	5	0.7	1.3	0.4	0.8	0.7	4.5	10.2	13.6
1979	5	3	4.8	6	0.7	1.2	0.4	1	1	5	11.9	16.2
1980	5.5	3	5.3	6	0.6	2	0.4	1.1	1.1	5.9	12.9	18

NOTE : ALL CONSUMPTION (CONS'N) AND PRODUCTION (PROD'N) FIGURES IN UNITS x 10^6

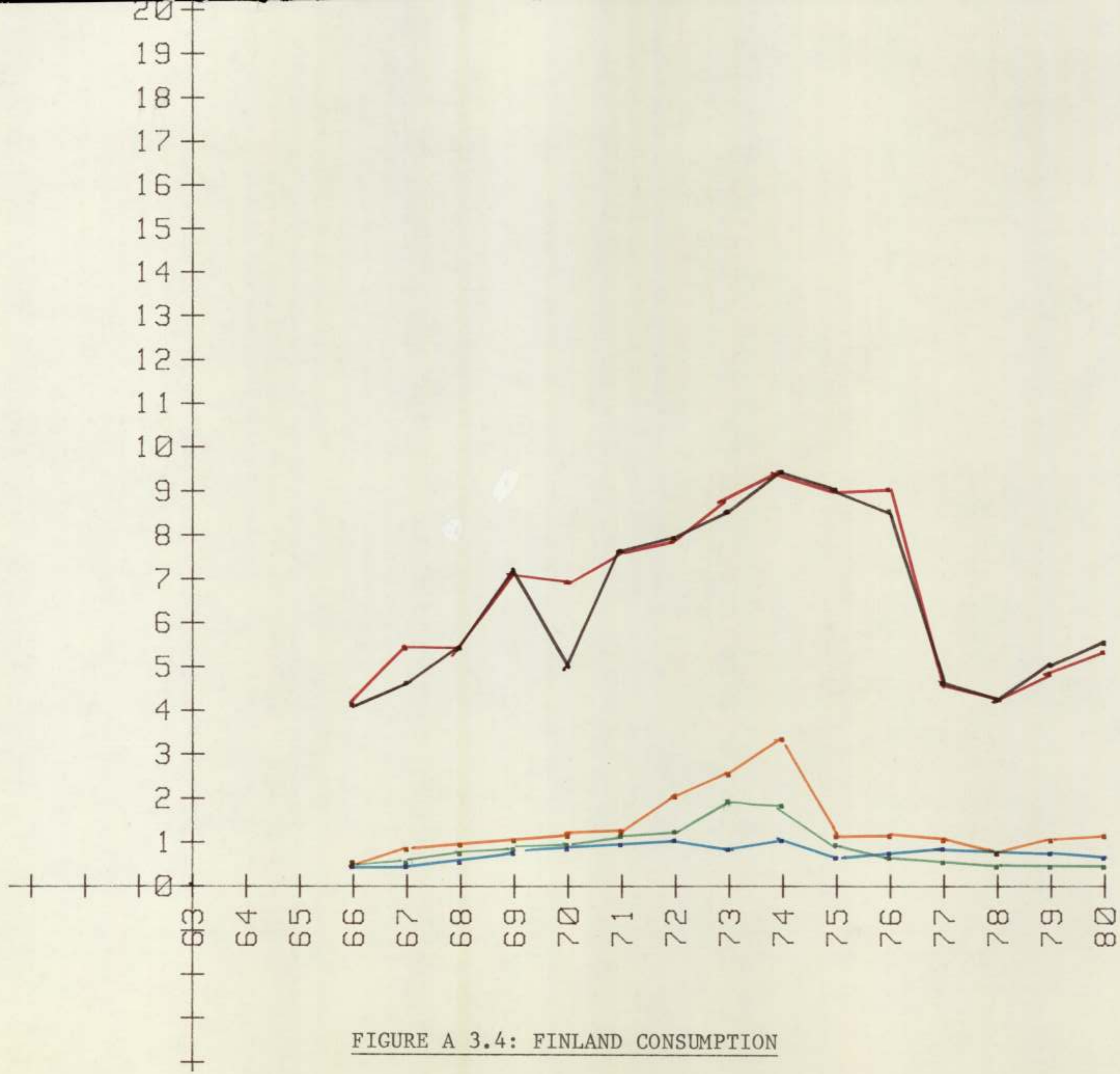


FIGURE A 3.4: FINLAND CONSUMPTION

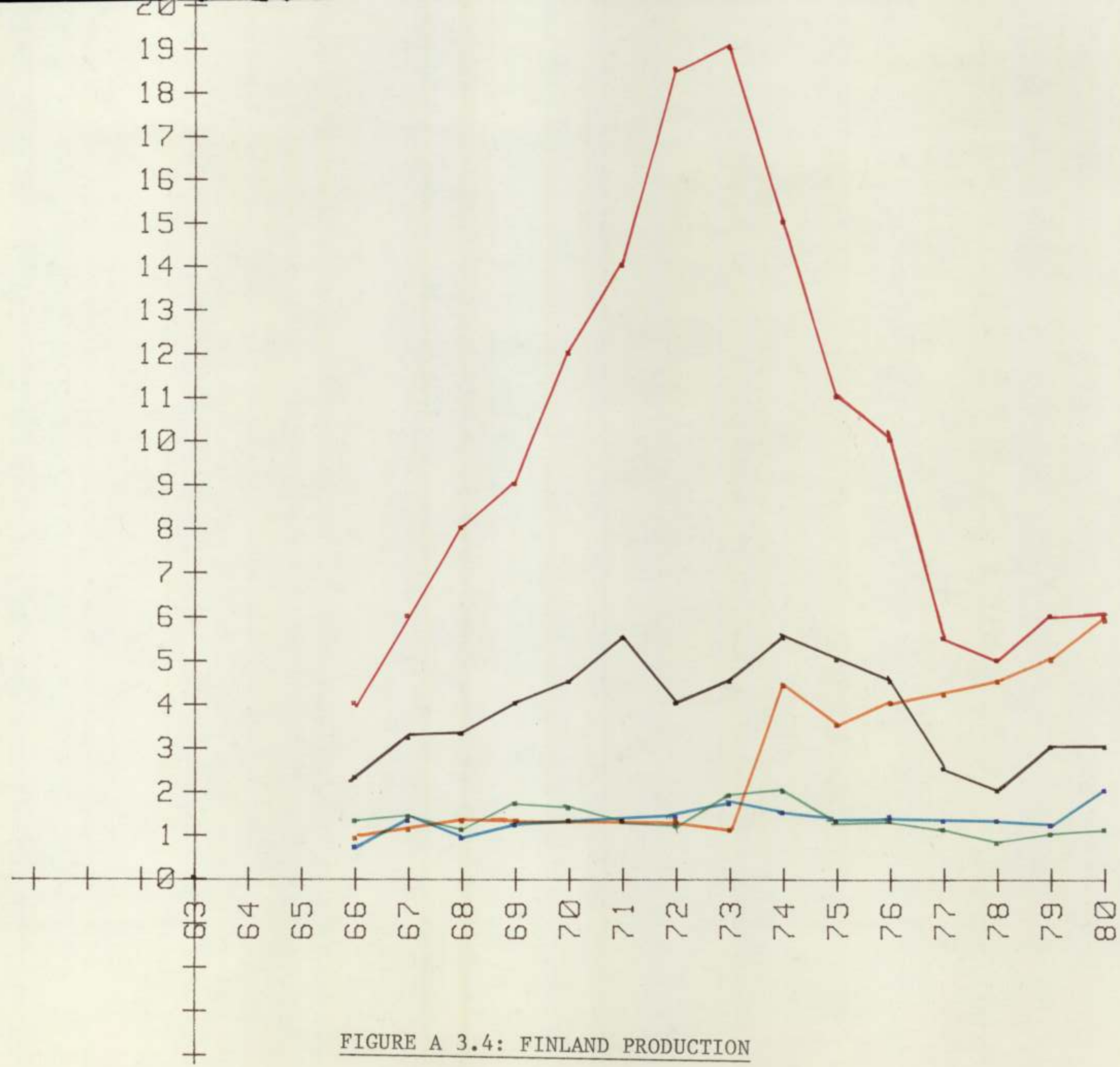


FIGURE A 3.4: FINLAND PRODUCTION

TABLE A3.5. COUNTRY - FRANCE

YEAR	HAIRSPRAY		PERSONAL CARE		HOUSEHOLD		INSECTS		MISCELLANEOUS		TOTALS FOR YEAR	
	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N
1963	17.3	18.5	12.5	12	19.7	21	24.5	23	15.4	12	89.4	86.5
1964	21.8	22	14.6	14	23.3	23	28	27.2	18.4	18	106.1	104.2
1965	41.7	40	17	17	19.6	19	24	28.9	22.1	22.5	124.4	127.4
1966	54.3	52	21.7	22	20.8	21	21	20.8	14.3	14	132.1	129.8
1967	59.9	64	24.5	24	19	19	18	17.5	26	25	147.4	149.5
1968	72.4	68	27.7	27.5	30.2	22	28	15.6	20.5	20	178.8	153.1
1969	86.3	95	33.5	32	39.6	39	15.5	15.2	28.5	22.5	203.4	203.7
1970	81.2	99	16.8	71.5	30.5	40	20	15.7	34.5	50	183	276.2
1971	89.7	100	28.7	105	30.8	41	21	17.9	45.1	67	215.3	330.9
1972	101	101	43.4	151	31.5	43	22.5	22.8	55.8	39.5	254	357.3
1973	101.9	123	63.6	145	29.2	50	23	20.9	48	55	265.7	393.9
1974	98.2	105	73	190	32.6	63	31	28.9	45.2	66.5	280	453.4
1975	95.6	95.6	81.3	166	21.6	45	25	26.4	48.6	62	272.1	395
1976	105	105	91	201	30.7	54	26	26.5	84.7	68	337.4	454.5
1977	100.9	97.5	74.3	211	26.5	55.5	24	29.7	57.3	76	283	469.7
1978	85.3	91	27	193	25.6	48	13.5	26.6	57	77	208.4	435.6
1979	85	88	35	190	26	45	12	27	60	80	218	430
1980	83	85	40	195	25	40	14	28	62	95	224	443

NOTE : ALL CONSUMPTION (CONS'N) AND PRODUCTION (PROD'N) FIGURES IN UNITS x 10^6

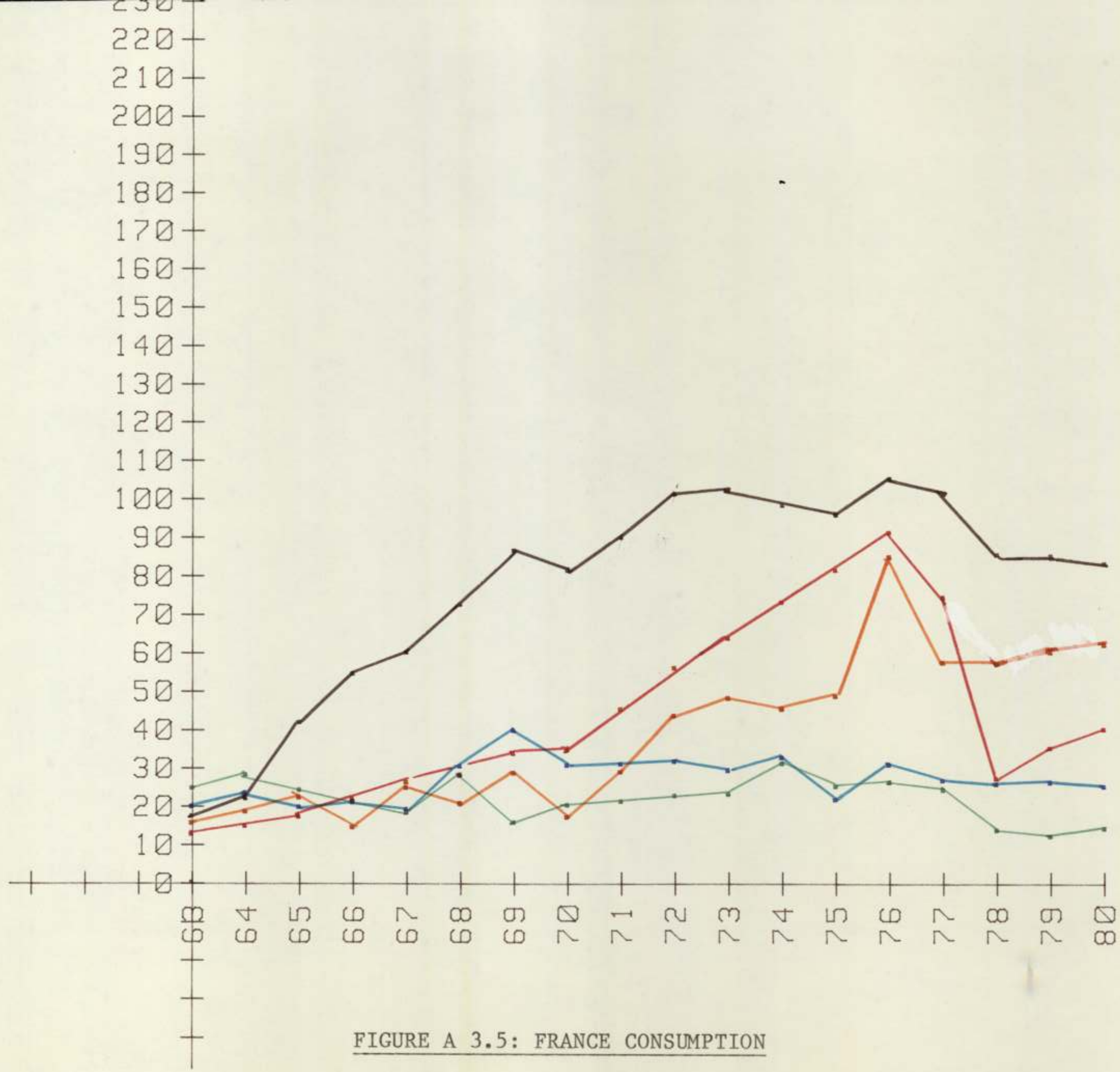


FIGURE A 3.5: FRANCE CONSUMPTION

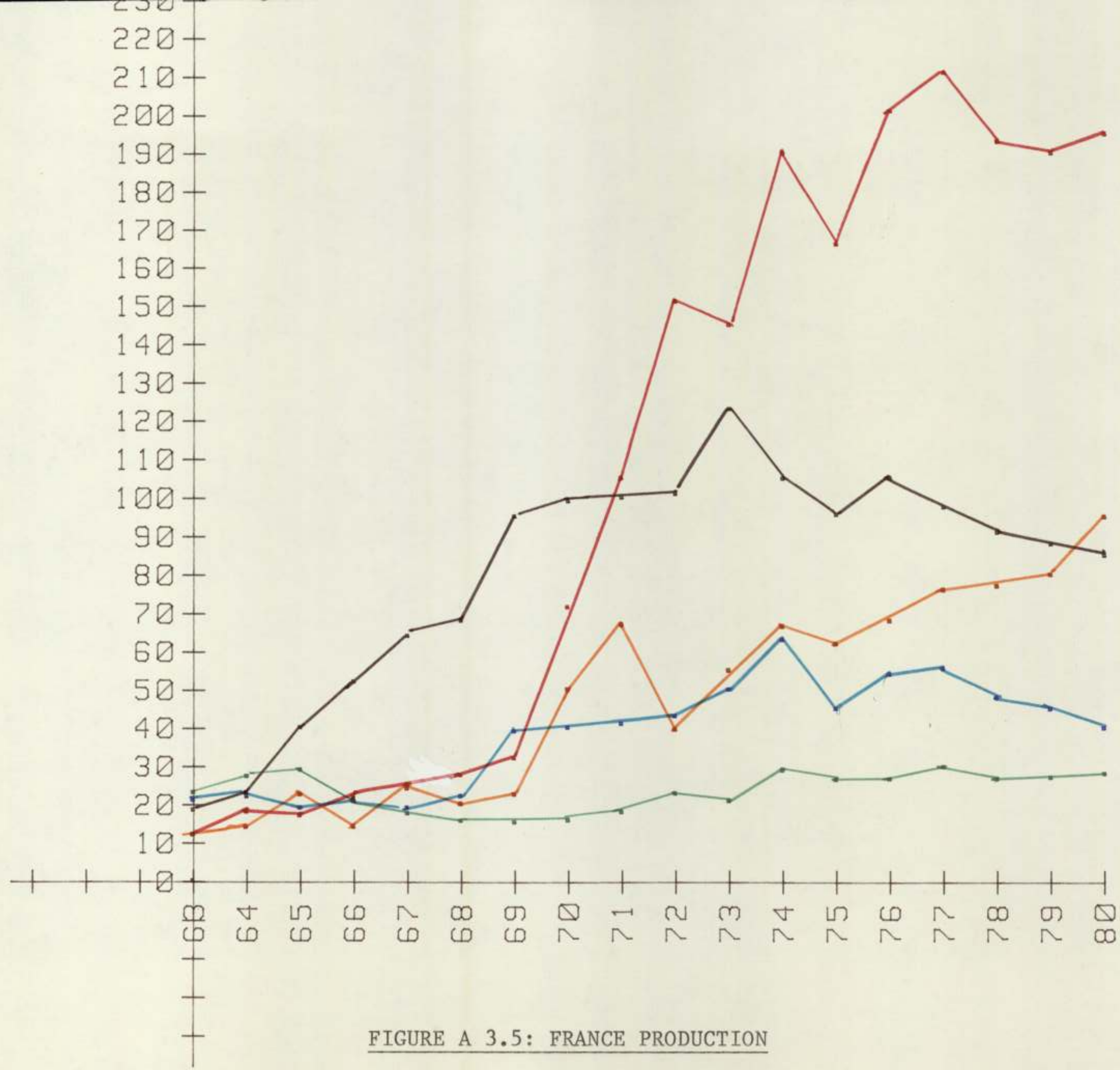


FIGURE A 3.5: FRANCE PRODUCTION

TABLE A3.6. COUNTRY - W GERMANY

YEAR	HAIRSPRAY		PERSONAL CARE		HOUSEHOLD		INSECTS		MISCELLANEOUS		TOTALS FOR YEAR	
	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N
1963	37.3	71	14	14	9.6	7	5.8	9	4.5	19	71.2	120
1964	84.5	85	25.7	17.5	14.9	9	7.4	11	5.1	29	137.6	151.5
1965	115.4	92	31.2	24	20.8	8.5	9.8	10.5	5.8	49	183	184
1966	125.9	109	35	30	26.8	26	11.1	12.5	8.8	31	207.6	208.5
1967	129.5	120	43.5	45	32.4	29	11.2	13	10	32.5	226.6	239.5
1968	139.7	135.5	55.9	73.5	35.7	33.5	12.5	13.5	13.7	36	257.5	292
1969	148.9	126	103.9	105	45.6	43	13.2	13.5	13.8	43	325.4	330.5
1970	157.7	160	120.1	129	53.4	51	13.3	13	15.2	48	359.7	401
1971	150.8	147	128.7	144	55.2	53.5	13.5	14	17.2	53	365.4	411.5
1972	132.6	131.5	131.4	133	53	53	14.2	14	52.4	57	383.6	388.5
1973	140	140	145	146	42.9	43	14.9	15	52.7	53	395.5	397
1974	139	139	158.8	159	50.9	50	16.1	16	54	54	418.8	418
1975	136	136	164.5	165	53.2	53	14.8	16	55	56	423.5	426
1976	133.5	134	159.9	174	52.9	54.5	26.5	26	68.9	69	441.7	457.5
1977	128.9	130	151	171	54	55.5	15.4	24	65.1	74	414/4	454.5
1978	122.6	125	128.8	169	50.9	50	14.1	20	67.4	86	383.8	450
1979	125	130	130	170	52	52	13	21	70	90	390	463
1980	130	120	129	171	54	53	14	23	75	95	402	462

NOTE : ALL CONSUMPTION (CONS'N) AND PRODUCTION (PROD'N) FIGURES IN UNITS x 10^6

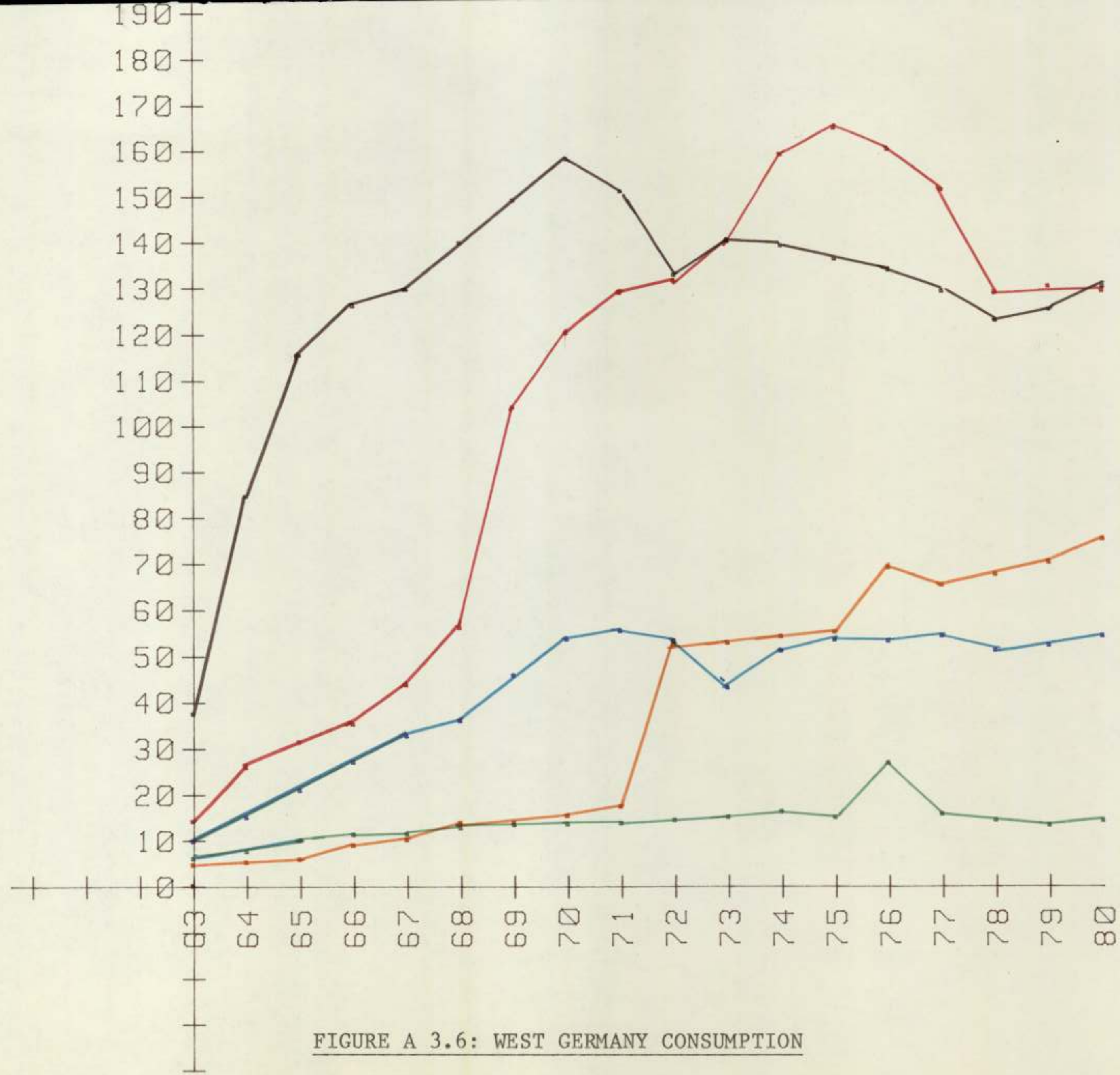


FIGURE A 3.6: WEST GERMANY CONSUMPTION

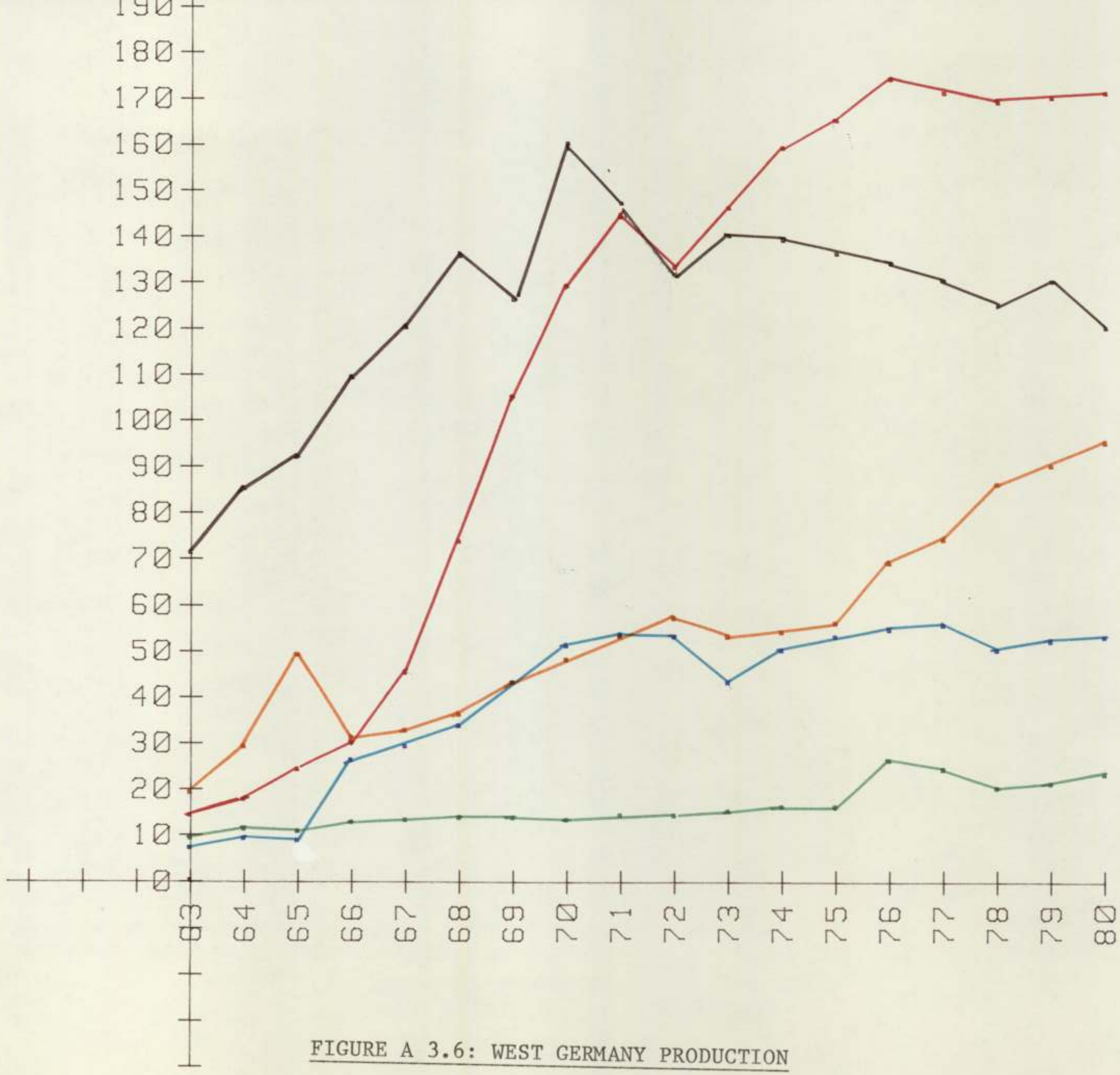


FIGURE A 3.6: WEST GERMANY PRODUCTION

TABLE A3.7.

COUNTRY - GREECE

YEAR	HAIRSPRAY		PERSONAL CARE		HOUSEHOLD		INSECTS		MISCELLANEOUS		TOTALS FOR YEAR	
	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N
1963												
1964												
1965							0.8	1.5				
1966	0.9	0.5	1.2				2.6	3.5				
1967	2.1	1	1.7		1.4		3.9	3.8	0.3			
1968	2.3	1	2.2		1.5		3.5	4	0.8			
1969	2.6	1.5	2.6	0.5	2.1	0.5	4.4	5	0.4		12.1	7.8
1970	2.8	1.5	3.2	1.0	2.4	1	5.3	5.5	0.8	0.6	14.5	9.6
1971	3.0	1.8	3.5	1.5	4	1.5	4.8	6.5	1	0.6	16.3	11.9
1972	2.7	2	3.6	3	4.4	3.5	7.2	6.8	1.2	0.8	19.1	16.1
1973	2.7	2.5	3.7	5	4.6	3.6	9.6	9	0.9	0.8	21.5	20.9
1974	2.6	2.8	3.7	5.5	3.8	3.7	10.9	10.5	1	1	22	23.5
1975	3.6	2.5	3.9	6	3.1	3.1	9.4	9.5	0.9	0.9	20.9	22.3
1976	3.6	3.6	4.2	7	4.5	4.4	10.1	10.5	0.8	0.9	23.2	26.4
1977	4.2	3.7	4.6	7.5	6.1	6.1	10.2	9.5	1.4	1.4	26.5	28.6
1978	3.9	4.2	4.6	8.5	4.3	4.2	11.3	11.5	1.9	1.9	26	30.3
1979	4	4.5	5.1	9	5	4.5	12	12	2.1	2	31.2	32
1980	4.5	3.5	5.5	8.2	5.5	4	12	10	2.5	2.3	30	28

NOTE : ALL CONSUMPTION ($CONS^{N}$) AND PRODUCTION ($PROD^{'N}$) FIGURES IN UNITS x 10^6

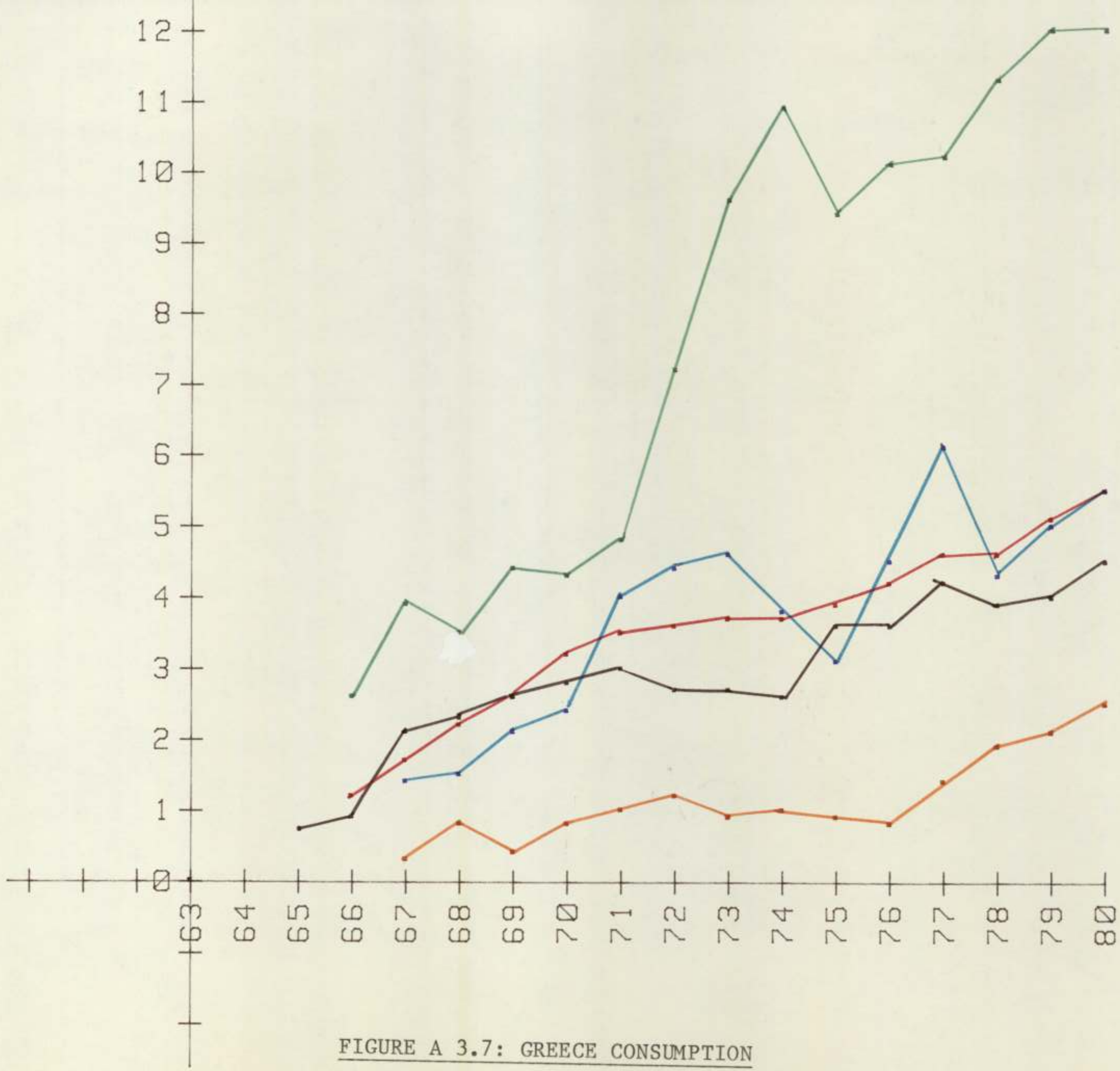


FIGURE A 3.7: GREECE CONSUMPTION

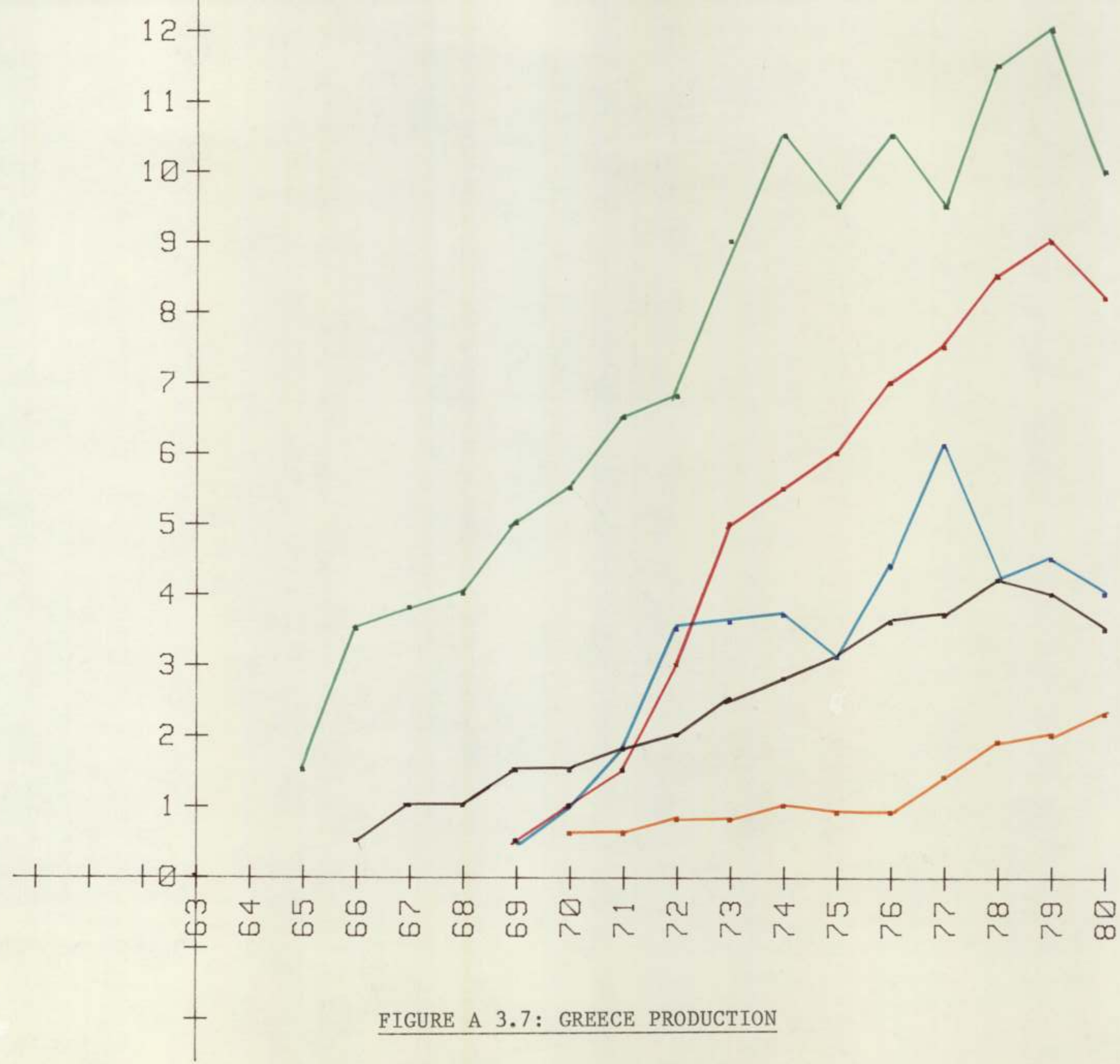


FIGURE A 3.7: GREECE PRODUCTION

TABLE A3.8. COUNTRY - HOLLAND

YEAR	HAIRSPRAY		PERSONAL CARE		HOUSEHOLD		INSECTS		MISCELLANEOUS		TOTALS FOR YEAR	
	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N
1963												11
1964												25
1965												31
1966												28
1967												33
1968	11.7		5.6		11.6		6		0.4			40
1969												80
1970	16.8		8.5		13		5.6		1			90
1971	23.3		9.5				5.1		1.1			119
1972	21.1	21.1	11.1	13	13.7	50.4	8.5	21.8	8.4	13.7	62.8	120
1973	25	23.8	14.8	17.6	14.3	53.8	9	25	9.5	16.2	72.6	136
1974	23	23	18	21	16.2	73.8	11	24	8	14.3	76.2	155
1975	20.3	19.2	12.2	17	15	72.8	7.9	27.3	5.5	11.7	60.9	147
1976	14.3	18	9.9	18	12.5	69	3.4	24.8	8	16	48.1	148.5
1977		17		10	9.8	69		32		20		143
1978	12.6	13	5.6	7	10	83	9.8	23	8.5	13	46.5	139
1979	13	15	5.6	15	11	85	10	23	9	14	48.6	159
1980	14	18	6	21.5	10	92	9.9	25	8.8	18.5	48.7	175

NOTE : ALL CONSUMPTION (CONS'N) AND PRODUCTION (PROD'N) FIGURES IN UNITS x 10^6

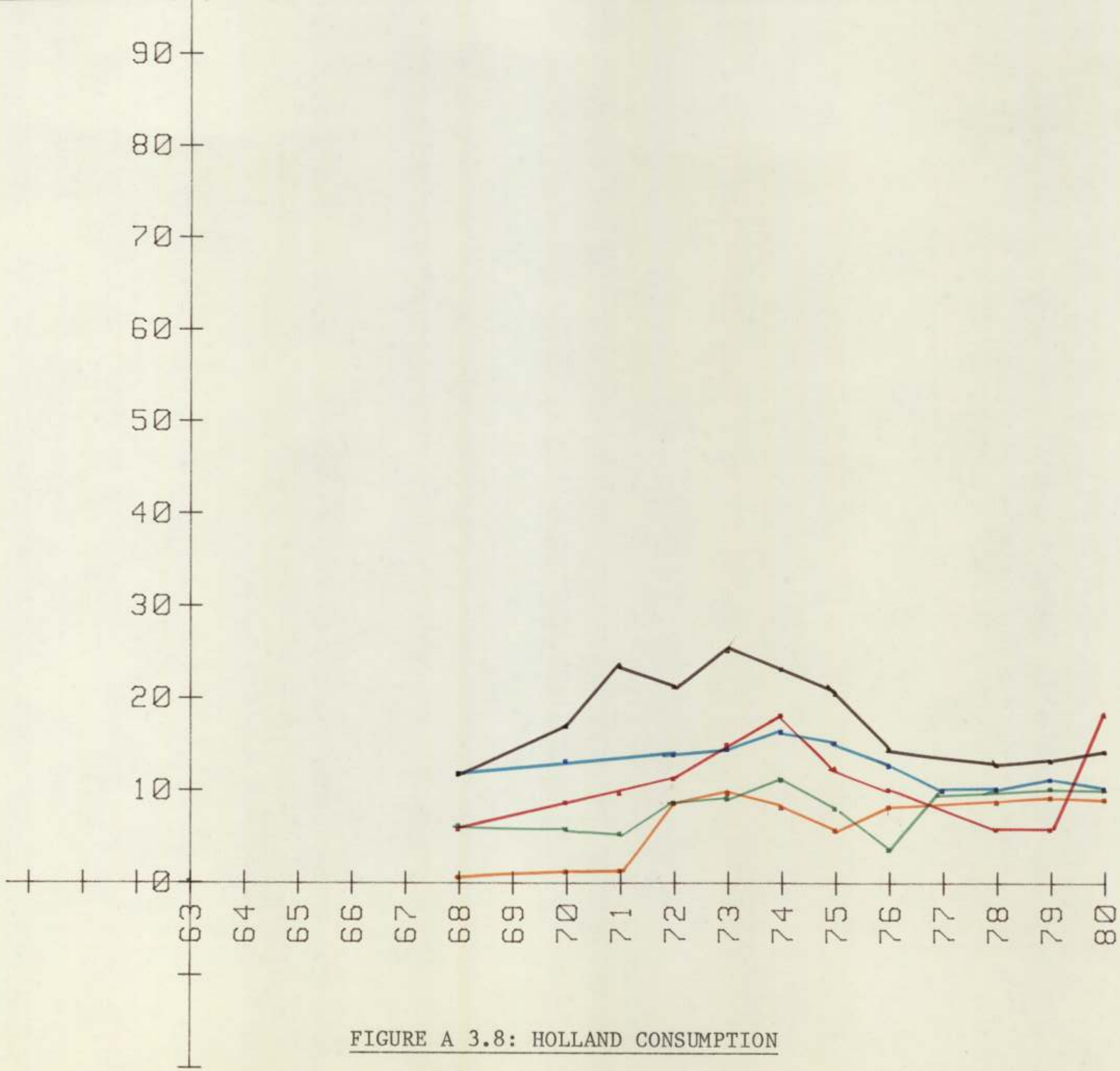


FIGURE A 3.8: HOLLAND CONSUMPTION

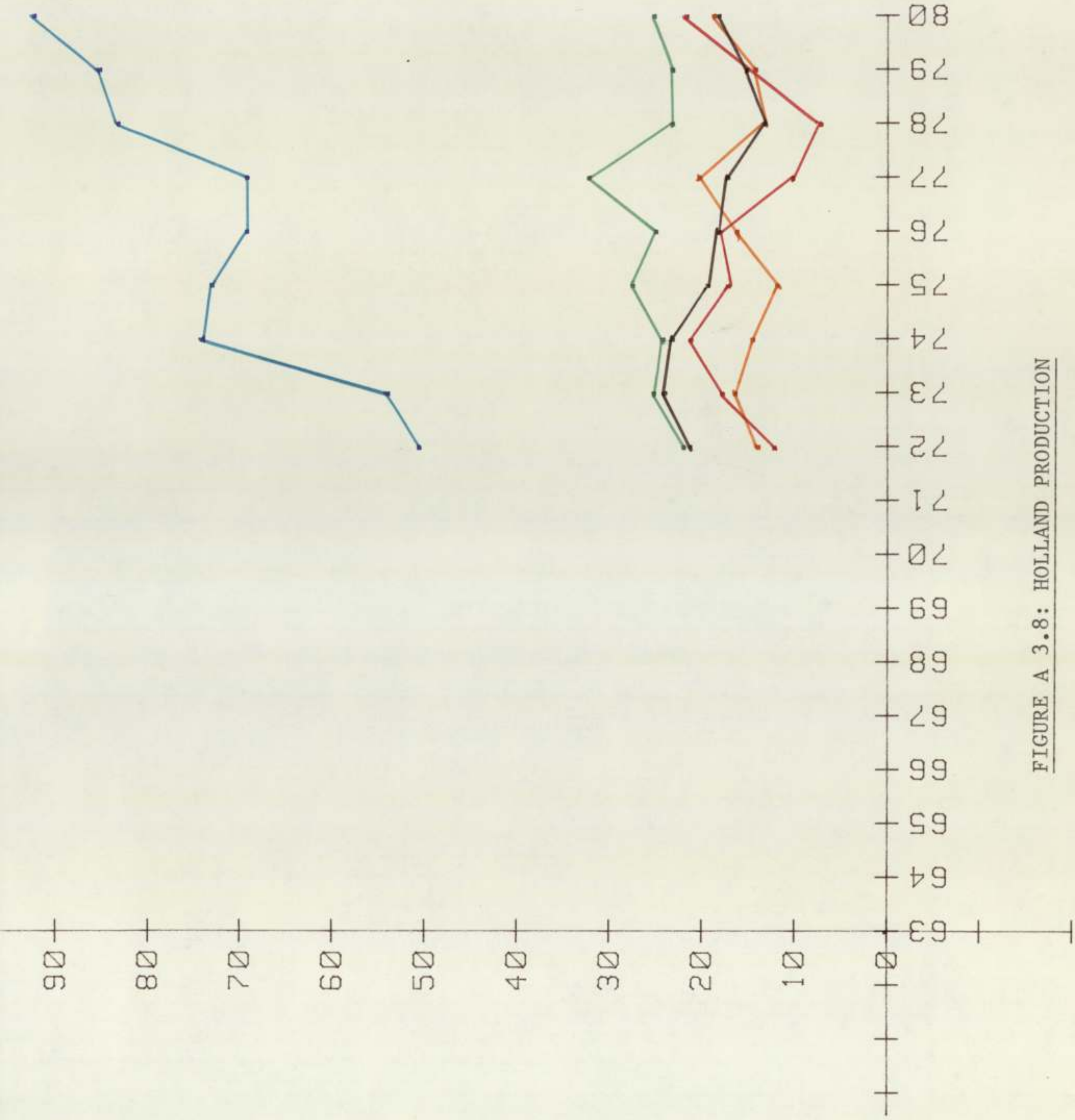


FIGURE A 3.8: HOLLAND PRODUCTION

TABLE A3.9 COUNTRY - ITALY

YEAR	HAIRSPRAY CONS'N	HAIRSPRAY PROD'N	PERSONAL CARE CONS'N	PERSONAL CARE PROD'N	HOUSEHOLD CONS'N	HOUSEHOLD PROD'N	INSECTS CONS'N	INSECTS PROD'N	MISCELLANEOUS CONS'N	MISCELLANEOUS PROD'N	TOTALS FOR YEAR CONS'N	TOTALS FOR YEAR PROD'N
1963						5.5		17				
1964		10		13		3		22		1.5		
1965		30		10	3.1	7		33		5		
1966		40	5.2	16.5	13	13		33.5		8		
1967		41.5	7.9	16.2	17.8	15.5		33.5		11		
1968	48.6	48	9.4	23	17.4	14		38		10.5		
1969	51	51	18.1	26	20.2	16		37		8.5		
1970	56.9	49	22.5	29	21.5	16	45.6	38	4.3	9.5	131.8	141.5
1971	55.6	54	25.9	31.5	27	19	38.5	38.5	9.2	14	151.2	157
1972	58.7	57	28.3	38.5	23.4	28	37	38.5	12	11	159.4	173
1973	59.8	58	14.3	43	25.3	25	48.3	49.5	19.2	18	166.9	193.5
1974	54	54	16.1	47	26	26	53.2	52.5	23.3	22	172.6	201.5
1975	49	49	14	41	22.9	23.5	39.6	40.5	19.5	30	145	184
1976	56	56	22.5	68	32	31	56.2	55	42.7	42.5	209.4	257.5
1977	59.3	56	35	43	46.9	13	70.6	38	31.1	42.5	243.1	192.5
1978	60.7	60	39.7	59	78.8	25	81.1	39.5	32.7	25.5	293	209
1979	61	65	40	60	80	30	82	40	24	26	287	221
1980	60	64	42	70	75	42	85	49	23	27	285	252

NOTE : ALL CONSUMPTION (CONS'N) AND PRODUCTION (PROD'N) FIGURES IN UNITS x 10^6

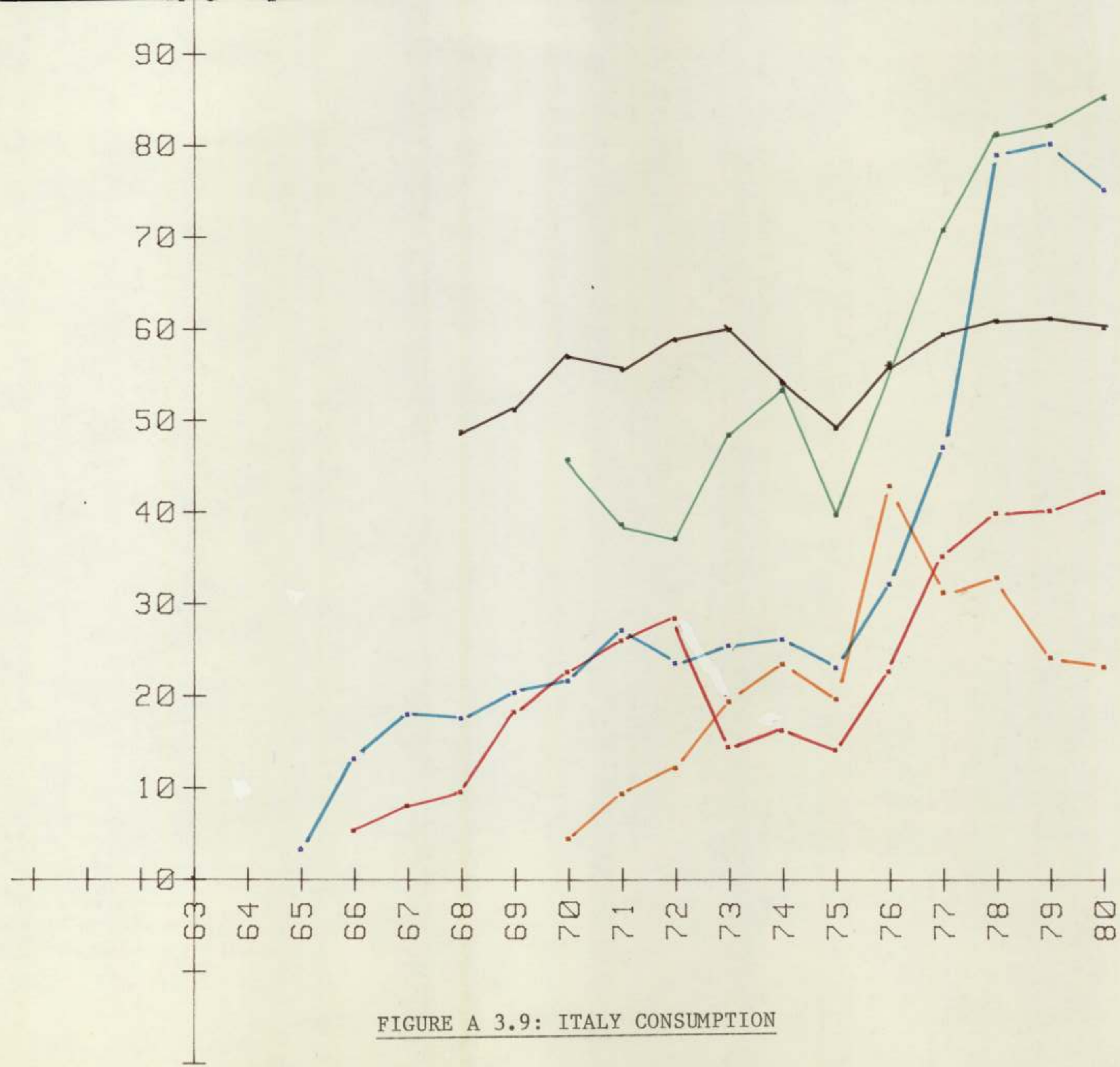


FIGURE A 3.9: ITALY CONSUMPTION

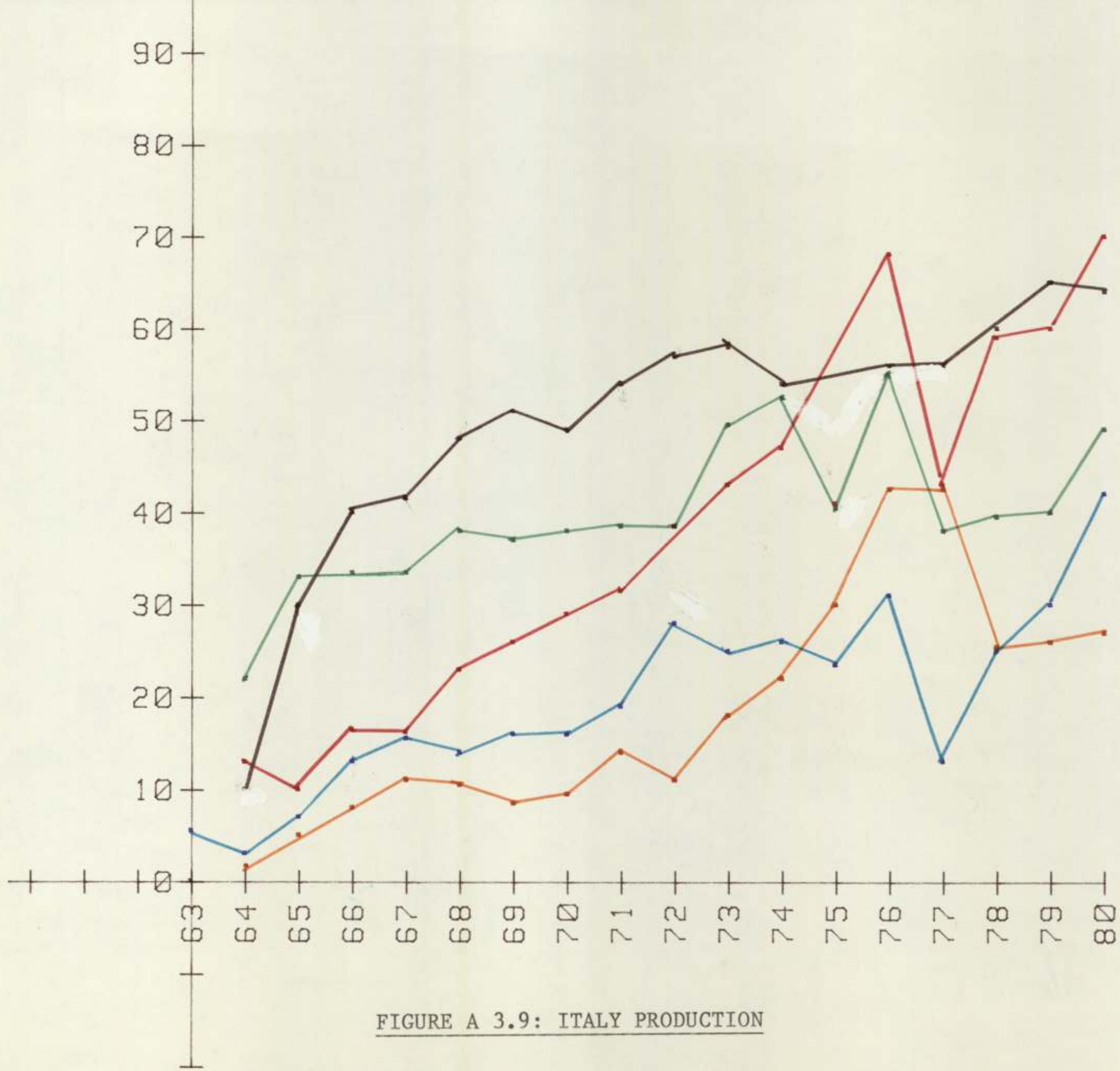


FIGURE A 3.9: ITALY PRODUCTION

TABLE A3.10 COUNTRY - NORWAY

YEAR	HAIRSPRAY		PERSONAL CARE		HOUSEHOLD		INSECTS		MISCELLANEOUS		TOTALS FOR YEAR	
	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N
1963												2.5
1964												3
1965	3.2		1.5		0.2		0.4		0.1			5
1966	3.7		1.8		0.5		0.2		0.4			8
1967	4.5	5.9	3.3	1.5	0.6	0.9	0.4	0.8	0.7	1.9		11
1968	5.2	7	4.5	2.8	0.8	1	0.5	0.6	1.3	2.5		14
1969	5.2	6.6	5.9	4.5	1.1	1.3	0.5	0.8	1.8	2.4		15.6
1970	6		6.8		1		0.5		2.2			13
1971	6.4	7.2	6.8	5.6	1.3	1.5	0.6	0.8	2.4	2.8	17.9	18
1972	6.7	6.7	7.5	7.5	1.3	1.3	0.5	0.8	1.6	2.7	17.9	19
1973	6.8	6.8	8.2	8.2	1.2	1.2	0.5	0.9	2.4	2.4	19.5	19.5
1974	5.7	5.6	8.5	8.5	1.9	1.9	0.6	0.7	2.6	2.7	19.4	19.4
1975	4.8	4.8	7.3	7.3	1.9	1.9	0.6	0.6	2.3	2.8	16.9	17.4
1976	4.4		6.9		2.2		0.5		2.7		16.8	14
1977	4.2		5.6		2.5		0.4		2.3		15	15
1978	4.1		3.9		2.2		0.4		2.2		12.8	12
1979												11
1980		4		4.2		0.9		0.4		0.5		10

NOTE : ALL CONSUMPTION (CONS'N) AND PRODUCTION (PROD'N) FIGURES IN UNITS x 10^6

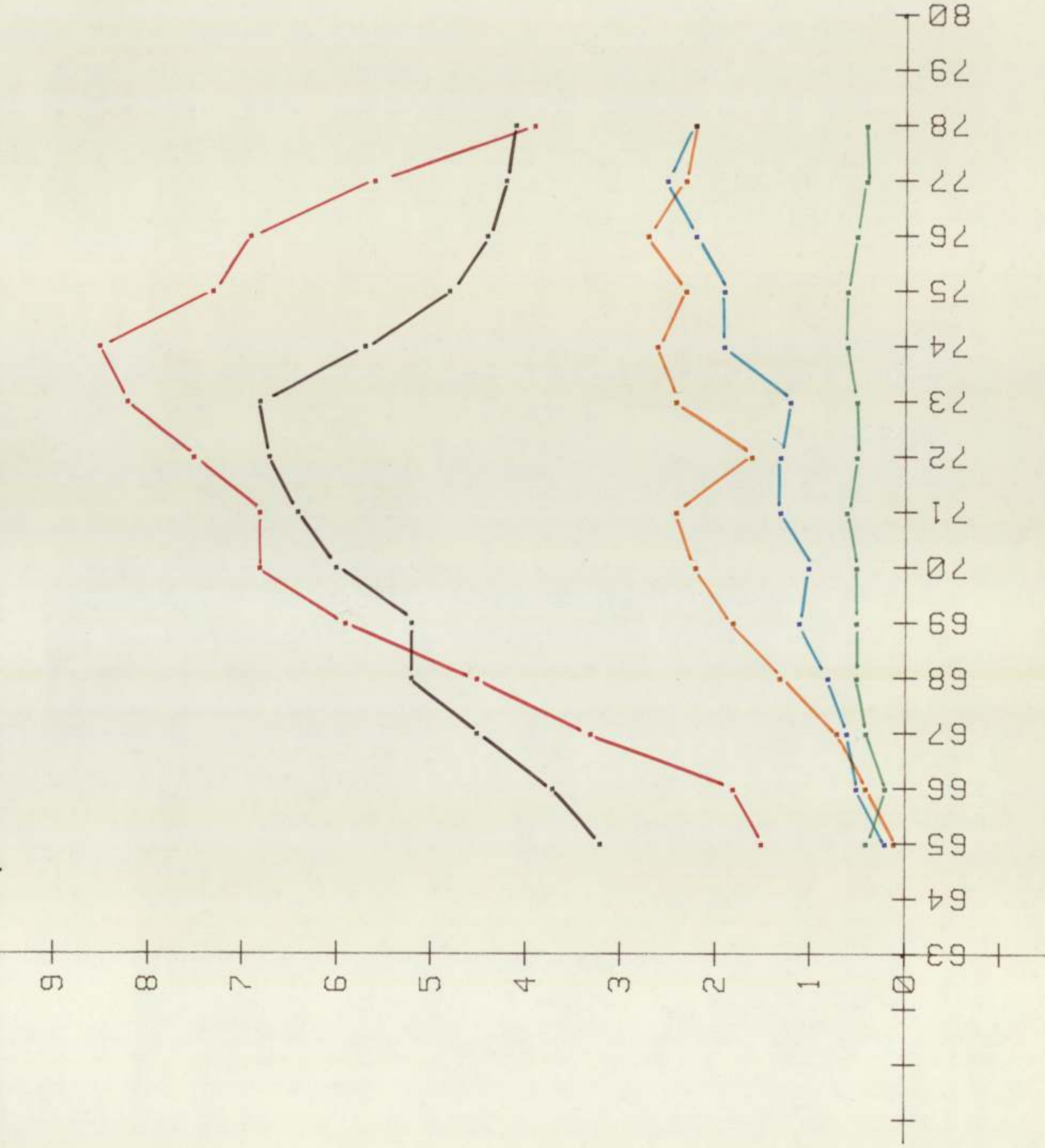


FIGURE A 3.10: NORWAY CONSUMPTION

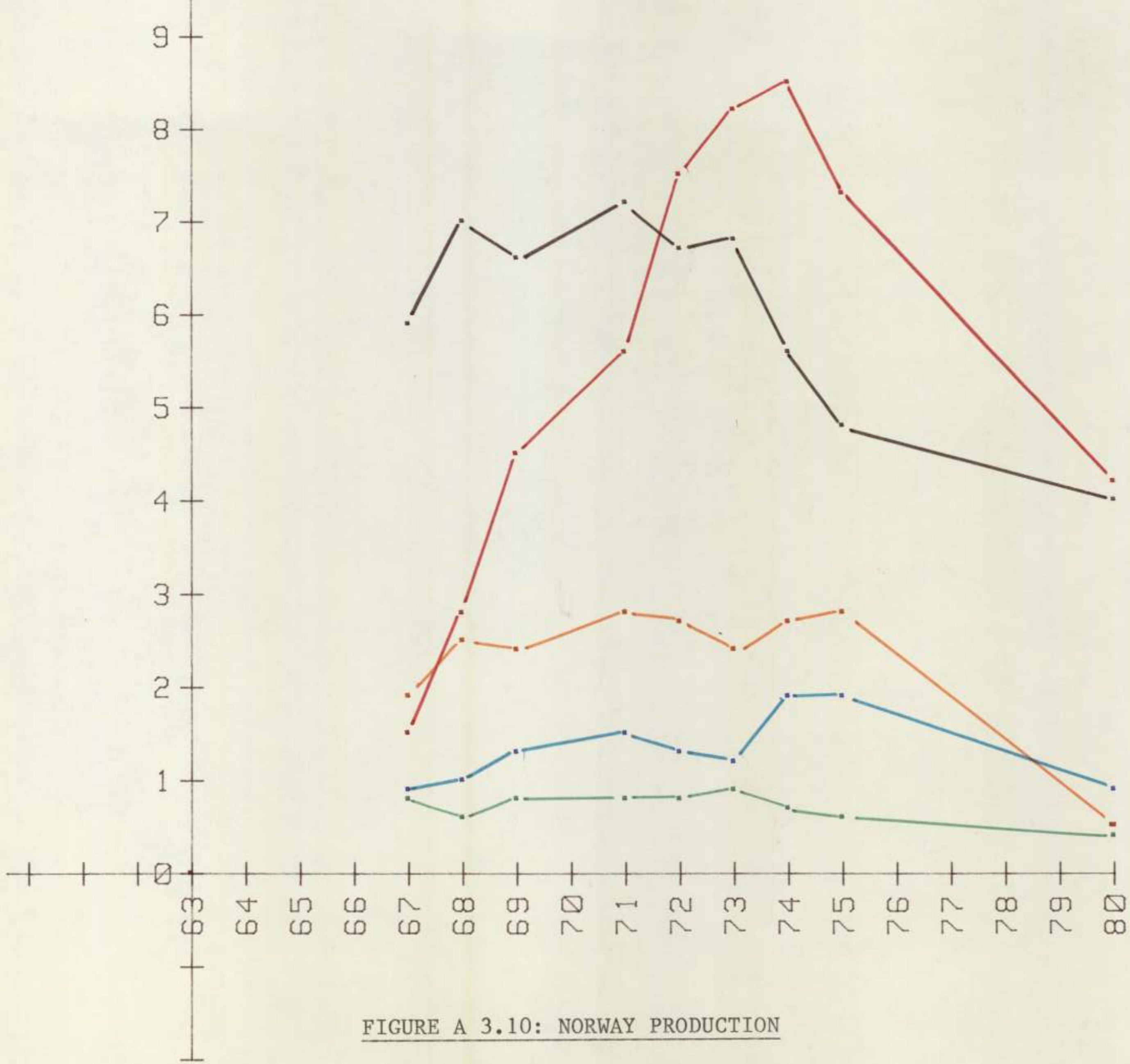


FIGURE A 3.10: NORWAY PRODUCTION

TABLE A3.11 COUNTRY - PORTUGAL

YEAR	HAIRSPRAY		PERSONAL CARE		HOUSEHOLD		INSECTS		MISCELLANEOUS		TOTALS FOR YEAR	
	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N
1963												0.5
1964												1
1965												1.5
1966												2
1967			0.4	0.7			1	1				2.5
1968			0.8	0.8	0.2	0.4	1.7	1.2				3
1969	0.3	0.5	1.7	1	0.5	0.5	2.2	1.4				3.5
1970	0.4	0.6	1.4	1.1	0.8	0.6	2.1	1.5				4
1971	0.7	0.9	1.3	1.7	0.3	0.9	2.2	2.3				6
1972	0.9	0.9	1.8	1.8	1	0.9	2.5	2.5	0.3	0.3	5.5	6.5
1973	1.1	1.1	6.5	2.2	1.1	1.1	3.1	3.1	0.4	0.4	12.2	8
1974	1.8	0.9	2.7	1.7	2.1	0.9	5.1	2.3	0.6	0.3	12.3	6
1975	2.3	1.7	4	3.4	2.8	1.7	6.2	4.6	0.9	0.6	16.2	12
1976	2.7	2.5	5.4	5.1	2.7	2.6	7.4	6.9	1.1	1.0	19.3	17
1977	2.8	4.4	5.8	8.7	4.4	4.4	8.5	11.9	1.2	1.6	22.7	31
1978	8.3	3.4	6.8	6.7	3.4	3.4	9.2	9.2	1.3	1.3	19.8	24
1979												
1980												

NOTE : ALL CONSUMPTION (CONS'N) AND PRODUCTION (PROD'N) FIGURES IN UNITS x 10^6

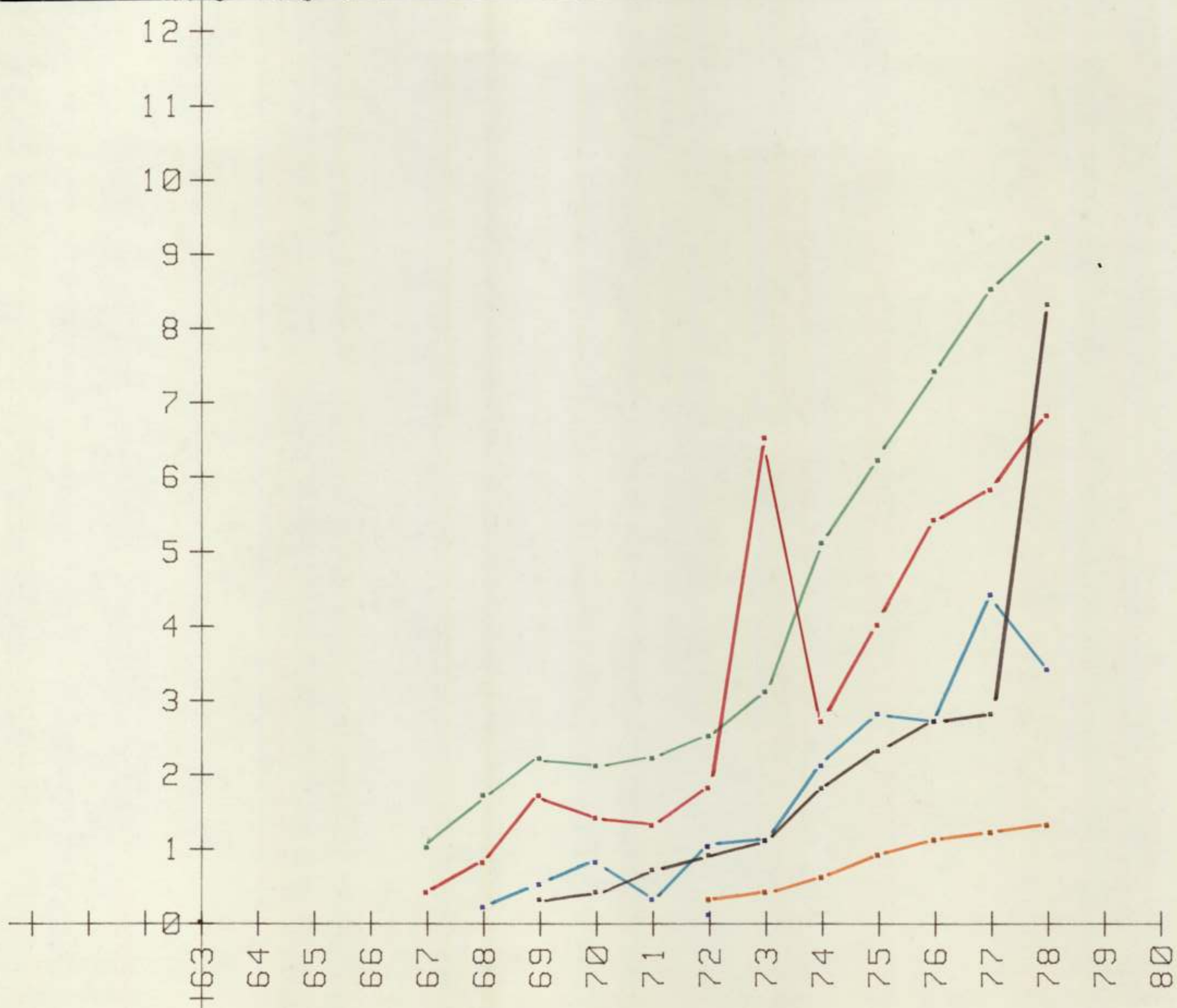


FIGURE A 3.11: PORTUGAL CONSUMPTION

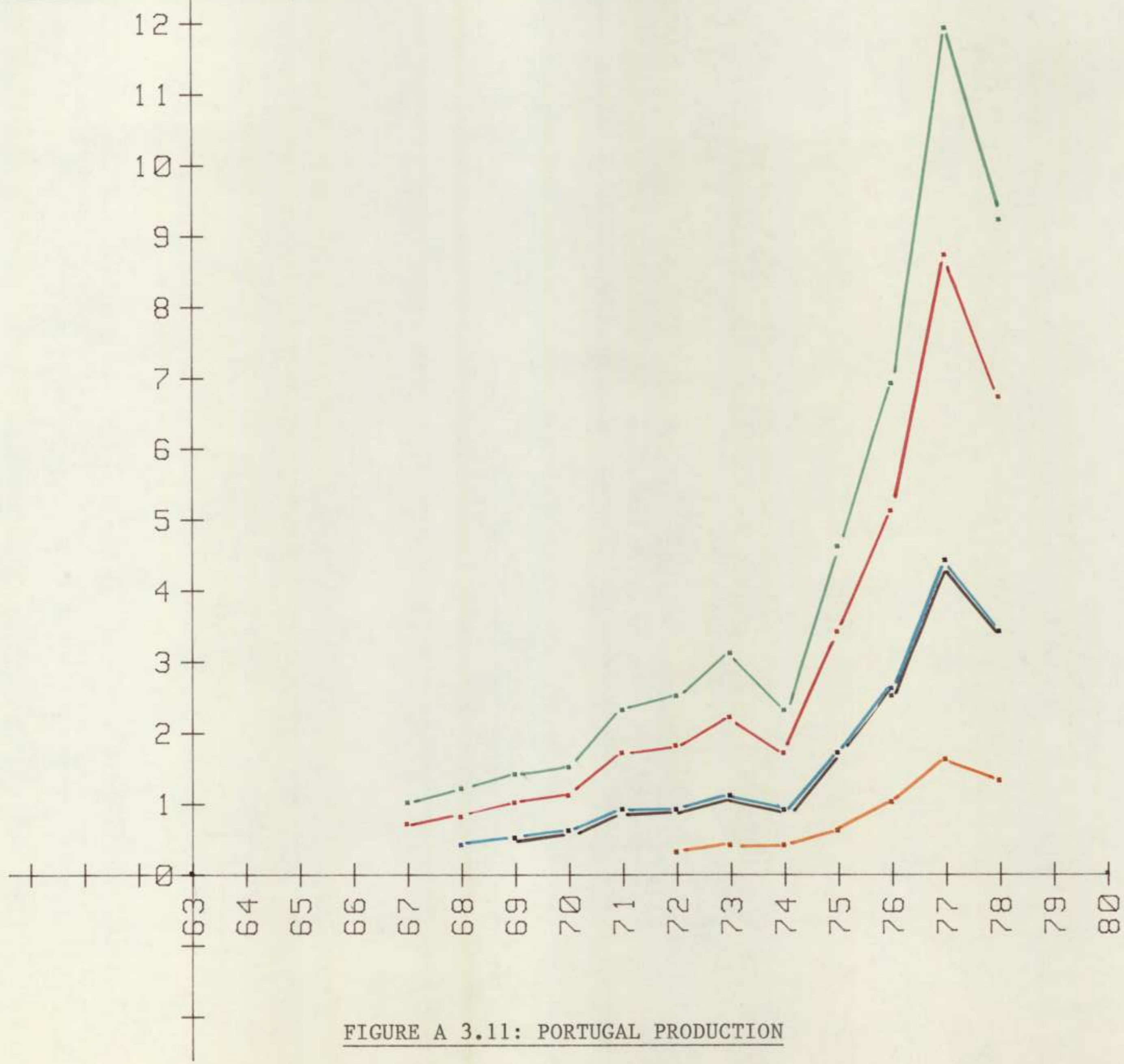


FIGURE A 3.11: PORTUGAL PRODUCTION

TABLE A3.12 COUNTRY - SPAIN

YEAR	HAIRSPRAY		PERSONAL CARE		HOUSEHOLD		INSECTS		MISCELLANEOUS		TOTALS FOR YEAR	
	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N
1963		0.6		0.5								2.6
1964	1.5	1.5										5
1965	4	3.6						2.5				8.2
1966	3.7	5.9					5.9	6.0				13.8
1967	8.2	5					6.0	6.5				25
1968	11.4	8	13.9	4	0.3	2.1	9.3	9.9	1.7	2	36.6	26
1969	11.6	11.5	16.2	4.5	1.8	2	8.7	9.5	1.7	4	40	30
1970	13.5	11	19.3	7	2	4	10.8	10.5	5.7	5.5	51.3	37
1971	12.6	13.4	18.4	11	5.5	5	13.7	14	8.5	6.5	58.7	47.7
1972	14.8	16.7	19.7	20	7.6	7	13.8	14	9.7	9.5	65.6	68.1
1973	17.4	24.9	28.6	29	12.9	13	17.4	17	13.9	14.5	90.2	99
1974	15.5	21	33.1	34	19	21	25.4	24	13	11.5	106	112
1975	18.5	18.3	28.5	29.5	21	24.5	26	26	13.5	11.5	107.5	109
1976	15.8	22	33.5	30.5	27.7	22	27.7	28	15.8	24	120.5	120
1977	22.7	23	33	40	44	23.5	39.2	31	20.2	28	159.1	146
1978	14.8	16	26	35	63.1	34	52.7	26	22.3	22	178.9	130
1979												
1980												151

NOTE : ALL CONSUMPTION (CONS^{N}) AND PRODUCTION (PROD$^{'N}$) FIGURES IN UNITS x 10^6

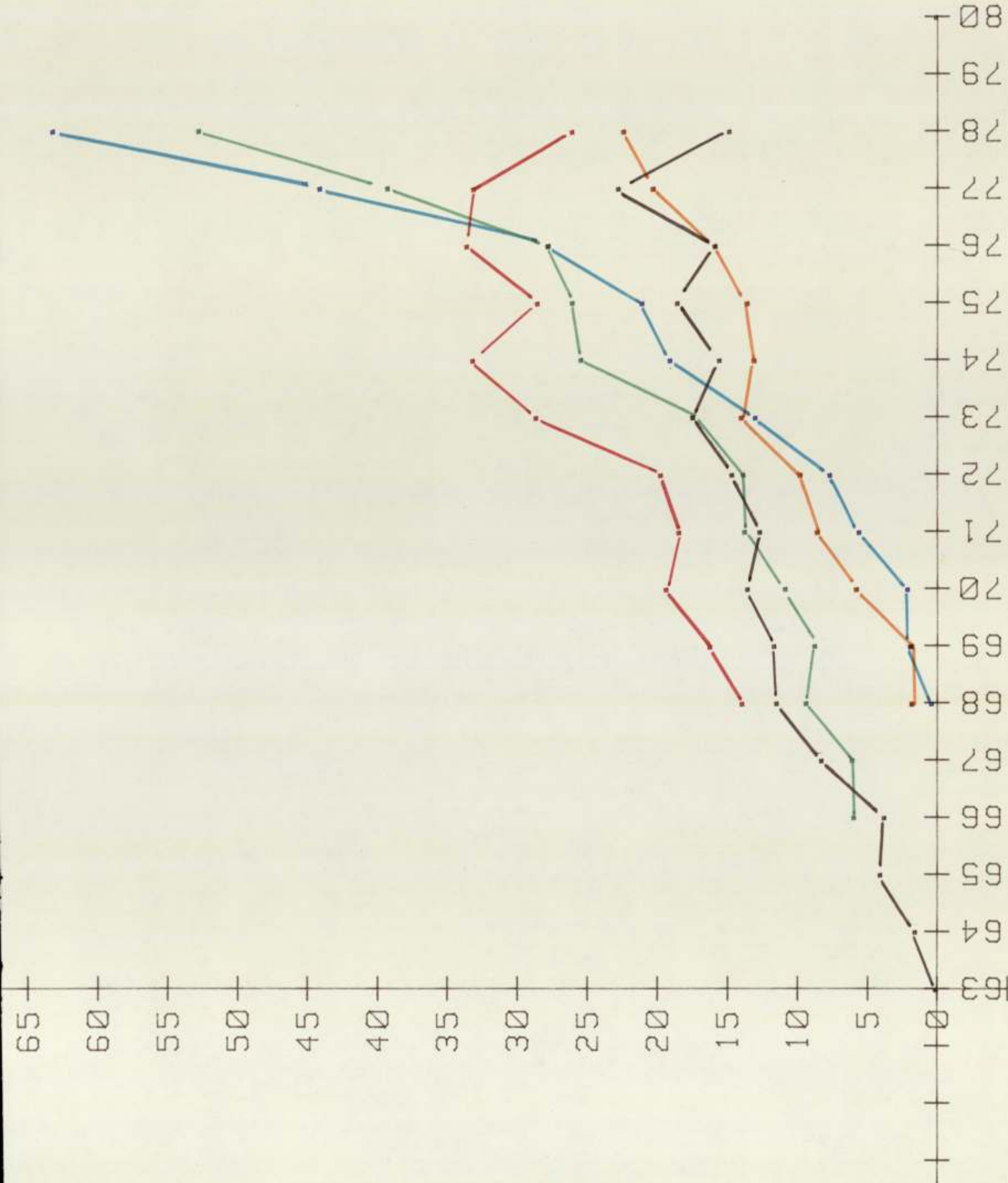


FIGURE A 3.12: SPAIN CONSUMPTION

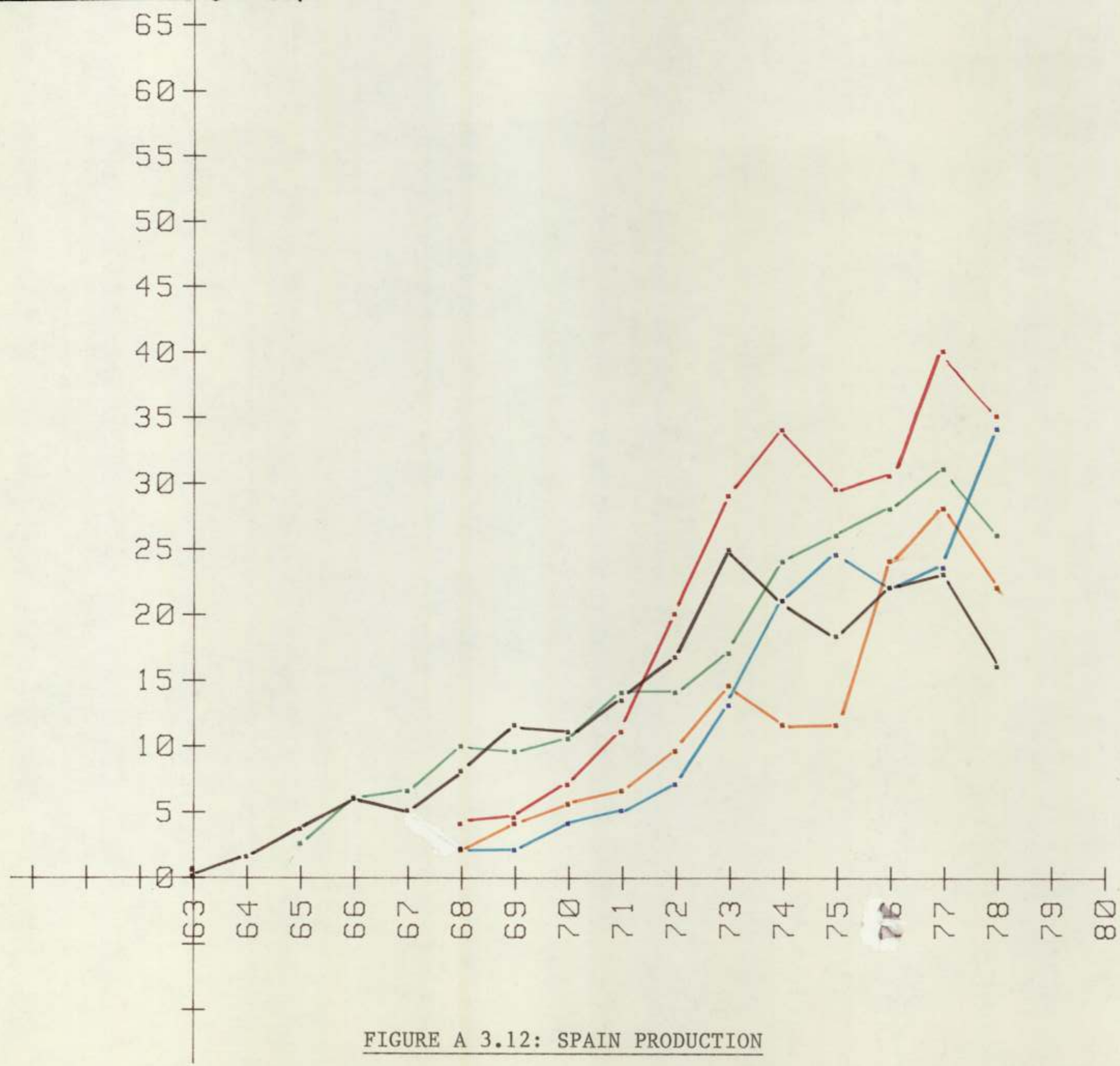


FIGURE A 3.12: SPAIN PRODUCTION

TABLE A3.13 COUNTRY - SWEDEN

YEAR	HAIRSPRAY		PERSONAL CARE		HOUSEHOLD		INSECTS		MISCELLANEOUS		TOTALS FOR YEAR	
	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N
1963		2.9		0.8		1.9						9
1964		2.8		1		1.2						11
1965	3.3	4.9		3.0	0.7	2.0	0.5	1.5		1.6		13
1966	4.9	6.8	1	4.3	0.2	1.8	0.6	2.2		2.9		18
1967	5.9	7.5	2.5	4.9	1.7	2.3	0.4	2.7	0.8	1.6	11.3	19
1968	6.4	9	5.5	5	2.8	2.3	1	2.5	3.1	4.2	18.8	23
1969	8.2	9	10	7	2.9	2.0	1.1	2	2.4	4	24.6	24
1970	10.5	9	11.3	9	3.3	2.5	0.8	1.8	2.2	1.7	28.1	23
1971	8.1	8.5	10.7	9.4	3.7	2.7	1.3	1.8	2.8	4.7	29.4	27
1972	8.2	7.7	10.9	5.9	4.1	0.8	0.9	1.7	3.1	4	27.2	20
1973	8.4	7.7	13.3	9	3.5	1.3	1.3	2	2.9	4	29.4	24
1974	9.8	6.3	13.1	8.6	2.6	1.3	1.6	1.9	2.2	6	29.3	24
1975	7.1	6	11.7	9	2.1	1	1.2	1	2.7	3	24.8	20
1976	6.1	6	10.7	8	1.9	1	0.9	1	2.9	2	22.5	18
1977	5.4	5	8.7	5	2.3	1	0.8	1	3	1	20.5	13
1978	4.6	3	7.9	5	1.7	1	1.1	1.5	2.9	1.5	18.2	12
1979												
1980												

NOTE : ALL CONSUMPTION (CONS'N) AND PRODUCTION (PROD'N) FIGURES IN UNITS x 10^6

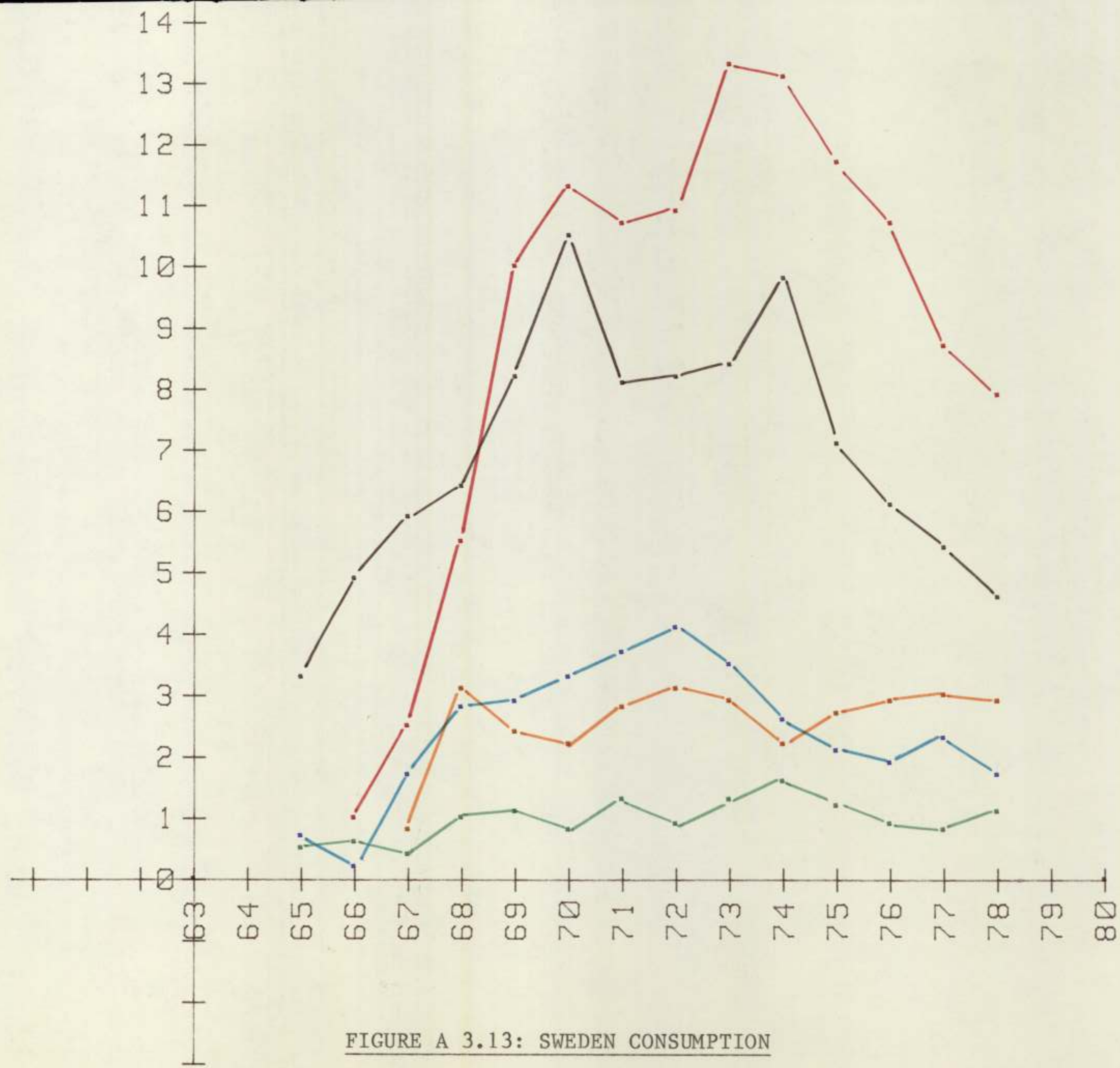


FIGURE A 3.13: SWEDEN CONSUMPTION

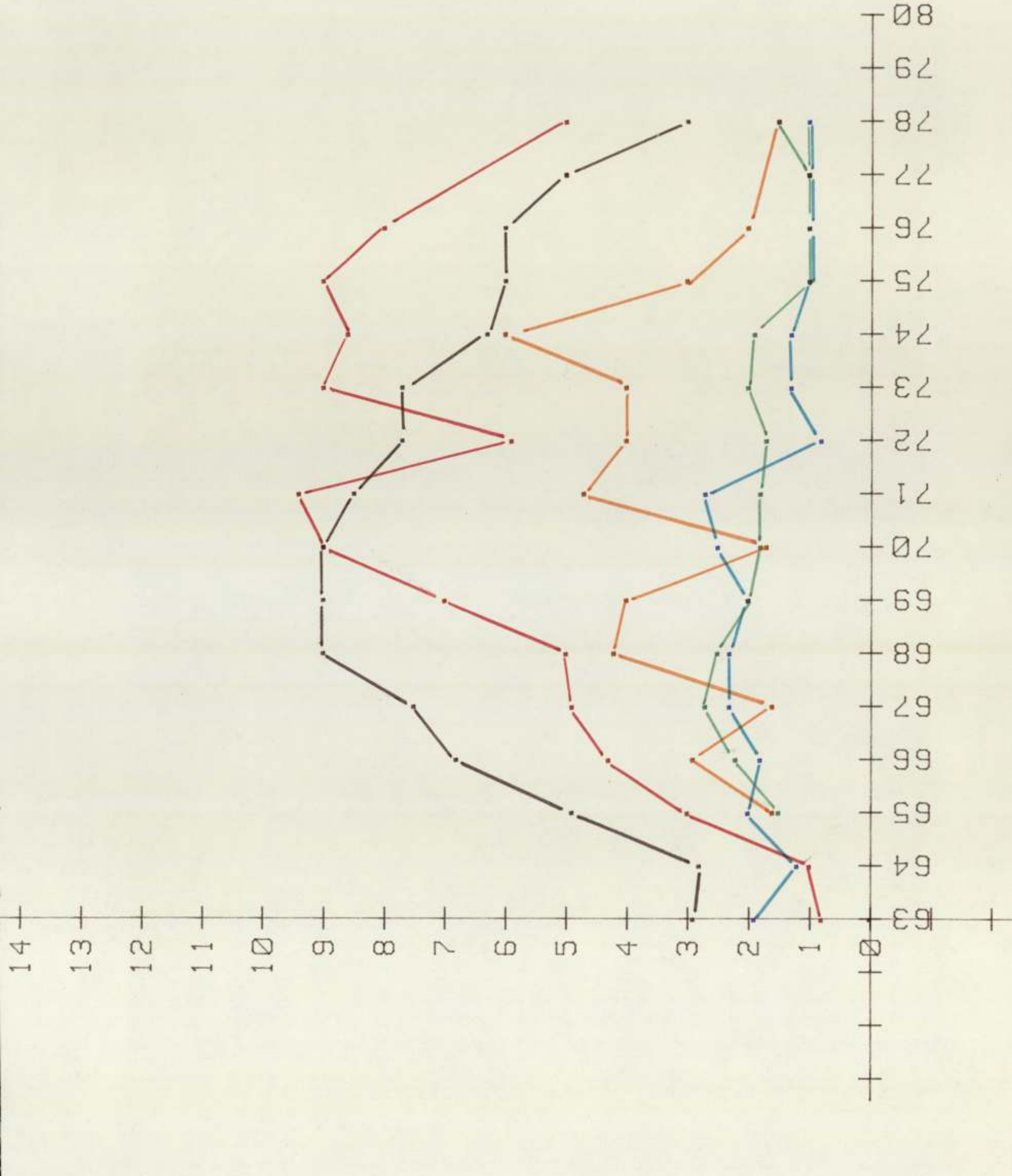


FIGURE A 3.13: SWEDEN PRODUCTION

TABLE A3.14 COUNTRY - SWITZERLAND

YEAR	HAIRSPRAY		PERSONAL CARE		HOUSEHOLD		INSECTS		MISCELLANEOUS		TOTALS FOR YEAR	
	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N
1963	9.2	7.7	6.6	2.2	7.6	2.4	0.6	1.2	0.2	2.5	24.2	16
1964	10.7	9.4	8.4	3.4	7.8	3.5	0.7	1.7	0.3	1	27.9	19
1965	12.5	13	8.6	6	7.6	4	1.2	1.1	0.8	0.9	30.7	25
1966	13.4	17	11.3	9	8.6	5	1.7	1.9	2	2	37	35
1967	14.3	17.5	12	7.4	9.8	6.4	1.4	2.2	2.2	2.5	39.7	36
1968	14.7	18.2	13.2	8.7	10.3	7.8	1.6	1.8	2.8	2.5	42.6	39
1969	15.4	18.7	14.7	11.9	11.3	8.9	1.7	1.7	2.6	3.8	45.7	45
1970	15.6	15	18.3	19	12	11	2.2	1.8	3.4	4.2	51.5	51
1971	16.6	17.9	20.6	22.3	12.5	10.6	2	1.9	4.1	4.3	55.8	57
1972	17.9	18	21.7	23.2	12.8	12.3	2.2	2.1	4.5	4.4	59.1	60
1973	17	17.1	20.9	24.9	11.3	10.5	2.4	2.5	3.4	3	55	58
1974	17.1	17.4	19.5	24.6	11.1	9.5	1.8	2.3	5.9	5.2	55.4	59
1975	16.2	14.2	17.3	20.7	9	6.8	2.5	2.2	4.2	3.1	49.2	47
1976	16.4	15.5	14.7	25	8.5	6.5	2.5	2	3.3	2	45.4	51
1977	15.1	18	11.8	19	7.8	5	2.5	3	3.8	8	41	53
1978	14.1	17.5	10.9	16	7.6	6.5	3.8	2	5.1	2	41.5	44
1979		17		17		6		2		3		45
1980		14		11		17		3		2		47

NOTE : ALL CONSUMPTION (CONS'N) AND PRODUCTION (PROD'N) FIGURES IN UNITS x 10^6

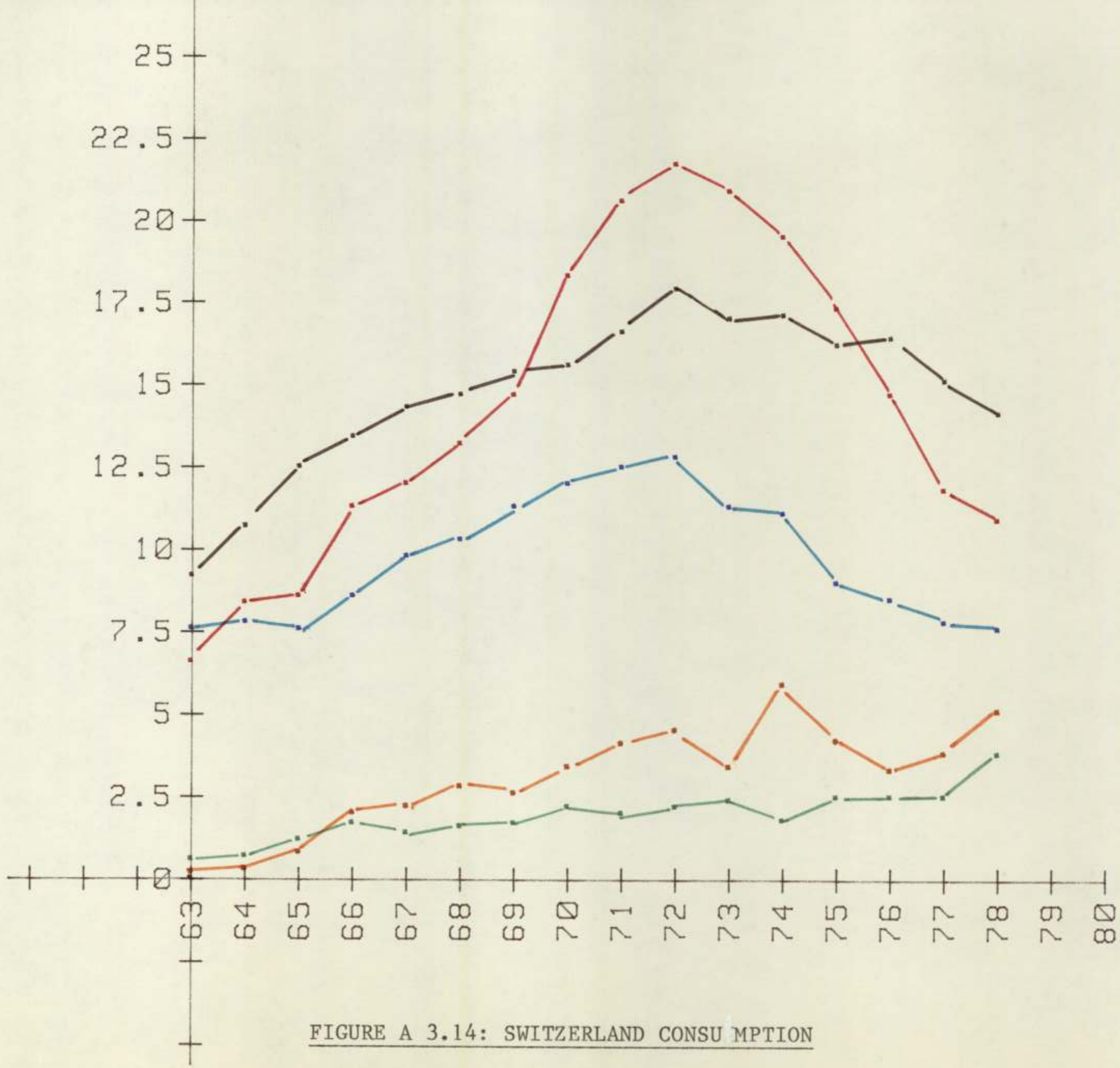


FIGURE A 3.14: SWITZERLAND CONSU MPTION

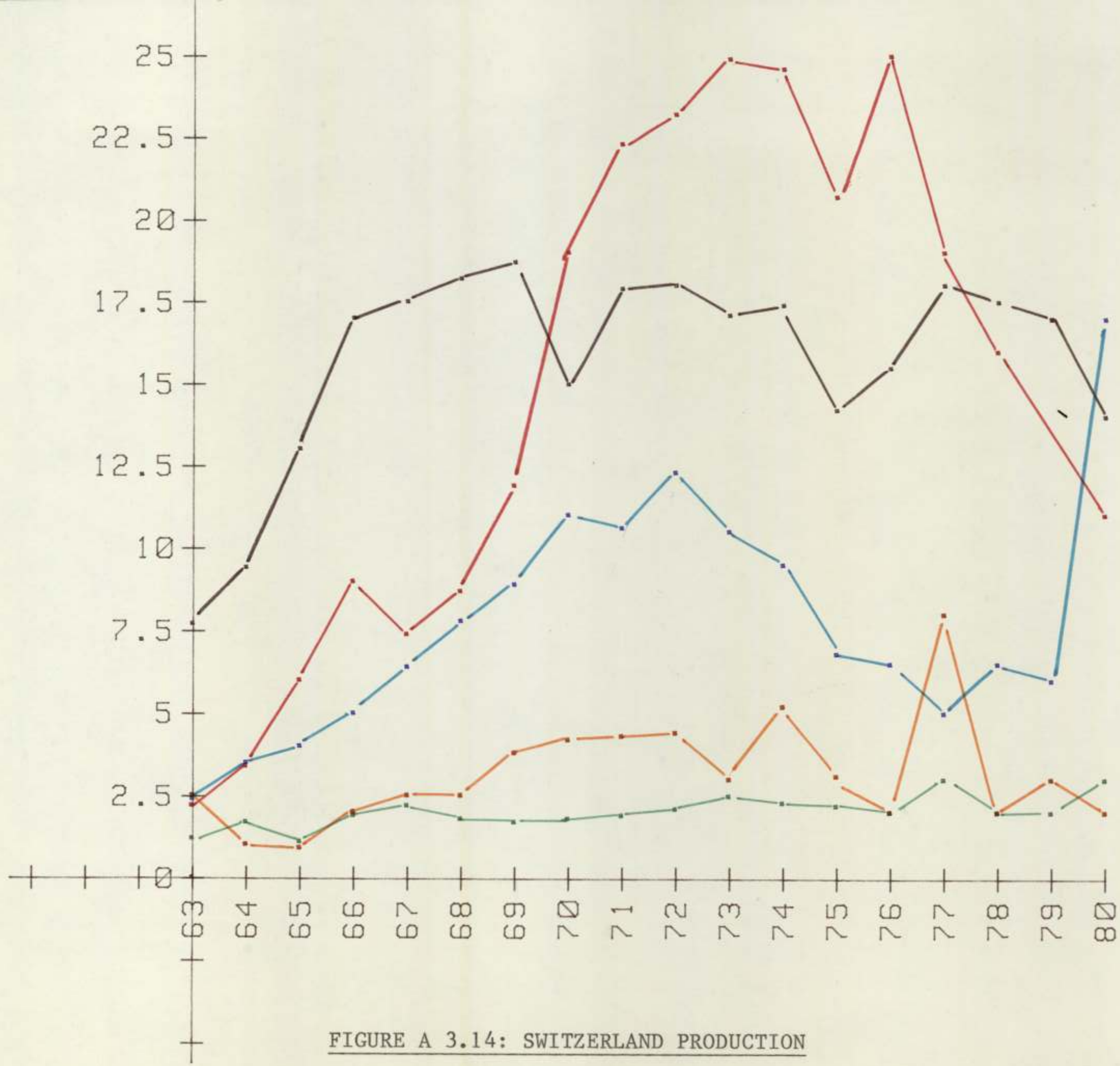


FIGURE A 3.14: SWITZERLAND PRODUCTION

TABLE A3.15 COUNTRY - U.K.

YEAR	HAIRSPRAY		PERSONAL CARE		HOUSEHOLD		INSECTS		MISCELLANEOUS		TOTALS FOR YEAR	
	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N
1963		22.2		4.7		25.2		12.2		5.7		70
1964		35.9		8		39.4		17.8		10.9		112
1965		43.7		10.5		44.5		17.1		12.2		128
1966		57.1		15.4		55.3		19.5		13.7		161
1967		63.8		18.2		60		20.2		14.8		177
1968	75.9	70.3	12.7	32.5	65.5	63.7	22	33.9	9.9	20.6	186	221
1969	82.5	80.3	19.3	39	71.5	79.5	22	25.1	12.1	29.1	207.4	253
1970	100.1	103	31	64.4	81.5	78.2	23.8	25	13.3	33.4	249.7	304
1971	115.6	125.9	48.4	75.9	78.4	75	25	36.7	15	35.5	282.4	349
1972	117.2	126.3	83.7	89.2	83.3	77.3	26.2	35.2	50.8	39.1	361.2	361
1973	133.1	143	124.7	106.1	96.2	96.2	27.4	47.1	55.9	45.3	437.3	438
1974	146	158	144.9	112.1	90.6	90.2	36.4	55.5	58.2	62.1	476.1	478
1975	131.9	148.1	120.2	98.4	90	87.7	41.9	51.1	54.2	59.4	438.2	440
1976	138.6	154.9	146.4	96.2	96.1	102.2	47.5	66.3	63.7	75.4	492.3	495
1977	134	136.9	83.8	124	201.1	115.5	67	76.3	72.6	79	558.5	532
1978	128.4	127	50.2	139	301.4	102	83.7	85	83.7	110	647.4	563
1979	123	103	55	52	251.1	101	55.6	60	72.3	206	557	522
1980	123	98	58	60	222.4	103	50	62	72	175	525.4	498

NOTE : ALL CONSUMPTION (CONS'N) AND PRODUCTION (PROD'N) FIGURES IN UNITS x 10^6

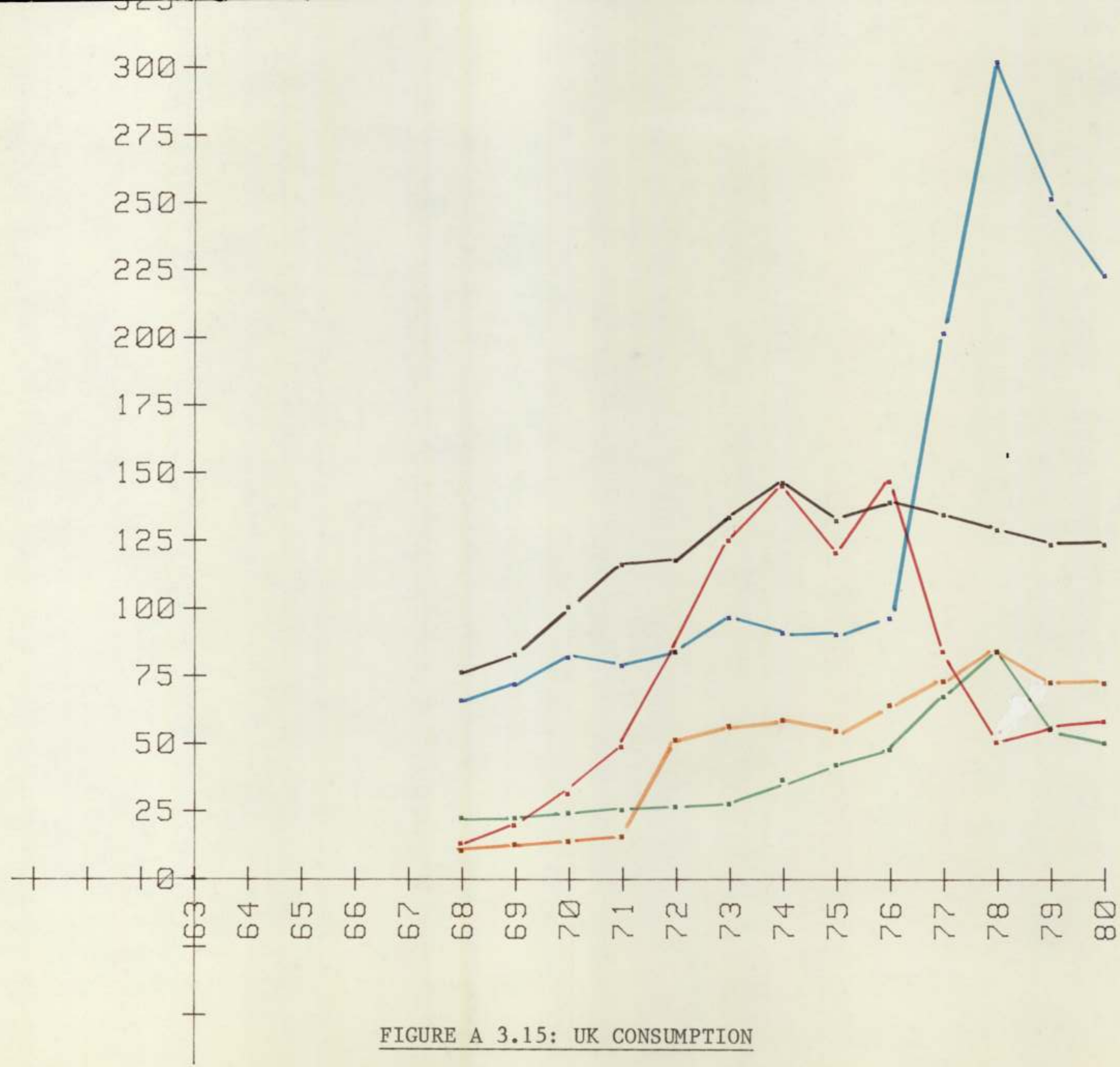


FIGURE A 3.15: UK CONSUMPTION

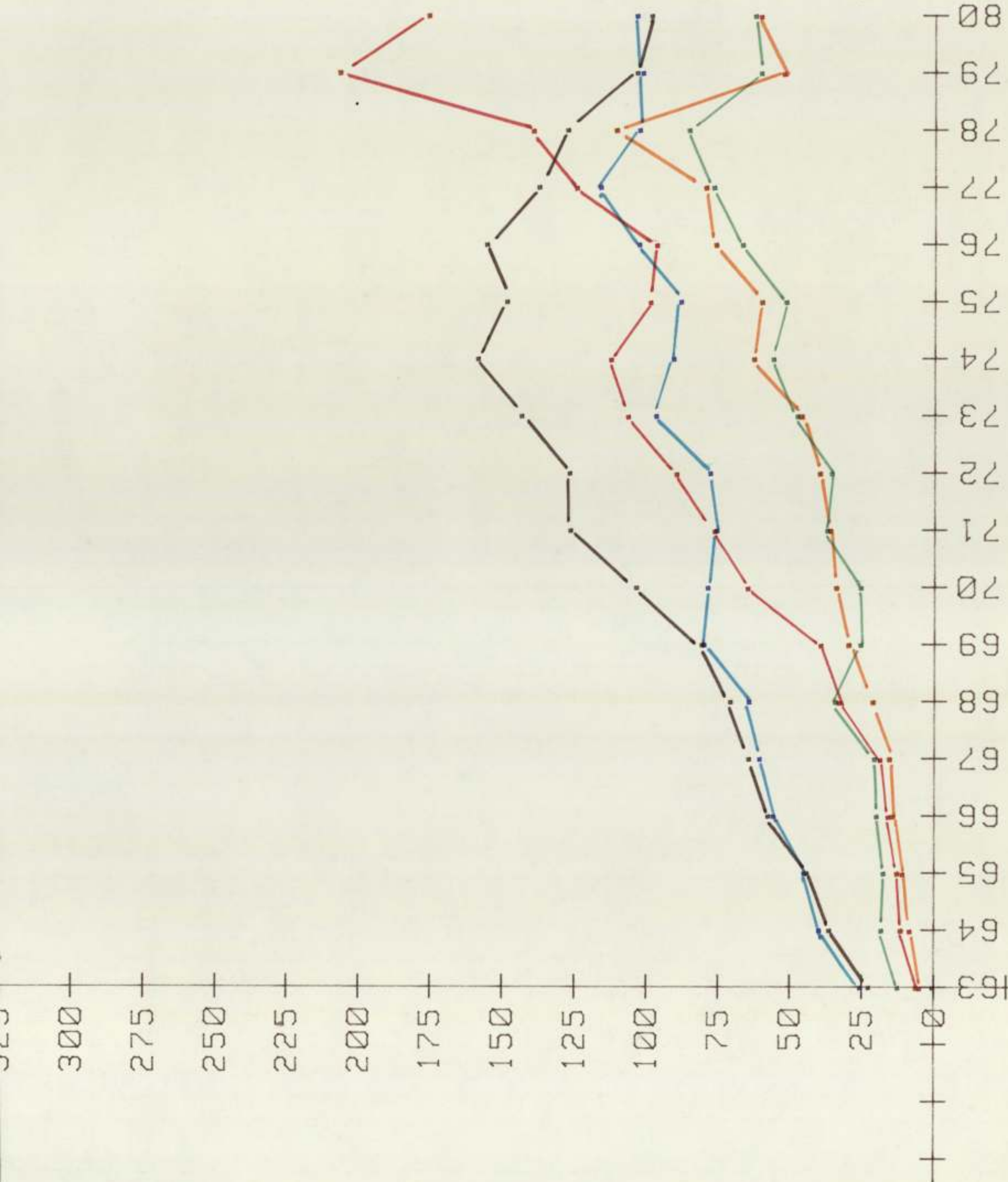


FIGURE A 3.15: UK PRODUCTION

TABLE A3.16 COUNTRY - U.S.A.

YEAR	HAIRSPRAY		PERSONAL CARE		HOUSEHOLD		INSECTS		MISCELLANEOUS		TOTALS FOR YEAR	
	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N
1963												1147
1964		307		328		320.5		81.8		260.7		1298
1965		471		434.7		408.7		83.9		324.9		1723
1966		463		427.7		439.3		91.6		321.7		1743
1967		525.7		460.5		500.8		91.6		412.4		1991
1968	203	597		577.7		571.8		92.2		451.6		2290
1969		670		618		601		100		473.2		2462
1970	491.7	720	825.7	670	629	710	102.4	110	563.4	413	2612.1	2623
1971	443.1	760	813.7	710	654.3	730	109.7	120	561.1	114	2581.9	2554
1972	459.5	735	889.7	678	703.8	703	127.4	127	639.1	580	2819.5	2823
1973	460.8	777	974.2	718.1	690.1	689.6	134.7	134.9	641.7	582.6	2901.5	2902
1974	409	702	862.5	649	625.1	625	125	125	697.2	621	2718.2	2722
1975	324.6	565	694.1	523	565.9	567	94	201	555.3	596	2233.9	2354
1976	296.9	518	634.7	479	529.2	532	114	144	664.8	622	2239.6	2295
1977	279.7	393.9	435.8	326.2	600.6	600.1	108.4	120.2	563.7	709.6	1988.2	2150
1978	283.7	398.2	443	330.3	635	628.5	113.5	132.1	589.2	742.5	2064.4	2231
1979	316.9	273.1	479.8	413.1	688.9	604.1	121.1	141.3	638.3	799.4	2245	2398
1980	295.9	142.4	448.5	495.2	641.9	580.4	113.8	149.6	594.1	794.4	2094.2	2162

NOTE : ALL CONSUMPTION (CONS'N) AND PRODUCTION (PROD'N) FIGURES IN UNITS x 10^6

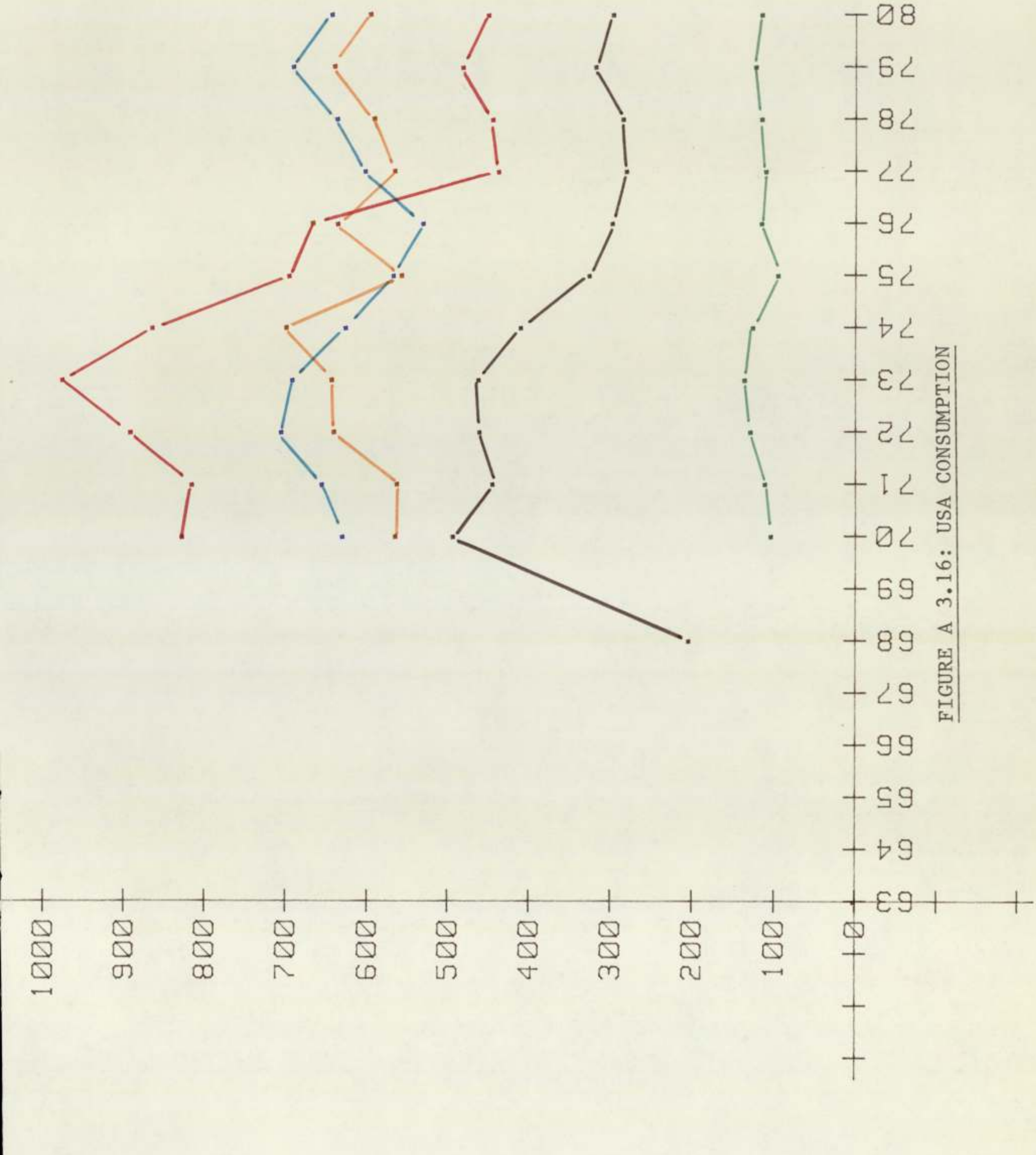


FIGURE A 3.16: USA CONSUMPTION

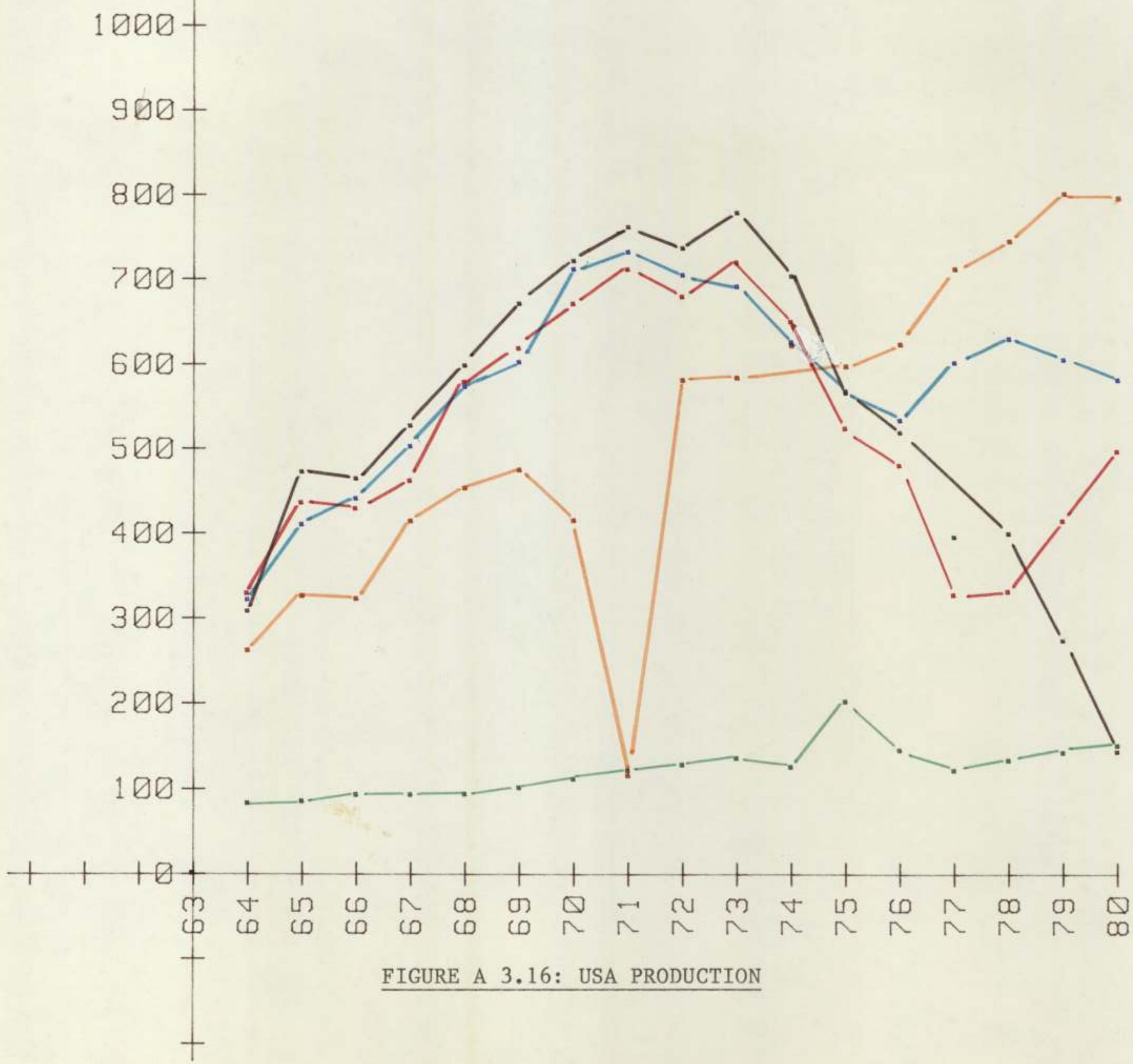


FIGURE A 3.16: USA PRODUCTION

TABLE A3.17 COUNTRY - CANADA

YEAR	HAIRSPRAY		PERSONAL CARE		HOUSEHOLD		INSECTS		MISCELLANEOUS		TOTALS FOR YEAR	
	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N
1963												
1964												
1965												
1966	14.7	14.6	31.1	31.1	23	23	4.5	4.5	18.8	18.8	92.1	92
1967	15.9	15.9	33.8	33.8	25	25	4.9	4.9	20.3	20.4	99.9	100
1968	17.8	17.8	38	37.9	28	28	5.5	5.5	22.9	22.9	111.9	112
1969	20.7	20.7	43.9	43.9	32.4	32.5	6.3	6.4	26.5	26.5	129.8	130
1970	22.8	22.2	48.8	47.3	36	35	7	6.9	29.4	28.6	144	140
1971	24.8	24.2	52.5	51.4	38.8	38	7.8	7.5	31.7	31	155.6	152
1972	26.3	25.9	55.9	55.1	41.5	40.8	8.1	8	33.9	33.3	165 7	163
1973	26.1	26	56	55.5	41.3	41	8.1	8	33.8	33.5	165.3	164
1974	28	28	63.5	63.5	46	46	9.6	9.5	37.1	37	184.2	184
1975	20.1	20	51.3	51	32.1	32	6.1	6	38.2	38	147.8	147
1976	23	22.9	48.8	48.7	35.9	36	7.1	7.1	29.5	29.4	144.2	144
1977	21.5	21.5	45.7	45.6	33.7	33.8	6.6	6.6	27.6	27.5	135.1	135
1978	18.1	22	46.3	46	34.1	34.5	9.1	9.5	28.4	28	136	140
1979	13.1	13.	46.8	46.5	34.7	34.5	10.7	10.5	29.6	29.5	134.9	134
1980	14	13	49.4	46.5	36.8	35	11.1	10.5	30.2	30	141.5	135

NOTE : ALL CONSUMPTION (CONS'N) AND PRODUCTION (PROD'N) FIGURES IN UNITS x 10^6

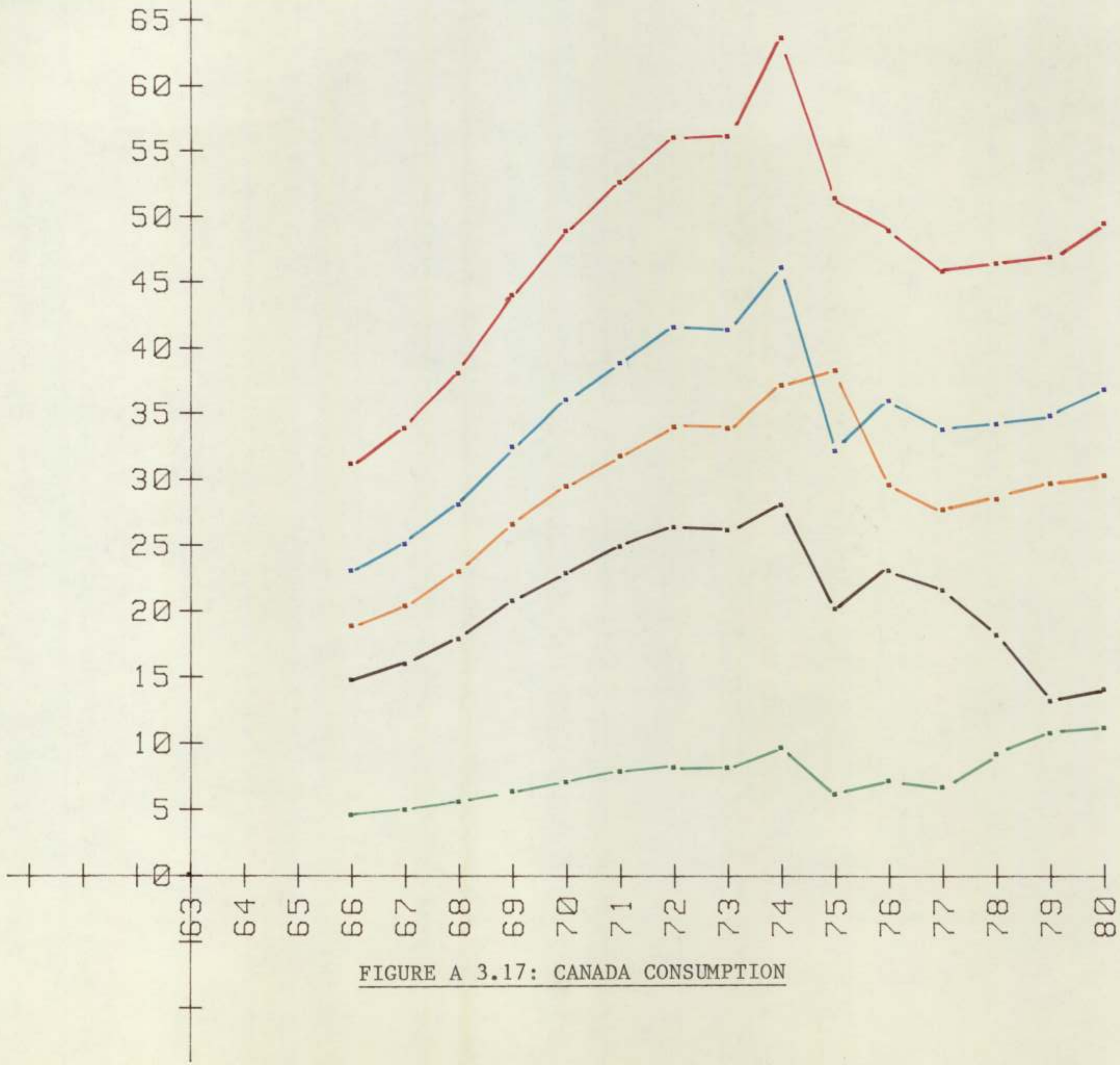


FIGURE A 3.17: CANADA CONSUMPTION

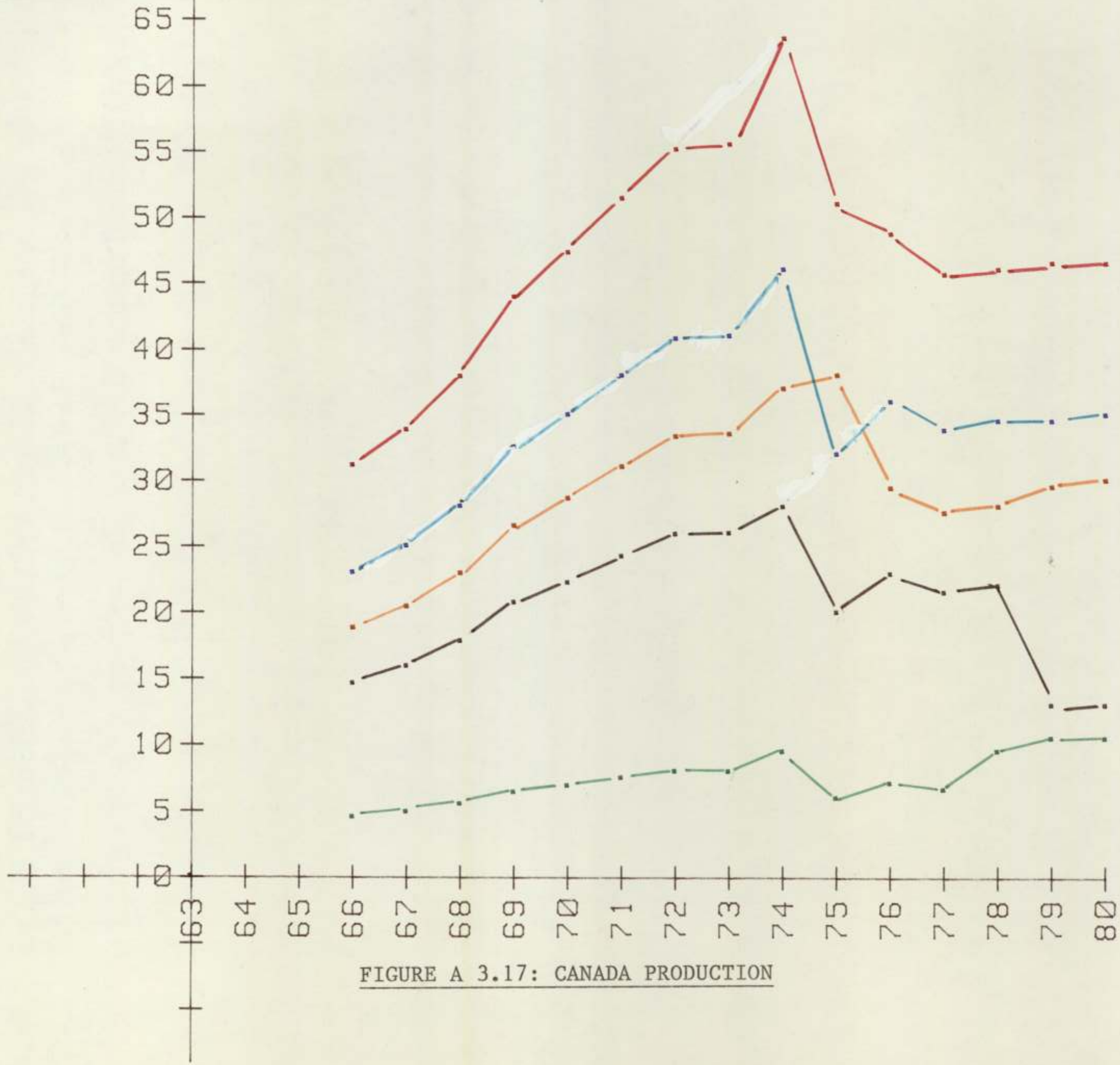


FIGURE A 3.17: CANADA PRODUCTION

TABLE A3. 18 COUNTRY - AUSTRALIA

YEAR	HAIRSPRAY		PERSONAL CARE		HOUSEHOLD		INSECTS		MISCELLANEOUS		TOTALS FOR YEAR	
	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N
1963												
1964												
1965												
1966												
1967												
1968												
1969												
1970	22.4	23.1	11.3	11.3	16.7	16.7	14.4	14.4	6.4	6.5		
1971	23.6	23.7	16.4	16.4	21.4	21.3	15.7	15.7	5.9	5.9		
1972	24.6	24.6	17.1	17.1	23.4	23.4	16	16	7	7		
1973	23.1	23.1	18.9	18.9	28	28	22.1	21.6	10.4	10.4		
1974	21.8	21.8	26.3	26.3	36.5	36.4	24.5	24.5	10.3	10.3		
1975	17.2	17.2	20.7	20.7	36.8	36.8	21.4	21.3	11.4	11.3		
1976	15.7	15.7	22.7	22.8	42.6	42.6	22.6	22.6	13.3	13.3		
1977	13.3	13.3	19.5	19.4	40.6	40.5	22.5	22.5	15.9	15.8		
1978	14.4	14.4	17.1	17.1	49	49	28.8	28.9	15.4	15.4		
1979	16	15	18	17	51	50	28.9	28	16	15		
1980	17.9	18	18.8	18	52.9	52	30.9	31	16	16		

NOTE : ALL CONSUMPTION (CONS'N) AND PRODUCTION (PROD'N) FIGURES IN UNITS x 10^6

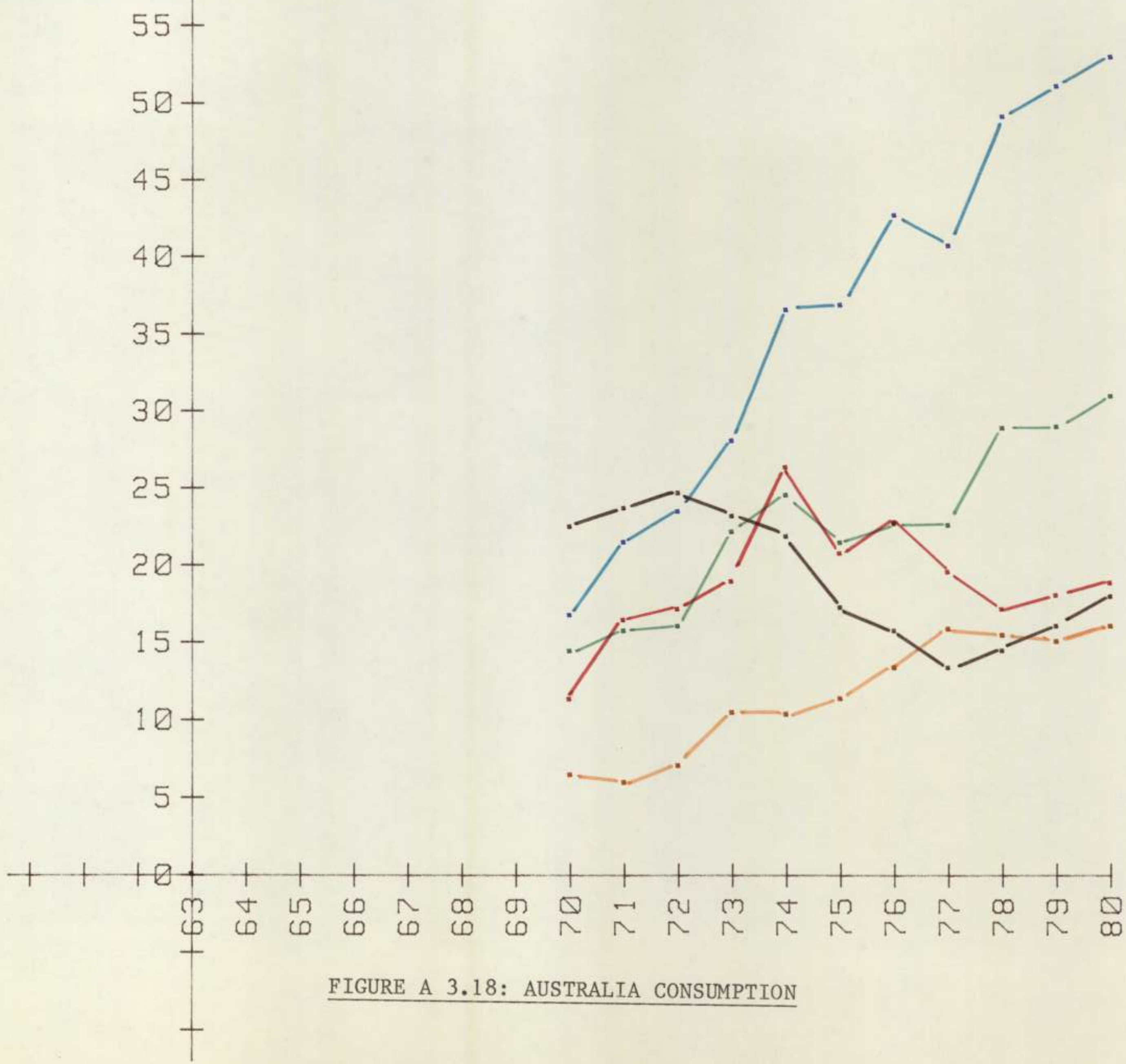


FIGURE A 3.18: AUSTRALIA CONSUMPTION

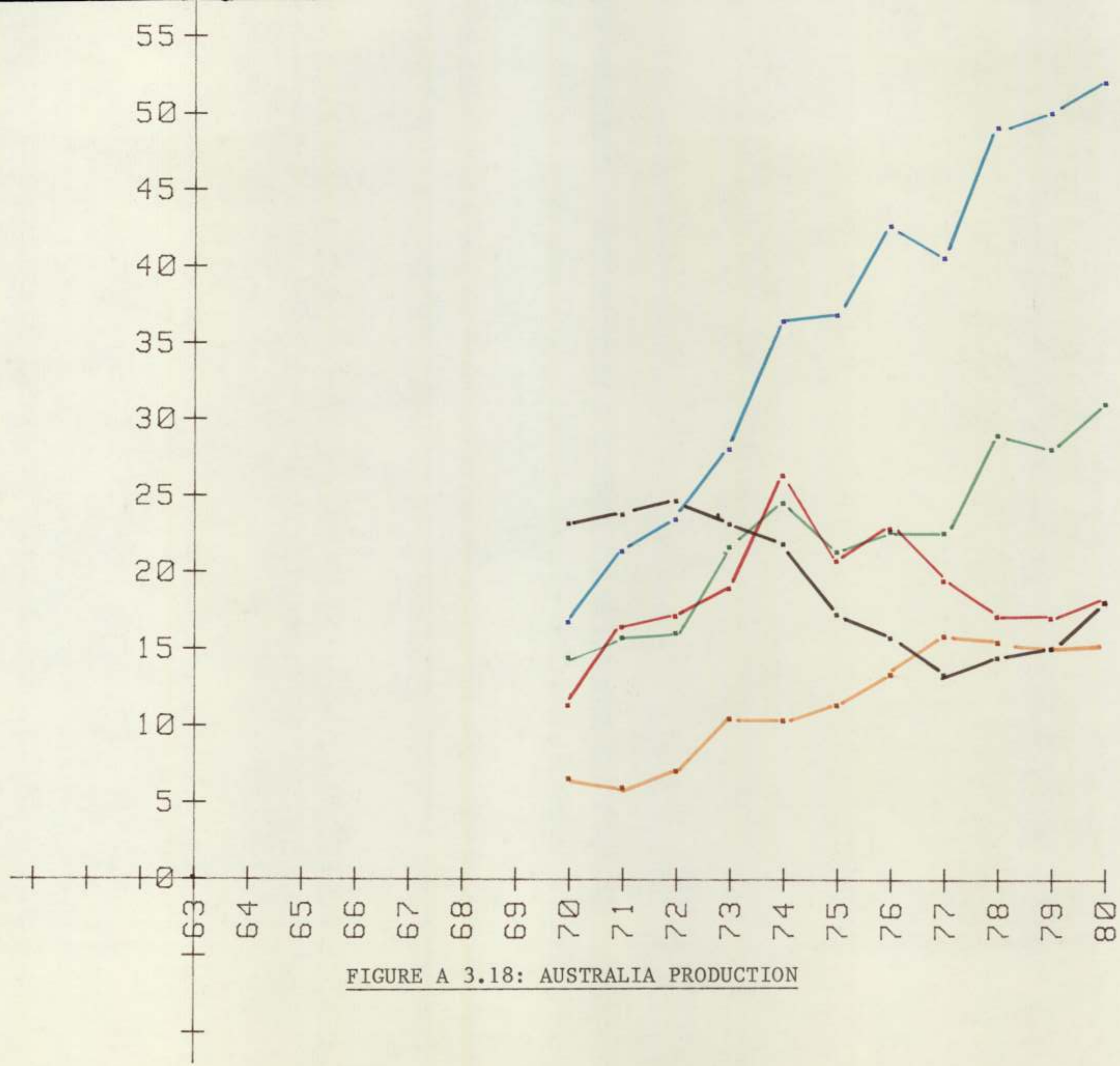


FIGURE A 3.18: AUSTRALIA PRODUCTION

TABLE A3.19 COUNTRY - NEW ZEALAND

YEAR	HAIRSPRAY		PERSONAL CARE		HOUSEHOLD		INSECTS		MISCELLANEOUS		TOTALS FOR YEAR	
	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N	CONS'N	PROD'N
1963												
1964												
1965												
1966	0.49	0.5	0.54	0.58	1.70	1.71	1.2	1.22	1	1	4.93	5
1967	0.5	0.5	0.58	0.58	1.73	1.71	1.24	1.22	1.02	1	5.07	5
1968	0.5	0.5	0.58	0.58	1.72	1.71	1.22	1.22	1	1	5.02	5
1969	0.9	0.89	1.07	1.04	3.12	3.08	2.22	2.2	1.83	1.79	9.14	9
1970	1.31	1.29	1.53	1.51	4.49	4.45	3.21	3.17	2.61	2.59	13.15	13
1971	1.69	1.68	1.98	1.97	5.86	5.81	4.19	4.15	3.41	3.38	17.13	17
1972	1.76	1.78	2.08	2.09	6.13	6.16	4.36	4.39	3.55	3.58	17.9	18
1973	2.15	2.18	2.50	2.55	7.42	7.52	5.30	5.37	4.3	4.38	21.7	22
1974	2.5	2.57	2.94	3.02	8.69	8.89	6.2	6.34	5.06	5.17	25.4	26
1975	1.45	1.49	1.69	1.74	4.94	5.13	3.52	3.66	2.87	2.99	14.5	15
1976	1.23	1.29	1.44	1.51	4.26	4.45	3.03	3.17	2.46	2.59	12.4	13
1977	1.39	1.39	1.64	1.62	4.79	4.79	3.42	3.42	2.79	2.79	14	14
1978	1.25	1.25	1.46	1.46	4.36	4.32	3.08	3.09	2.53	2.52	12.7	12.6
1979	1.61	1.6	1.51	1.5	4.3	4.3	3.1	3.1	2.5	2.5	13	13
1980	2	2	2.02	2	4	4	3	3	2.05	2	13.1	13

NOTE : ALL CONSUMPTION (CONS'N) AND PRODUCTION (PROD'N) FIGURES IN UNITS x 10^6

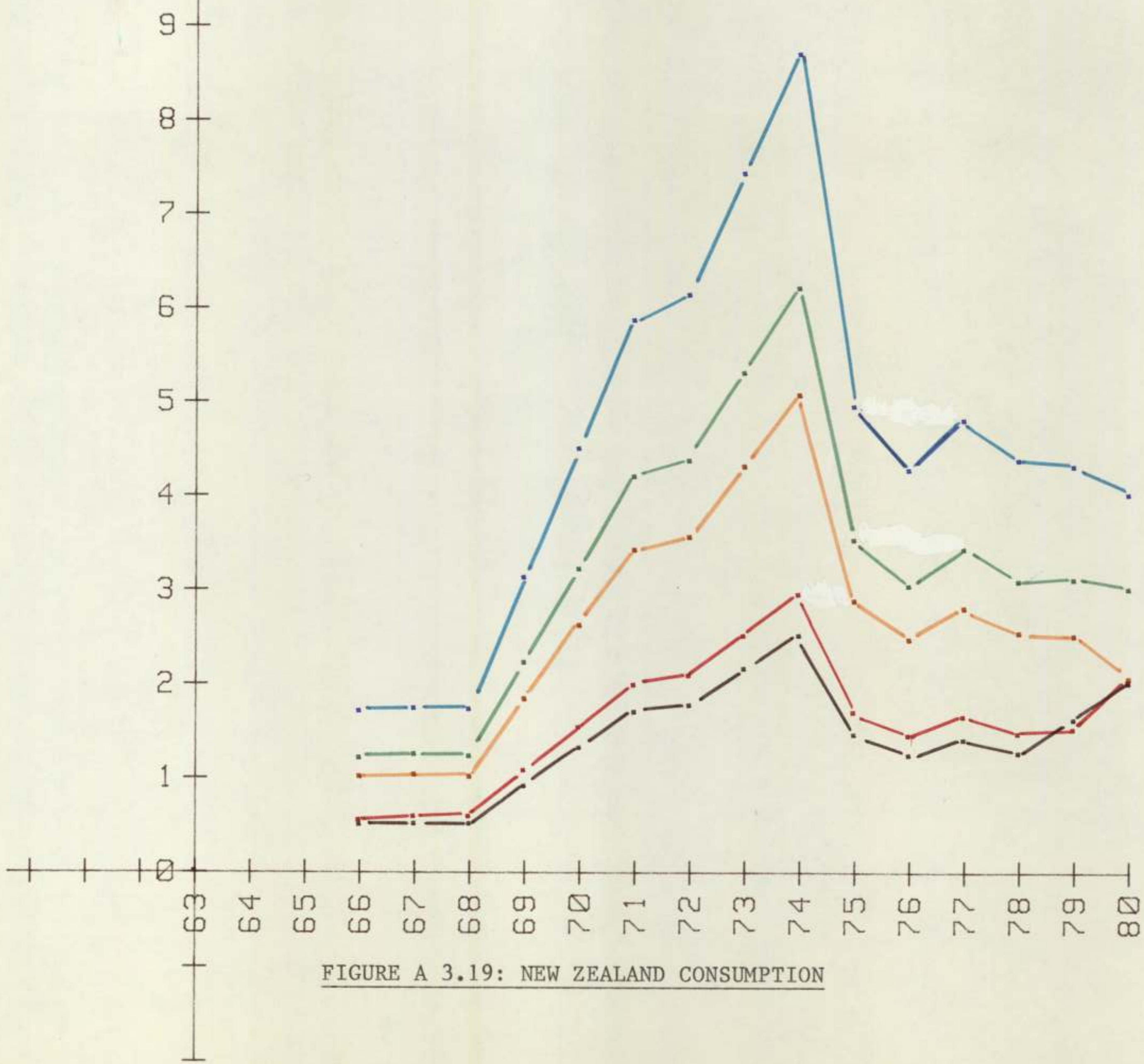


FIGURE A 3.19: NEW ZEALAND CONSUMPTION

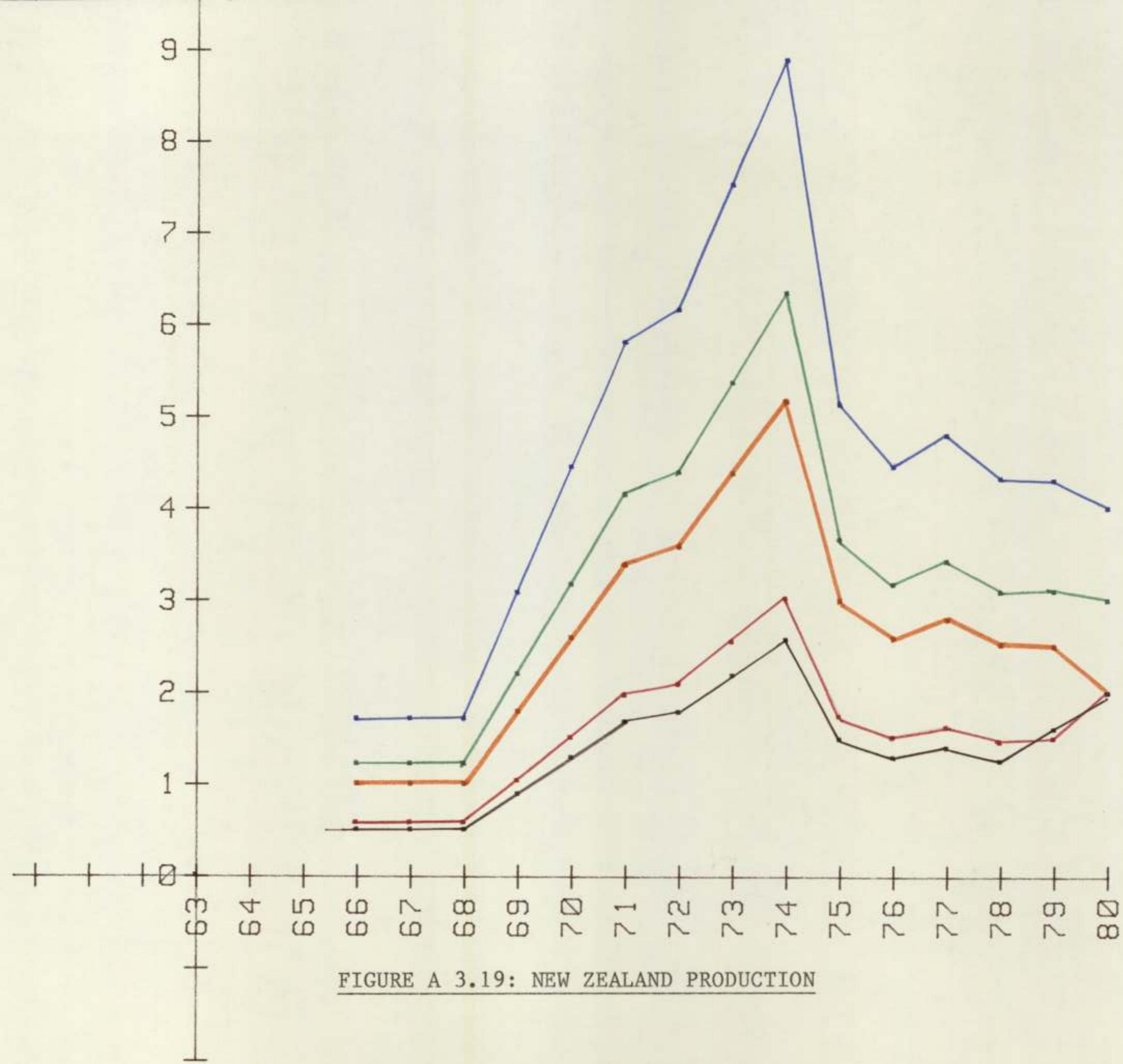


FIGURE A 3.19: NEW ZEALAND PRODUCTION

APPENDIX II: FACTORS AFFECTING ATOMISATION EFFICIENCY

INTRODUCTION

It has been stated in Section 7.2.1. that in general, compressed gas propelled `aerosols' and pump sprays produce a spray which is more coarse and usually less dry than a comparable H.C. or C.F.C. propelled true aerosol. This disadvantage is one of the factors which have prevented the widespread adoption of aerosol alternative spray systems and this Appendix provides the explaination of this phenomenon and evidence to support the conclusions in Chapter 13 that the pump units have probably reached the peak of their development.

Factors Affecting Spray Characteristics

The characteristics of a spray delivery system are:-

* Particle size distribution.
* Pattern i.e. cone angle, type of cross section.
* Discharge rate.

Saunders (194) described six types of spray as follows:-

1. Very fine: The spray disappears at a distance of approximately 2 - 3 feet after it leaves the actuator. The spray does not wet paper at a distance of about 1 foot.

2. Fine: The spray travels for a distance of at least 5 - 6 feet before disappearing. Slight wetting of paper occurs at a distance of about 1 foot.

3. Medium: The spray tends to travel in a horizontal path and the particle size is noticeably larger than that in a fine spray. Wetting of paper occurs at a distance of about 1 foot.

4. Coarse: Fallout of large droplets is apparent. Heavy wetting of paper occurs at a distance of 2 feet.

5. Streamy: A broken stream consisting of a mixture of spray and stream.

6. Stream. A stream with essentially no spray.

Sprays with properties intermediate between the groups listed above are classified as fine; very fine; medium-fine; and medium-coarse.

Reference to Figure 2.3 will confirm that there are several factors which influence the spray characteristics (194), (195) and these are generally accepted to be as listed below in decreasing order of importance.

* Volatility or boiling point of propellants.
* Heat of vapourisation of propellent and to a lesser extent specific heat.
* Vapour pressure or pressure of propellent at ambient temperature.
* Propellent/active product ratio.
* Type of actuator.
* Type of valving.
* Surface tension of active product.
* Viscosity of active product.

Mechanism of spray Formation

A true aerosol produces a spray by virtue of the propellants vapour pressure forcing active product up the dip tube, through a valve where, mixed with propellant vapour, it enters an expansion chamber. Here some of the propellant vapourises causing primary breakup of the liquid stream prior to its entrance to the actuator. In the actuator, mechanical breakup is achieved by imparting a swirling motion to the product stream as shown in Figure A. The actuator then dispenses liquid droplets to the exterior consisting of either active product surrounded by propellant or vice versa - shown schematically in Figure B. Vapourisation of the propellent then occurs (by drawing heat from the surrounding air) and this violent and energetic process reduces the size of the product droplets. Thus flash vapourisation is often the controlling factor in determining the droplet size in the resultant spray and the higher the proportion of propellent which flashes, the smaller and drier the issuing spray.

Propellants may be thus regarded not just as the driving force to move the product from inside the can to the exterior, but also as a reservoir of stored energy for small droplet production. Consequently propellants with a lower boiling point and a greater readyness to form vapour have the highest and most useable store of energy. According to Wiener (196), up to 70% of the conversion of the liquid product into droplets occurs by this means.

In the case of compressed gas 'aerosols' or pump sprays no such vapourisation occurs and the breakup of the liquid product is dependant almost entirely on mechanical atomisation within the actuator or spray head device. This is to some extent retarded by the release of dissolved or entrapped compressed gas propellent.

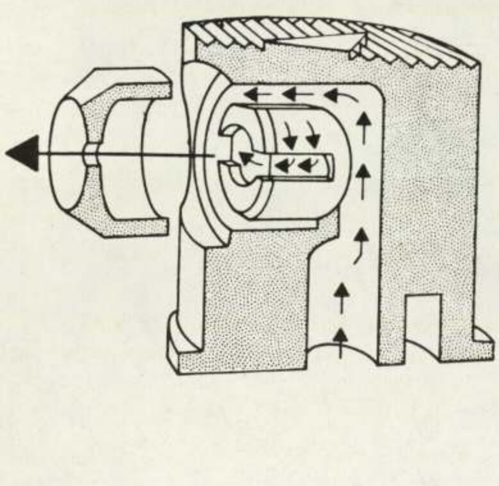


FIGURE A: MECHANICAL BREAKUP ACTUATOR

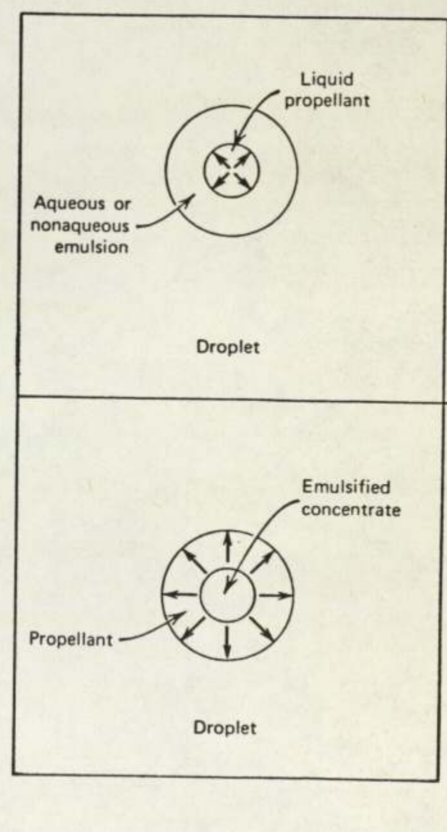


FIGURE B: TYPES OF AEROSOL DROPLETS

Comparison of Spray Characteristics

From the above discussion it can be deduced that when comparing pump sprays and compressed gas aerosol alternatives with true aerosols, a major energy source for droplet formation is absent - namely the vapourising propellant. This places high emphasis on actuator design and mechanical atomisation efficiency and to a lesser extent on the optimisation of active product physical properties e.g. viscosity; surface tension.

Tauscher (197)and Shay and Falkowski (198) studied the factors affecting spray characteristics in various valve/actuator and active product systems. They reported that the relationships between the spray characteristics (e.g. discharge rate, cone angle), the geometry of the actuator and the pressure driving the system can be described via the use of the following dimensionless groups.

$$\phi = \frac{R r_o}{n \, r_{ex}^{2}} = \frac{\pi R r_o}{A} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (I)$$

$$r = \frac{4G}{\pi \sqrt{2e \, P_T} \, d_o^{2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (II)$$

Where

ϕ	=	Geometric characteristic.
R	=	Radius of swirl chamber.
ro	=	Radius of exit orifice.
n	=	Number of inlet channels.
r_{ex}	=	Radius of inlet channels.
A	=	Total cross-sectional area of inlet channels.
G	=	Flow Rate g/sec
r	=	Discharge coefficient.
P_T	=	Pressure at inlet to actuator.
do	=	Diameter of actuator orifice.
e	=	Fluid Density

By using the above relationships and graphs C and D overleaf, it is claimed that optimum actuators can be selected for given can pressures and discharge rates. No account is however taken of particle size distribution.

While much of this work is theoretical, supported in part by questionable measurements directed towards the assessment of fluid flow characteristics, the conclusions appear to explain the reduced spray performance of the aerosol alternatives.

The energy requirements for mechanically induced droplet formation have been estimated by Roberts (199). More recently Roberts (200) has reported direct energy and particle size comparisons between L.P.G. and compressed air propelled spray systems operating at equal pressures with the same actuators using deionised water. Typical data abstracted from this study is shown in Figures E and F and in Table A, from which it is seen that considerably finer particles are available from the true aerosol due to up to 30% more available energy for droplet formation.

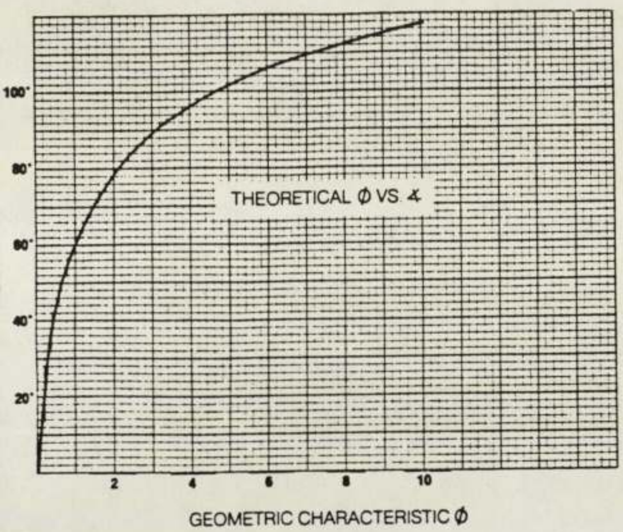


FIGURE C: SPRAY CONE ANGLE VERSUS GEOMETRIC CHARACTERISTIC

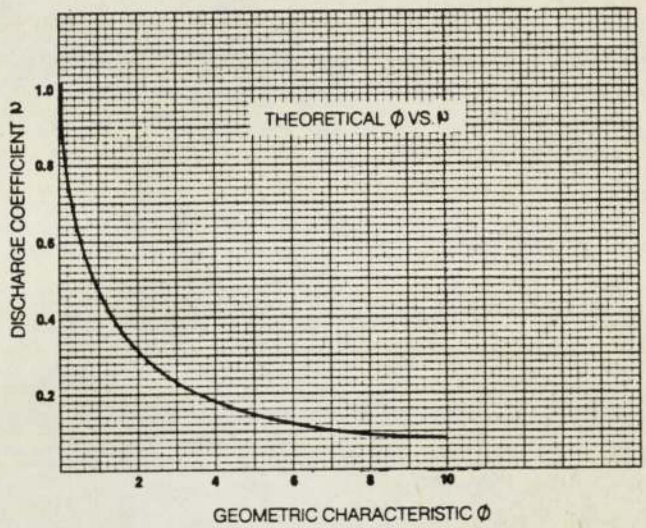


FIGURE D: SPRAY DISCHARGE COEFFICIENT VERSUS GEOMETRIC CHARACTERISTIC

Figure E shows a comparison between compressed air and L.P.G. systems operating at 60 p.s.i.g. on deionised water. As shown, the particle size distribution is coarse in both cases mostly due to the immiscibility of the propellent and to a lesser extent the high surface tension of the 'active product' (70 dynes/cm).

Figure F illustrates the established and widely used effect obtained by using a surface active agent (emulsifier) to give a degree of miscibility of the propellent with active product by emulsificaztion. This only applies to the L.P.G. system which then benefits from the flash vapourisation mechanism described earlier subsequently yielding a finer spray. The surface active agent also reduces the surface tension of the active product thereby making the atomisation process easier.

Table A summarises the work done or energy utilised in performing the atomisation illustrated in Figure E and F using the relationship

$$\Delta F = \Delta A \, \gamma$$

Where

ΔF = increase in surface free energy in ergs.

γ = interfacial tension in dyne/cm of the active product.

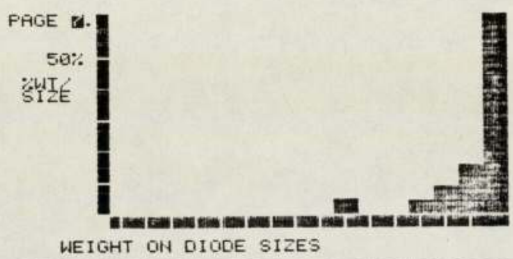
ΔA = increase in surface area effected by atomising the active product.

From this data it is seen that although both systems operate at equal pressure (60 p.s.i.g.) on the same active product using identical valving and actuator components, the L.P.G. can generate up to 30% extra energy for atomisation because of its ability to mix with the active product via emulsification.

TIME 06-46-30 RUN NO. 12 LOG ERROR = 5.68

SAMPLE CONCENTRATION = 0.0002 % BY VOLUME
OBSCURATION = 0.00

SIZE BAND UPPER	LOWER	CUMULATIVE WT BELOW	WEIGHT IN BAND	CUMULATIVE WT ABOVE	LIGHT ENERGY COMPUTED	MEASURED
564.0	261.6	36.1	63.9	0.0	2047	2047
261.6	160.4	20.2	15.9	63.9	1270	1391
160.4	112.8	10.8	9.4	79.8	938	857
112.8	84.3	6.0	4.9	89.2	799	739
84.3	64.6	6.0	0.0	94.1	726	727
64.6	50.2	6.0	0.0	94.1	668	649
50.2	39.0	0.6	5.3	94.1	694	562
39.0	30.3	0.6	0.0	99.4	767	496
30.3	23.7	0.5	0.1	99.4	759	459
23.7	18.5	0.5	0.1	99.5	586	431
18.5	14.5	0.4	0.0	99.5	515	427
14.5	11.4	0.4	0.0	99.6	769	454
11.4	9.1	0.4	0.0	99.6	1012	473
9.1	7.2	0.4	0.0	99.6	1319	510
7.2	5.8	0.4	0.0	99.6	1793	690

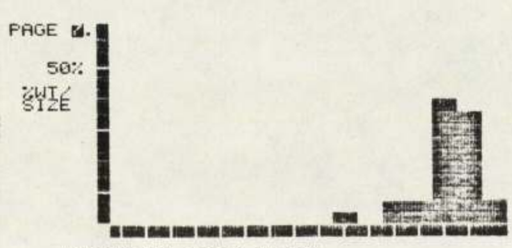


COMPRESSED AIR

TIME 06-48-20 RUN NO. 16 LOG ERROR = 4.74

SAMPLE CONCENTRATION = 0.0000 % BY VOLUME
OBSCURATION = 0.00

SIZE BAND UPPER	LOWER	CUMULATIVE WT BELOW	WEIGHT IN BAND	CUMULATIVE WT ABOVE	LIGHT ENERGY COMPUTED	MEASURED
564.0	261.6	92.3	7.7	0.0	1544	1599
261.6	160.4	56.4	35.9	7.7	1968	1949
160.4	112.8	17.1	39.3	43.6	2047	2047
112.8	84.3	10.2	6.9	82.9	1784	1780
84.3	64.6	3.5	6.6	89.8	1425	1390
64.6	50.2	3.5	0.0	96.5	1048	1005
50.2	39.0	0.3	3.2	96.5	873	863
39.0	30.3	0.3	0.0	99.7	810	759
30.3	23.7	0.2	0.1	99.7	584	603
23.7	18.5	0.1	0.1	99.8	480	511
18.5	14.5	0.1	0.0	99.9	294	432
14.5	11.4	0.1	0.0	99.9	285	378
11.4	9.1	0.1	0.0	99.9	232	323
9.1	7.2	0.1	0.0	99.9	175	260
7.2	5.8	0.1	0.0	99.9	159	225



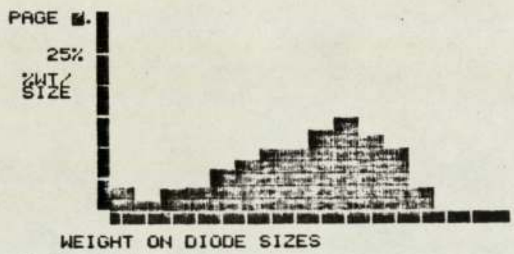
L.P.G.

FIGURE E: COMPARISON OF PROPELLENTS - WATER ONLY

TIME 06-43-00 RUN NO. 4 LOG ERROR = 3.00

SAMPLE CONCENTRATION = 0.0026 % BY VOLUME
OBSCURATION = 0.05

SIZE BAND UPPER	SIZE BAND LOWER	CUMULATIVE WT BELOW	WEIGHT IN BAND	CUMULATIVE WT ABOVE	LIGHT ENERGY COMPUTED	LIGHT ENERGY MEASURED
564.0	261.6	100.0	0.0	0.0	88	81
261.6	160.4	100.0	0.0	0.0	155	147
160.4	112.8	100.0	0.0	0.0	249	247
112.8	84.3	96.5	3.5	0.0	380	382
84.3	64.6	86.9	9.6	3.5	572	581
64.6	50.2	75.2	11.7	13.1	822	828
50.2	39.0	60.3	14.9	24.8	1130	1135
39.0	30.3	47.5	12.8	39.7	1425	1435
30.3	23.7	37.6	9.9	52.5	1675	1677
23.7	18.5	28.0	9.6	62.4	1870	1873
18.5	14.5	19.9	8.2	72.0	1978	1987
14.5	11.4	13.0	6.9	80.2	2047	2047
11.4	9.1	9.0	4.0	87.0	2010	2021
9.1	7.2	5.6	3.4	91.0	1865	1827
7.2	5.8	3.7	1.9	94.4	1675	1649

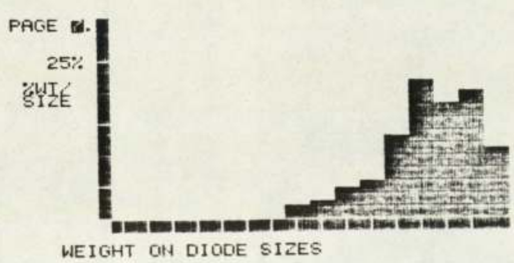


L P G

TIME 06-43-50 RUN NO. 6 LOG ERROR = 4.70

SAMPLE CONCENTRATION = 0.0000 % BY VOLUME
OBSCURATION = 0.00

SIZE BAND UPPER	SIZE BAND LOWER	CUMULATIVE WT BELOW	WEIGHT IN BAND	CUMULATIVE WT ABOVE	LIGHT ENERGY COMPUTED	LIGHT ENERGY MEASURED
564.0	261.6	88.8	11.2	0.0	1200	1193
261.6	160.4	68.6	20.2	11.2	1505	1529
160.4	112.8	50.6	18.0	31.4	1751	1745
112.8	84.3	28.9	21.7	49.4	1906	1887
84.3	64.6	15.8	13.1	71.1	2047	2047
64.6	50.2	10.3	5.5	84.2	2034	2007
50.2	39.0	5.5	4.8	89.7	1858	1830
39.0	30.3	2.6	2.9	94.5	1611	1568
30.3	23.7	0.5	2.1	97.4	1445	1376
23.7	18.5	0.3	0.2	99.5	1211	1122
18.5	14.5	0.2	0.1	99.7	914	898
14.5	11.4	0.2	0.0	99.8	705	708
11.4	9.1	0.2	0.0	99.8	616	566
9.1	7.2	0.1	0.0	99.9	638	452
7.2	5.8	0.1	0.0	99.9	689	405



Compressed Air

FIGURE F: COMPARISON OF PROPELLENTS - WATER AND EMULSIFIER

TABLE A: COMPARISON OF ENERGY AVAILABLE FOR ATOMISATION

SYSTEM	MEAN PARTICLE DIAMETER MICRONS	SURFACE TENSION OF ACTIVE PRODUCT DYNES/CM	ENERGY EXPENDED ERGS/SEC
Water + C.A.	260	70	8.8×10^3
Water + L.P.G.	150	70	14×10^3
Water + Emulsifier + C.A.	112	35	18.8×10^3
Water + Emulsifier + L.P.G.	30	35	70×10^3

APPENDIX III

The name is

Johnson wax

No matter where you are, the chances are that Johnson Wax will be there too, helping to improve the environment in which we live and work and play; making it that much cleaner, healthier and more pleasing to the eye.

Johnson Wax though is not just about products, or profits, or performance, or progress. It is also about people.

Johnson Wax is a Company which really cares about people. Perhaps that is why it has been such a success and why it goes from strength to strength.

This concern for people – employees, consumers, the general public, neighbours and the community at large – is explicitly committed to paper in a booklet entitled "This We Believe", which spells out the Johnson Wax Corporate beliefs practised since its foundation.

he Company was founded in 1886, by Samuel Curtis Johnson when he bought a parquet flooring business in Racine, nsin, USA and founded his own ny.

eople liked his oors, but the thods of g them clean the surface. years later, he making wax to help keep n good condition. By 1914 his son, t Fisk Johnson had given up

Samuel Curtis Johnson

making floors and was doing so well with the wax paste preparation that he felt ready to open his first overseas branch – in London's High Holborn.

Not even the sinking of the first consignment of wax to Britain put him off. Within two years, in fact, British housewives had so taken to Mr Johnson's prepared wax that the Company had to move to bigger premises at West Drayton. *(shown below)* And so the first overseas factory

Herbert Fisk Johnson

got started. By 1923, the whole of the UK's needs were coming from locally produced products. Over the years, the range of products steadily increased, and the site at West Drayton became more and more congested.

In 1960, the whole company – production, warehousing, research and administration – moved to Frimley Green, in Surrey. They moved into a brand new, tailor-made factory and office block standing in the middle of 66 acres.

Staff facilities include regular medical checks, holiday chalets, and on-site social centre and sports and social activities, run by employees. The Frimley site incorporates a football pitch, tennis courts, a 9 hole golf course, archery field, putting green and croquet lawn.

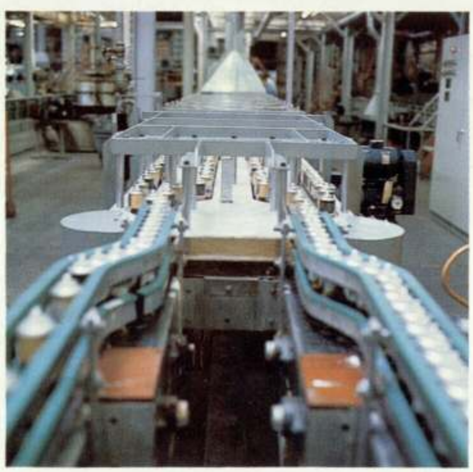
Johnson Wax believes in contributing to the well-being of the countries and communities where it conducts business and it commits itself to helping the development of these communities by involving itself in social, cultural and educational projects both at a national and local level.

Some examples of such involvement include annual grants to the University of Surrey to encourage the development of international contact of scholars: sponsorship for several years of the Royal Philharmonic Orchestra: commissioning the composition of new works of music: financial support for the National Federation of Women's Institutes in their promotion of drama and folk art in the regions of the country: numerous grants to a variety of strictly charitable causes for the sick and the under-priveleged. The Company pays for the heating of the swimming-pool of the school situated next door to it.

This is a human and considerate company; but it is not soft or undisciplined. It is a company which operates in fiercely competitive markets where flexibility and speed of reaction count for much.

The fruits of long and careful research by Johnson scientists all over the world are at the disposal of the Company here in Britain.

Not only is there then a wide range of products but they are backed by the very best production resources. The aerosol products are manufactured on the most sophisticated and efficient machinery of its kind in the worl
Run by experienced technicians,
have been making aerosol produc
here in the UK since 1962, the hig
standards of safety for people and
products are rigidly enforced. But
Frimley Green factory does not o
manufacture aerosols. Paste, liqu
gel products also account for a siz
proportion of total production.
Not infrequently, machinery to c
out specific work is invented or
developed by the Company's eng



n Britain, the company has a
staff of over 700. Nearly a third
of them are concerned with the
sharp end of the business –
t.
ach Division – industrial and
mer – has its own sales force,
n regions, working from their
s.
The Industrial Sales Force sells its
cts through distributors as well
ctly to major end users. Because
particularly varied cleaning and
ted problems of the Industrial
t, individual customer needs
ntly have to be identified and the
right products matched to them.

The consumer sales force works almost entirely through the retail trade where it checks stock levels for the local manager, keeps him up to date with products and promotional activity, helps merchandize goods on shelf and on display and, of course, discusses and agrees orders.

Distribution in the UK is largely through contractors, with the exception of a small fleet of local delivery vans working directly out of Frimley.

The British Company also produces goods for a variety of associated Johnson Companies, mainly in Europe, Africa and the Middle East. In fact, a third of its entire production goes abroad.

Ask a British housewife about the care of floors and furniture and working surfaces, and the odds are that the name 'Johnson Wax' will be mentioned. It is a name synonymous with quality and reliability over the years, and a Company to which people still turn in their thousands for advice and guidance on all aspects of household cleaning.

This is not surprising since Johnson Wax produces products for virtually every consumer home caring need – furniture, floors, carpets, silver and brass, ovens, laundry and air fresheners. It has products too for car and personal care.

On the Industrial front, the range of products is even wider to meet the variety of needs of every type of public building and every kind of factory, office and canteen. The company is proud to number Royal palaces amongst its customers.

Some of the products sold by the Industrial Division are similar to those sold by their colleagues in Consumer Products. Many more though are specific for heavy duty uses – drain cleaners, degreasers for food processing, special soap for people handling food, as well as a range of industrial floor cleaners for every sort of surface.

Ceaselessly, work continues in the Company's laboratories to improve on the present standard and performance of its products and to find and meet new needs in the myriad of activities in and outside the home.

Johnson Wax is now a world-wide organisation, with its headquarters still in Racine, Wisconsin, USA, and 50 or so operating companies around the globe. It is still a privately-owned Company – one of the biggest of its kind in the world. It is a multi-racial company with an international view of itself and the business it runs. It seeks talent from within itself, and provides opportunities for its people to move around the world.

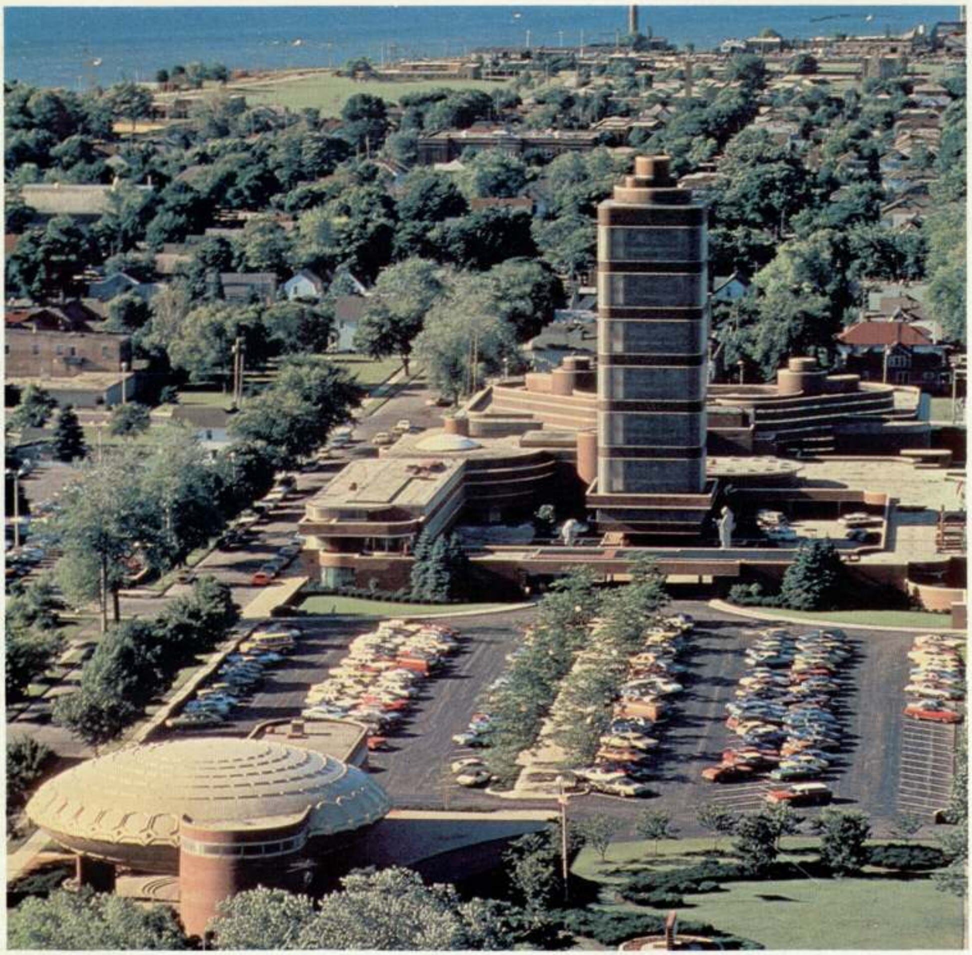
Americans, Europeans, Africans, Asians and Latin Americans work side-by- side seeking out new ways to develop the world-wide business, looking for fresh applications of technological know-how, looking for new uses of marketing skills and sales resources, searching for acquisitions which will fit into the Johnson development strategy, and offer still more career opportunities and financial security to the people already within the group.

Johnson Wax has always laid great stress in its corporate philosophy on the importance of international understanding and the improvement of international relations. It comes as no surprise therefore that one of the Johnson family homes, Wingspread, in Racine, designed by the eminent American architect, Frank Lloyd Wright, should have been given c aTrust to become a centre where leading decision makers from all the world, from a variety of intell disciplines, could meet to discuss think about global problems in ar environment of tranquility and b

Frank Lloyd Wright was als commissioned to design the Company's present headquarters Racine, still a remarkable buildin its own right over 40 years later.

In more recent years, the Company has established Johnso Wax Associates which has been a in building up around the world of interests in the fast-expanding leisure market.

Johnson Wax has been expa its business since 1886 and this g continues unabated. It accepts ch as the very stuff of business life. I proud of its reputation – the rewa constant vigilance and effort, bui the excellence of its products, th value they offer and the improve to the quality of life which they provide to their users. It is proud profitability for this profit is usec generate more business and jobs. used to improve staff facilities an provide additional income to its employees through a profit sharin scheme. A proportion is ploughe back into the community throug grants to sponsorships and charit



Johnson Wax Headquarters
Racine, Wisconsin, USA

The Company takes pride in its
iency and its activities. Its continued
ess, however, is never taken for
ted. It remains consistently concious,
F Johnson, Snr. said in a speech on
stmas Eve in 1927:

"The goodwill of the people is the
enduring thing in any business. It is
ole substance. The rest is shadow."

APPENDIX IV: SURVEY OF THE UK MARKETS OF JOHNSON WAX LTD

TABLE A9.1 U.K. MARKET ANALYSIS - AEROSOL POLISHES

MARKET SIZE (145)

In value : £17,239) 1982
In volume : 24,254,000 units)

GROWTH TRENDS (146)

	1978	1979	1980	1981	1982
In Value £'s	10,153,000	11,575,000	14,555,000	16,709,000	17,500,000
In Volume units	22,256,000	22,338,000	23,627,000	23,566,000	24,000,000

COMPETITORS & MARKET SHARE - 1982 (145)

By value : % total market

	%
Pledge - Johnson Wax	22.7
Sparkle - Johnson Wax	16.8
Woodcare - Johnson Wax	1.9
Favor - Johnson Wax	1.6
Future - Johnson Wax	4.9
	47.9
Mr Sheen - Reckitt & Coleman	24.5
Mansion Choice - Reckitt & Coleman	5.1
	29.6
All others	22.5
	100.0

DISTRIBUTION PATTERNS : (BY VALUE) (146)

	% total sales
Supermarket & multiple grocery	7
Independant grocery	14
Discount & Variety stores	11
Hardware/furniture	4
	100

TABLE A9.1 (CONTINUED)

COMMENTS ON FUTURE MARKET ACTIVITY

Little growth anticipated on changes in market share. Trigger alternatives to aerosols are unlikely to gain acceptance in competition with aerosols.

TABLE A9.2 U.K. MARKET ANALYSIS - AIRFRESHENERS

MARKET SIZE - 1982 DATA (145)

In Value :	£20,805,000	(50.2% solid types (30.0% aerosols (19.8% powders 100.0
In volume :	44,794,000 units	(57.1% solids (28.0% aerosols (14.9% powders 100.0

GROWTH TRENDS (145)

Market	1980	1981	1982
By Value £	17,648,000 Solids -50.1% Aerosols-30.9% Powders -19.0%	21,773,000 Solids -50.6% Aerosols-27.5% Powders -21.9%	20,300,000 Solids -50% Aerosols-30% Powders -20%
By Volume Units	36,573,000 Solids -53.1% Aerosols-33.1% Powders -13.8%	46,529,000 Solids -57.2% Aerosols-26.6% Powders -16.2%	43,500,000 Solids -57% Aerosols-28% Powders -15%

COMPETITORS & MARKET SHARE - 1982 (145)

By Value : Total SOLIDS market

BRAND	TYPE	COMPANY	% TOTAL SOLIDS MARKET
Glade Secrets	paper	J. Wax	3.1
Glade Solid	gel	J. Wax	11.3
Glade Flo Thru	paper	J. Wax	6.7
		SUB TOTAL:	21.1
Airwick Candle	gel	Beechams	9.0
Air Wave	paper	Beechams	4.6
Stick ups	paper	Beechams	14.1
		SUB TOTAL:	27.7
Airbal	paper	Shell	5.6
Twice as Fresh	paper	Clorox	10.0
Hide Away	paper	W.R. Jones	6.6
Tiny Tim	paper	Reckitt	7.1
All Others		Various	21.9

TABLE A9.2 (CONTINUED)

AEROSOLS

BRAND	COMPANY	% SHARE VALUE
Haze	Reckitt & Coleman	40
Glade	Johnson Wax	20
Bayfresh	Bayer	10
Freshaire	Coopers (Wellcome)	5
Big D	Domestic Fillers	5
Others	Various	20
		100

POWDERS

BRAND	COMPANY	% SHARE VALUE
Glade	Johnson Wax	30
Airwick	Beechams	17
Haze	Reckitt & Coleman	12
Bayfresh	Bayer	8
Twice as Fresh	Clorox	8
Airbal	Shell	5
Others	Various	20
		100

DISTRIBUTION PATTERNS (146)

BY VOLUME : Foods 87.5%
Drug Stores 12.5%
100.0

BY VALUE : Foods 88.8%
Drug Store 11.2%
100.0

COMMENTS ON FUTURE ACTIVITY

Stabilisation of market - little real growth with some brands failing. Most companies searching for new product forms but category has probably been fully exploited.

TABLE A9.3 U.K. MARKET ANALYSIS - METAL POLISHES

MARKET SIZE - 1981 (145)

In Value £'s 3,709,000
In Volume units 6,135,000

GROWTH TRENDS

MEASUREMENT	1976	1977	1978	1979	1980	1981
By Value £'s	2,697,000	3,004,000	3,893,000	4,349,000	3,955,000	3,709,000
By Volume tonnes	7,481	8,594	9,369	9,560	8,098	6,135

COMPETITORS AND MARKET SHARE - 1981

BRAND	COMPANY	% SHARE VALUE
Duraglit		34
Brasso	Reckitt & Coleman	29
Goddards range		25
Silvo	Reckitt & Coleman	9
All others	Various	3

DISTRIBUTION PATTERNS : BY VALUE 1981 (147)

Supermarket and multiple grocery	70
Department Stores	10
Hardware	10
Boots and Chemists	10
	100

COMMENTS ON FUTURE MARKET ACTIVITY

Little opportunity for growth but brands remain profitable.

TABLE A9.4- U.K. MARKET ANALYSIS - FLOOR POLISH

MARKET SIZE : 1982 (145)

In Value £'s	2,700,000
In Volume units	2,350,000

GROWTH TRENDS (145)

MEASUREMENT	1980	1981	1982
By Value £'s	2,500,000	2,750,000	2,700,000
By Volume-units	2,730,000	2,560,000	2,350,000

COMPETITORS AND MARKET SHARE

BRAND	COMPANY	% SHARE VALUE
Klear-dry bright	Johnson Wax Ltd	66
Dual-dry bright	Reckitt & Coleman	21
Others	Various	13
		100

DISTRIBUTION PATTERNS : (145) (146)

By value	%
Supermarket and multiple grocery	69
Independent Grocers	14
Discount and variety stores	11
Hardware/furniture	6
	100

COMMENTS ON FUTURE ACTIVITY

Decline due to - falling profit margins - major companies lost interest.
- reduced potential due to increased use of carpets and alternative coverings to lino.

TABLE A9.5 U.K. MARKET ANALYSIS : LAUNDRY PRETREATMENT AND IRONING AIDS

IRONING AIDS : Comprise starch and starch substitutes which are applied. Market information was obtained on this segment of Laundry Care category. Overall growth from £3x10^6 (1979) to £5x10^6 (1982). U.K. market dominated by Johnson Wax (55%) and Reckitt (20%)

PRETREATERS : Comprise aerosol dispensed concentrated detergents for spot and stain removal. Products applied to garments prior to laundry cycle.

MARKET SIZE - 1982 (145)

In Value £ : 1,179,000
In Volume units : 1,838,000

GROWTH TRENDS (145)

MEASUREMENT	1979	1980	1981	1982
In Value £'s	1,288,000	1,342,000	1,229,000	1,150,000
In Volume units	2,770,000	2,351,000	1,932,000	1,800,000

COMPETITORS AND MARKET SHARE - 1982 (145)

BRAND	COMPANY	% SHARE VALUE
Shout	Johnson Wax	36.3
Friend	Reckitt & Coleman	63.7
		100.0

DISTRIBUTION PATTERNS - 1982 (145)

	%
Supermarket and multiple grocery	90
Independent grocers	5
Discount and variety stores	5
	100

TABLE A9.5 (CONTINUED)

COMMENTS ON FUTURE ACTIVITY (146) (147)

This market has failed to develop as planned due to higher efficacy detergent powders and lack of real product benefit over detergents along. Market is not expected to develop but may remain static.

TABLE A9.6 - U.K. MARKET ANALYSIS

ANTIPERSPIRANTS/DEODORANTS

MARKET SIZE - 1982 (147) (148)

In Value : £45 x 10^6
The market is segmented into 3 areas namely : Antiperspirants
Deodorants
Body Sprays

Antiperspirants endeavour to control perspiration.
Deodorants contain a bactericide and deal with body odour.
Body Sprays are a recent development primarily for body freshness and comprising fragrance and alcohol.

Antiperspirants and deodorants are available as aerosols and liquid/solid forms.

GROWTH TRENDS : TOTAL MARKET BY VALUE (148)

VALUE	1978	1979	1980	1981	1982
£ x 10^6	38	39	42	45	43

COMPETITORS AND MARKET SHARE (146) (148)

BRAND	TYPE	COMPANY	% SHARE BY VALUE
Right Guard	Aerosol	Gillette	14
Arrid Extra Dry	Aerosol		12
Impulse	Aerosol	Levers	10
Sure	Aerosol		10
Mum	Roller		15
Amplex	Roller		9
Daylong	Roller		8
Others (incl US Rollers)	Aerosols & Rollers		22
			100

TABLE A9.6 (CONTINUED)

DISTRIBUTION PATTERNS : BY VALUE 1982 (145)

	%
Supermarkets and multiple grocery	55
Drug stores	35
Discount and Variety	5
Independent grocers	5
	100

COMMENTS ON FUTURE MARKET ACTIVITY

The only major development in a decade has been the introduction of body sprays which now have 10% of an otherwise stagment market. Little growth is foreseen on an overall basis or within the various segments.

TABLE A9.7 - U.K. MARKET ANALYSIS - SHAMPOO

MARKET SIZE - 1981 (146)

In Value £'s : 78,000,000 - (Cosmetic segment 60%
(Medicated segment 40%

In Volume litres : 150,000,000

GROWTH TRENDS

MEASUREMENT	1976	1977	1978	1979	1980	1981
Total Market Value £'s	37	46	55	60	70	78

COMPETITORS AND MARKET SHARE - 1981 (146)

BRAND	TYPE	COMPANY	% SHARE BY VALUE
Head & Shoulders	medicated	P & G	16
Vosene	medicated		8
Silverkrin	cosmetic	Beechams	6
Sunsilk	cosmetic	Levers	6
All Clear	medicated		5
Alberto V05	cosmetic	Alberto Culver	4
Pears	medicated	Lever	3
Bristows	cosmetic	B Meyers	3
Alberto Balsam	cosmetic	Alberto Culver	3
Others incl U.S.	both cosmetic & medicated	Various	46
			100

DISTRIBUTION PATTERNS : BY VALUE (146)

Chemists		50%
Grocery		25%
Departmental Stores	)	
Discount and Variety	)	25%
Drug Stores	)	
		100%

COMMENTS ON FUTURE ACTIVITY (146)

The market has reached matruity and it is unlikely that Shampoo's will achieve further penetration. New brands are forecasted to continue to appear making the marketing of all but leading brands increasingly difficult.

TABLE A9.8- U.K. MARKET ANALYSIS - HAIR CONDITIONERS

MARKET SIZE - 1981 (146)

In Value : £33,000,000

GROWTH TRENDS

	1978	1981
By value £x10^6	15	33

By volume : conditions have shown an average of 7% p.a. growth for 1978-1981.

COMPETITORS AND MARKET SHARE - 1981 (146)

BRAND	COMPANY	% SHARE BY VALUE
Cream Silk		10
Alberto Balsam	Alberto Culver	9
Wella		7
Flex		7
Silkience	Gillette	7
Boots own	Boots	6
Henana		5
Alberto VO5	Alberto Culver	5
Natural Balance		4
Perform	P & G	4
Elseve Balsam		3
Agree	Johnson Wax	3
All others	Various	20
		100

DISTRIBUTION PATTERNS (146)

Boots	40%
Other Chemists	12%
Drug Stores	10%
Grocery	16%
Others	22%

COMMENTS ON FUTURE ACTIVITY

Growth appears to be continuing although having reached the younger segment of the population this will cease as it is considered unlikely that the older members of the populus will be convinced by the advertising.

TABLE A9.9 - U.K. MARKET ANALYSIS

BATH ADDITIVES

MARKET SIZE - 1981 (146)

In Value : £38,100,000)80% liquids
)18% salts
)2% cubes

In volume units: 62,600,000

GROWTH TRENDS (146)

MEASUREMENT	1977	1978	1979	1980	1981
By value £'s	23,200,000	25,600,000	30,500,000	35,400,000	38,100,000
By Volume units	70,500,000	66,600,000	62,900,000	63,000,000	62,600,000

COMPETITORS AND MARKET SHARE - 1982 (145)

BRAND	TYPE	COMPANY	% SHARE BY VALUE
Avon	liquid	Avon	14
Boots own label	liquid	Boots	13
Radox	liquid		7
Private label	liquid	Various	8
Matey	liquid		4
Johnson's	liquid	Johnson & Johnson	4
Deep Fresh	liquid		3
Salence	liquid		3
Others	liquid	Various	44
			100
Radox	salts		37
Sona	salts		17
Boots own label	salts	Boots	12
Fynnan	salts		8
Delafina	salts		5
Others	salts	Various	21
			100

TABLE A9.9 (CONTINUED)

DISTRIBUTION PATTERNS - 1981 BY VALUE (146)

	%
Boots	32
Department Stores	16
Avon	11
Other door to door	3
Grocery	10
Woolworth	7
Other Chemists	8
Others	13
	100

COMMENTS ON FUTURE ACTIVITY (146)

Little real market growth is envisaged although liquids are predicted to be capturing some of the "salts" segment.

TABLE A9.10 - U.K. MARKET ANALYSIS

AUTO PRODUCTS

MARKET SIZE - 1981 (148)

Market mainly comprises Polishes and Shampoo's.
Analysed by Volume.

Shampoo - 8,300,000 units) 63% sachets
37% bottles/tins

Polish - 6,600,000 units

GROWTH TRENDS : BY VOLUME (146)

	SHAMPOO	POLISH
1978	11,900,000 units	6,100,000 units
1979	9,700,000 units	6,900,000 units
1980	8,900,000 units	6,700,000 units
1981	8,300,000 units	6,600,000 units

COMPETITORS & MARKET SHARE - 1981 (145)

BRAND	TYPE	COMPANY	% SHARE BY VALUE
Turtle Wax	Liquid Wax polish		27
Rally Waxes	Paste & liquid wax	J. Wax	12
Simoniz	Paste wax		10
Other polish	paste & liquid	various	3
Turtle wax	shampoo sachet		22
Turtle wax	shampoo bottle		5
Rally Wax	Shampoo sachet	J. Wax	5
Other shampoo	bottles	Various	16
			100

TABLE A9.10 (CONTINUED)

DISTRIBUTION PATTERNS - 1981 (146)

Halfords	55
Supermarkets & multiple grocery	35
Auto shops	10
	100

COMMENTS ON FUTURE ACTIVITY - (146)

Both the shampoo and polish markets have matured and decline is forecasted due to improved car finishes and the frequency of 6 year corrosion protection warranty. Total market value of £5-10 x 10^6 has changed only marginally since 1978.

TABLE A9.11 - U.K. MARKET ANALYSIS

OVEN CLEANERS

MARKET SIZE - 1982 (147)

In Value : £4,000,000
In Volume : 5,000,000 units

GROWTH TRENDS (147)

MEASUREMENT	1976	1981
By Value £'s	7,000,000	4,000,000
By volume units	3,000,000	5,000,000

COMPETITORS AND MARKET SHARE - 1980 (147)

BRAND	TYPE	COMPANY	MARKET SHARE BY VALUE %
Mansion	Pad	Reckitt & Coleman	52
Shift	Aerosol	Gen. Welfare for blind	12
Force	Aerosol	J. Wax	8
Big D	Aerosol	Domestic fillers	6
Other aerosol incl Force	Aerosol	Various incl J.Wax	18
Other non aerosol	pads, sticks	Various	4
			100

DISTRIBUTION PATTERNS

Grocery	75%
Hardware	25%
	100%

TABLE A 9.11(CONTINUED)

COMMENTS ON FUTURE ACTIVITY

Aerosol products in decline. The Mansion Oven pad represented a technical berakthrough being non-aerosol and therefore unlikely to cause facial or eye irritation. Also low in cost.

However the increasing incidence of "self cleaning" ovens indicates that this category will continue to decrease. The self cleaning direction is accompanied by the equally increased use of 'Hobs' - ceramic and otherwise. This may provide an equal heavy duty cleaning opportunity for oven cleaner type products in the future.

APPENDIX V: PROPOSED LIST OF CONTACTS

UNIVERSITIES AND POLYTECHNICS

ABERDEEN

1. ROBERT GORDON´S INSTITUTE OF TECHNOLOGY,
Schoolhill, Aberdeen, AB9 1FR, Tel. Aberdeen (0224) 574511.

Science, Faculty of,
Dean: Professor N.H. Langton,
Chemistry, School of, St. Andrew Street, Aberdeen, AB1 1HG.

Pharmacy, School of,
Head of School: Dabiel Edwards, BSc, PhD, FPS, CChem, FRIC.

2. UNIVERSITY OF ABERDEEN,
Regent Walk, Aberdeen AB9 1FX, Tel. Aberdeen (0224) 40241.

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Meston Walk, Old Aberdeen, AB9 2UE,
Head of Department and Professor of Physical Chemistry:
P. Meares, DSc, ScD, FRSE.

BATH

3. UNIVERSITY OF BATH,
Claverton Down, Bath, Avon BA2 7AY, Tel. Bath (0225) 61244.

Chemistry School of,
Head of School: Professor F.S. Stone, BSc, PhD, DSc, FRIC.

Management School of,
Head of School: Professor R.E. Thomas, MCom, FBIM.

Materials Science, School of,
Head of School: Professor B. Harris, DSc, PhD, CEng, MIM, FInstP.

Pharmacy and Pharmacology, School of,
Head of School and Professor of Pharmacy:
D.A. Norton, BSc, FPS, FIBiol, DBA, ACT.

Pharmaceutics Group,
Head: Professor D.A. Norton.

Bath Institute of Medical Engineering,

St Martin´s Hospital, Wellsway, Bath, Avon, Tel. Bath (0255) 833803.
Director: Professor S.C. Lillicrap, PhD, DIC, ARCS.

BELFAST

4. QUEEN´S UNIVERSITY OF BELFAST,
Belfast, Northern Ireland, BT7 1NN, Tel. Belfast (0232) 45133.

Engineering Department of, Electrical and Electronic,
Ashby Building, Stranmillis Road, Belfast BT9 5AH.

Professor of Electrical Engineering: B.W. Hogg, PhD, CEng, MIEE, SMIEEE.

Economics and Social Sciences, Faculty of,
Dean and Professor: C. Ehrlich.

Science Faculty of,
Dean: Professor R.S. Asquith, Department of Chemistry,
David Keir Building, Belfast, BT9 5AG.

Inorganic Chemistry,
Head of Department: Professor F. Glockling, PhD, DSc.

Organic Chemistry,
Head of Department: Professor R. Grigg, Grad RIC, PhD.

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21 Chlorine Gardens, Belfast BT9 5DL,
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BIRMINGHAM

5. UNIVERSITY OF ASTON IN BIRMINGHAM
Gosta Green, Birmingham B4 7ET, Tel. 021-359 3611.

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Biology Sciences, Department of,
Head of Department: Professor A.J. Matty, DSc, FIBiol.

Chemistry Department of,
Head of Department and Professor of Inorganic Chemistry:
W.R. McWhinnie.

Construction and Environmental Health, Department of,
Head of Department: Professor A.W. Pratt, DSc, FInstP, HonFIAAS.

Engineering, Department of Chemical,
Head of Department: Professor G.V. Jeffreys, MSc, PhD, DSc, FRIC, CEng, FIChemE.

Engineering, Department of Mechanical,
Head of Department: Professor K. Foster, MA, PhD, MIMechE, CEng.

Engineering, Department of Production,
Head of Department: Professor R.H. Thornley, MSc, PhD, DSc, AMCT, CEng, FIMechE, FIProdE, MJSME.

Interdisciplinary Higher Degrees (IHD) Scheme,
IHD House, 70 Duke Street, Birmingham B4 7PJ.

Management Centre,
Economics, Econometrics, Statistics and Marketing Group,
158 Corporation Street, Birmingham B4 6TE.

Metallurgy and Materials, Department of,
Head of Department: Professor I.L.Dillamore, BSc, PhD, DSc, FIM, CEng.

Pharmacy, Department of,
Head of Department and Professor of Pharmacology:
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BRADFORD

7. UNIVERSITY OF BRADFORD,
Richmond Road, Bradford, West Yorkshire, BD7 1DP, Tel. Bradford (0274) 33466.

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Industrial Technology, Postgraduate School of Studies in Phoenix Building, University of Bradford, Bradford, West Yorkshire BD7 1DP,
Head of School: Alfred Z. Keller, BSc, PhD, FBCIS, FIQA.

Powder Technology, Postgraduate School of Studies in,
Chairman of School: Dr J.C. Williams, BSc, PhD,

Pharmacology, Postgraduate School of Studies in,
Chairman of School: J.M. Foy, BPharm, PhD, MPS.

Physical Sciences, Board of Studies in,
Colour Chemistry and Colour Technology, Postgraduate School of Studies in,
Chairman: E. Coates, MA, BSc, PhD, FRIC, FSDC.

Polymer Science, Postgraduate School of Studies in,
Chairman of School: Profesor I. Goodman, MSc, PhD, CChem, FRIC.

BRIGHTON

8. BRIGHTON POLYTECHNIC,
Moulsecoomb, Brighton East Sussex BN 2 4AT, Tel. Brighton (0273) 693655.

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Head of Department: J.P. Gillies, FCA, FCWA.

BRISTOL

9. BRISTOL POLYTECHNIC,
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25 Great George Street, Bristol BS1 5RA.
Head of Department: Professor Ivor Smith,

Physical Chemistry, Department of,
Head of Department: Professor D.H.Everett, MA, DSc, FRIC.

Horticulture and Agriculture, Department of,
Long Ashton Research Station, Long Ashton, Bristol BS18 9AF,
Head of Department: Professor J.M. Hirst, PhD, FRS.

CAMBRIDGE

11. UNIVERSITY OF CAMBRIDGE,
4 Mill Lane, Cambridge, CB2 1RZ, Tel. (0223) 58933.

Physics and Chemistry, Faculty of,
Chemistry Department of,
University Chemical Laboratories, Lensfield Road,
Cambridge, CB2 1EW,
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Head or Department (Physical Chemistry): Professor J.M. Thomas, PhD, DSc, FRS.

COVENTRY

12. COVENTRY (LANCHESTER) POLYTECHNIC,
Priory Street, Coventry, CV1 5FB, Tel. (0203) 24166.

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13. CRANFIELD INSTITUTE OF TECHNOLOGY
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Engineering Unit, Fluid,
Head of Unit: Professor R.C Barker, PhD, MIMechE, CEng.

Management and Administration, Faculty of,
Management School of,
Director: Professor P.G. Forrester, MSc, FIM.

Manufacturing Technology and Production Management Faculty of,
Dean: Professor B.B. Hundy,
National Materials Handling Centre,
Director: J.M. Williamd, BSc, CEng, MIMechE, MIProdE, MRAeS, AMBIM, FIMH.

Production Studies, School of,
Head of School: Professor B.B. Hundy, BSc, PhD.

Science and Technology, Faculty of,
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Mathematics Department of,
Head of Department and Professor of Theoretical Mechanics:
N. Lawss, BSc, PhD, FIMA.

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Silsoe, Bedfordshire MK45 4DT,
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DUNDEE

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DURHAM

16. UNIVERSITY OF DURHAM,
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Chairman and Director of Computing Service: I.R. MacCallum, MA, MSc.

Engineering Science, Department of Electrical,
Head of Department: Professor K.W. Cattermole, BSc.

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20. UNIVERSITY OF EXETER,
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GLASGOW

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Physical Chemistry,
Head of Department: Professor A.M. North, PhD, DSc, FRIC, CChem, FRSE.

Chemical Technology,
Head of Department and Young Professor of Chemistry:
N.B. Graham, PhD, FPI, FRIC.

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Head of Department: Professor T. Allan, BSc, PhD, ARCST, CEng, FIMechE.

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Production Management and Manufacturing Technology, Department of,
Head of Department: Professor D.S. Ross.

Pharmaceutical Sciences, School of Pharmaceutical Chemistry, Department of,
Head of Department: Professor John N. Stenlake, DSc, CChem, PhD, FPS, FRIC, FRSE.

Pharmaceutics, Department of,
Head of Department: Professor A.T. Florence, BSc, PhD, CChem, FRIC, MPS.

Physical and Pharmacology, Department of,
Head of Department: Professor W.C. Bowman, DSc, FRSE.

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23. UNIVERSITY OF GLASGOW,
Glasgow, G12 8QQ.

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Zoology, Department of,
Head of Department: Professor K. Vickerman, PhD, FRSE.

HATFIELD

24. HATFIELD POLYTECHNIC,
PO Box 109, College Lane, Hatfield, Hertfordshire AL10 9AB, Tel. (07072) 681000.

Management Centre,
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Information Sciences, School of,
Dean: R.W. Sharp, BSc, PhD, ARCS, FBCS.

Natural Sciences, School of,
Dean: W. Boardman, MSc, PhD, CChem, FRIC, ARCTS.

National Reprographic Centre for Documentation,
Bayfordbury, Hertford, Hertfordshire SG13 8LD,
Head: B.J.S. Williams,

HUDDERSFIELD

25. HUDDERSFIELD POLYTECHNIC,
Queensgate, Huddersfield HD1 3DH, Tel. (00484) 22288,
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HULL

26. UNIVERSITY OF HULL,
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Chemistry, Department of,
Head of Department and G.F.Grant Professor of Chemistry:
N.B. Chapman, MA, PhD, FRIC.

Electronic Engineering, Department of,
Head of Department: Professor G.B. Cook.

Physics, Department of Applied,
Head of Department: Professor S.A. Ramsden, BA, DPhil,

KEELE

28. UNIVERSITY OF KEELE,
Keele, Staffordshire ST5 5BG Tel. (0782) 621111.

Chemistry, Department of,
Head of Department: Professor I.T. Millar, BSc, PhD, CChem, FRIC.

Electronics, Department of,
Head of Department: Professor W. Fuller, BSc, PhD, AKC, FinstP.

Mathematics, Department of,
Head of Department: Professor P.C. Kendall, BSc, PhD, FIMA, FRAS.

KENT

29. UNIVERSITY OF KENT AT CANTERBURY,
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KINGSTON

30. KINGSTON POLYTECHNIC,
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Knights Park Centre, Kingston-upon-Thames, Surrey, KT1 2QJ, Tel. 01-549-6151.

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Head of School: J. Lloyd, BSc (Econ).

Chemical and Physical Sciences, School of,
Head of School: R.Long, BSc, PhD, CChem, FRIC.

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LANCASTER

31. UNIVERSITY OF LANCASTER,
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Biological Sciences, Department of,
Head of Department: Professor W.T.W.Potts, BA, MA, PhD, DSc.

Chemistry, Department of,
Head of Department: Professor J.C. Bevington, MA, PhD, DSc.

Management and Organisational Sciences, School of,
Gillow House, Lancaster, Lancashire LA1 4YX,
Chairman: M.J. Thomas, BSc, MBA, FRSA, FInstM.

Business Analysis. Department of,
Head of Department: Professor P.B. Checkland, MA.

LEEDS

32. LEEDS POLYTECHNIC,
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33. UNIVERSITY OF LEEDS,
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Chemistry and Dyeing, Department of Colour,
Head of Department: Professor I.D. Ratee, BSc, FRIC, ARCs.

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Head of Department: Professor B.N. Cole, BSc, WhSc, PhD.

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34. LEICESTER POLYTECHNIC,
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Industrial Design, School of,
Head: A.W. Hodge, DesRCA, MSIAD.

Business, Faculty of,
Dean: f. Mee.

Management, School of,
Head of School: F.A. Mee, CEng, MIMechE, FIProdE, FBIM.

Mathematics, Computing and Statistics, School of,
Head of School: Professor D.E. Conway, MA, FBCS, FIMA.

Science, School of,
Dean: Jeanne M. Thompson, BSc, PhD.

Pharmacy, School of,
Head: F. Newcombe, BSc, PhD, ARCST, MIBiol, MPS.

Technology and Construction, Faculty of,
Dean: Professor D.G. Picken.

Engineering, School of, Mechanical and Production,
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35. UNIVERSITY OF LEICESTER,
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Head of Department: Professor S. Trippett, MA, PhD, ScD.

Physical Chemistry,
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37. LIVERPOOL POLYTECHNIC,
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Head of Department: C. Metcalfe.

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Head of Department: R.H. Sharp, ARCA.

Business and Management, STudies, Faculty of,
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Head of Department: M. Stephens, MA, BSc (Econ), FCIS, MBIM, DipEd.

Pharmacy, School of,
Head of School: V. Walters, BPharm, PhD, FPS.

35. UNIVERSITY OF LIVERPOOL,
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LONDON

38. CITY UNIVERSITY,
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Paramedical Sciences, Department of,
Head of Department: J.E. Neville, BSc, MTech, MIBiol.

40. POLYTECHNIC OF CENTRAL LONDON,
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Head of Department: C.R. Clark, BSc, DipOR, MSc,FSS, FIS, MBIM, FIPC, FIWM.

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Chemistry Department of,
Head of Department: P.G. Owston, BSc, PhD, DSc, CChem, FIC, FInsTP.

National College of Rubber Technology,
Head of Department: J. Glazer, PhD, BSc, CChem, FRIC, FPRI.

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Head of Department and Sir Edward Frankland Professor of Inorganic Chemistry: Sir G. Wilkinson, PhD, ARCS, FRS, HonDSc, DIC.

Life Sciences, Division of,
Chairman: Professor E.A. Barnard.

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Acting Head of Department and Professor of Parasitology: J.D. Smyth, PhD, ScD.

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Chemistry, Department of,
Head of Department: Professor V. Gold, FRS.

(4) Queen Mary College,
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LOUGHBOROUGH

44. LOUGHBOROUGH UNIVERSITY OF TECHNOLOGY,
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MANCHESTER

45. MANCHESTER POLYTECHNIC,
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Institute of Advanced Studies,
Head of Institute: Dean J. Langrish, MSc, PhD.

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Industrial Liaison Officer: W. Chapman, DipEngProd, CEng, MIProdE.

46. UNIVERSITY OF MANCHESTER,
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Pharmacology, Materia Medica and Therapeutics, Department of,
Head of Department: Professor H. Schnieden, MD.

Botany, Department of,
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George Harrison Professor of Botany: Elizabeth G. Cutter, PhD, DSc, FLS.
Barker Professor of Cryptonic Botany: J. Colhoun, MAgr, PhD, DSc, DIC, FLS, FIBiol.

Liberal Studies in Science, Department of,
Head of Department: Professor M. Gibbons, BSc, BEng, MSc, PhD.

Pharmacy, Department of,
Head of Department: Professor P.H. Elsworthy, BPharm, PhD, DSc, MSc, MRIC, MPS.

Manchester Business School,
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Director and Professor of Organisational Behaviour: Tom Lupton, MA, PhD.

47. UNIVERSITY OF MANCHESTER INSTITUTE OF SCIENCE AND TECHNOLOGY - UMIST,
PO Box 88, Manchester M60 1QD

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Corrosion and Protection Centre,
Head of Department: Professor G.C. Wood, MA, MSc, ScD, CEng, FIM,, CChem, FRIC, FICorrT, FIMF.

Opthalmic Optics, Department of,
Head of Department: Professor J. R. Cronly-Dillon, MA, MSc, PhD.

MIDDLESBROUGH

48. TEESSIDE POLYTECHNIC,
Middlesbrough, Cleveland TS1 3BA.

Chemistry, Department of,
Head of Department: V. Moss, BSc, PhD, FRIC.

MIDDLESEX

49. MIDDLESEX POLYTECHNIC,
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Behavioural Studies Centre,
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Measurement and Quality Assurance Centre,
Principal Consultants: Ralph Threader, DIC, MTech, CEng, FIProdE, MIMechE; Robert Malivoire, CEng, MIMechE, MIProdE; John Telfer, CEng, MIProdE, MIEI, MIQUA.

MILTON KEYNES

50. OPEN UNIVERSITY,
Walton Hall, Milton Keynes, Buckinghamshire MK7 6AA.

Technology, Faculty of,
Dean and Director of Studies: Professor J.J. Sparkes.

Material Science, Department of,
Head of Department: Professor C.W.A. Newey.

NEWCASTLE

51. NEWCASTLE UPON TYNE POLYTECHNIC,
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Head of Faculty: G. Mitchell, BA, MBIM, FRSA.

Business Analysis, School of,
Head of School: C. Cassells, Bsc, MSc.

Physical Chemistry, Department of,
Professor: D.H. Whiffen, FRS.

NOTTINGHAM

52. TRENT POLYTECHNIC,
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Three-Dimensional Design, Department of,
Head of Department: A.L. Holloway, ARCA, ATD.

Visual Communication, Department of,
Head of Department: D.M. Glen, FSIAD.

Physical Sciences, Department of,
Head of Department: R. Stock, BSc, PhD, CChem,FRIC.

53. UNIVERSITY OF NOTTINGHAM
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Head of Department: Professor R.L. Beurle, BSc, PhD, FIEE, FIERE, FInstP.

Engineering and Production Management, Department of Production,
Acting Head of Department: M.C. Boney.

Metallurgy and Materials Science, Department of,
Head of Department: Professor J.S.L. Leach, BSc, PhD, CEng, FInstP, FIM, FICorrT.

Chemistry, Department of,
Head of Department: Professor T.J. King, BSc, MA, DPhil.

Organic Chemistry,
Head of Division: Professor L. Crombie, PhD, DSc, CChem,FRS.

Pharmacy, Department of,
Head of Department: Professor J. Crossland, MA, PhD, FIBiol.

OXFORD

54. UNIVERSITY OF OXFORD,
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PAISLEY

55. COLLEGE OF TECHNOLOGY,
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PLYMOUTH

56. PLYMOUTH POLYTECHNIC,
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PRESTON

57. PRESTON POLYTECHNIC,
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READING

58. UNIVERSITY OF READING,
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Science, Faculty of,
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Chemistry, Department of,
Head of Department: Professor H.M. Frey, MA, DPhil.

SALFORD

59. UNIVERSITY OF SALFORD,
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SHEFFIELD

60. CITY POLYTECHNIC,
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61. UNIVERSITY OF SHEFFIELD,
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Head of Department: Professor J.K. Page, BA FCIBS.

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STIRLING

63. UNIVERSITY OF STIRLING,
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64. STOCKPORT COLLEGE OF TECHNOLOGY,
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65. NORTH STAFFORDSHIRE POLYTECHNIC,
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66. SUNDERLAND POLYTECHNIC,
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Head of Division: J.T. Pearson, PhD, BSc, FRIC.

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67. UNIVERSITY OF SURREY,
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Head of Department: Professor S.R. Tailby, PhD, CChem, FRIC, CEng, FIChemE, FIndtF.

Mechanical Engineering, DEpartment of,
Head of Department: Professor I.M. Allison, PhD, CEng, MRAeS.

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Head of Department: Professor Daphne F. Jackson.

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68. UNIVERSITY OF SUSSEX,
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69. ULSTER POLYTECHNIC,
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Technology, Faculty of,
Dean: Vacant.

UXBRIDGE

70. BRUNEL UNIVERSITY,
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Head of Department: Professor G. Emery, MA, FBCS.

Statistics, Department of,
Llandinam Building, Penglais, Aberystsyth, Dyfed SY23 2DB.

Welsh Plant Breeding Station,
Plas Gogerddan, Aberystwytg, Dyfed SY23 3EB,
Director of Station:Professor J.P. Cooper, DSc, FRS.

73. UNIVERSITY COLLEGE OF NORTH WALES,
Bangor, Gwynedd LL57 2DG.

Biochemistry and Soil Science, Department of,
Head of Department: Professor W.C. Evans, MSc, PhD, FRIC, FIBiol.

Zoology, Department of Applied,
Deiniol Road, Bangor, Gwynedd LL57 2UW,
Head of Department: J. Hobart, BSc, FRES.

74. UNIVERSITY COLLEGE CARDIFF,
PO Box 78, Cardiff CF1 1XL.

Engineering and Energy Studies, Department of Mechanical,
Newport Road, Cardiff CF2 1TA,
Head of Department: Professor E. Markland, PhD, DSc, CEng, FIMechE, FICE, MemASME.

Science, Faculty of,
Dean: W.A.L. Evans, BSc, MSc, PhD.

Organic Chemistry, Department of,
Professor of Organic Chemistry: A.H. Jackson.

Microbiology Department and Wolfson Laboratory for the Biology of Industry,
Head of Department: D.E. Hughes, BSc, PhD, MA, DSc, FIBiol.

75. UNIVERSITY OF WALES INSTITUTE OF SCIENCE AND TECHNOLOGY - UWIST,
King Edward VII Avenue, Cathays Park, Cardiff CF1 3NU.

Pharmacy, The Welsh School of,
Head of Department: Professor P.S.J. Spencer, BPharm, PhD, FIBiol, FPS.

Metallurgy and Materials Technology, Department of,
Applied Science Building, Singleton Park, Swansea SA2 8PP.

YORK

76. UNIVERSITY OF YORK,
Heslington, York YO1 5DD.

Biology, Department of,
Head of Department: Professor M.H. Williamson, MA, PhD.

SUPPLIER	CONTACT & PHONE	AREA(S) OF SPECIALISATION
AKZO CHEMIE UK 12-14 St Ann's Crescent, Wandsworth, London SW18 2LS.	01-874-7761 M. Lulham	Detergents, inorganic chemicals i.e. peroxides
ARD Fitzherbert Spur, Farlington, Hants.	0705-370951 D. Stockman	Aerosol valves (pumps, tubes etc.)
ATLAS LTD Mill Lane, Carsholton, Surrey, SM 2JS.	01-669-2261/4 Nick Lawson	Detergents - mainly nonionic. Facility to tailor make surfactants to specific requirements.
B.A.S.F. UK LTD PO Box 4, Earl Road, Cheadle Hulme, Cheadle, Cheshire SK8 6QG.	061-485-6222 M. Slack	Surfactants, dyestuffs.
BEROL KEMI (UK) LTD 55/57 Clarendon Road, Watford, Herts.	Watford 25602	Detergents - mostly nonionic Oxygenated solvents.
BP OIL LTD BP House, Victoria Street, London SW1E 5NJ.	01-821-2000	Solvents.
BUSH BOAKE ALLEN LTD Black Horse Lane, E17 5QP.	01-531-4211 Ray Hone.	Perfumes.
CIBA-GEIGY Industrial Chemicals Div, Clayton, Manchester.	061-223-1341	Dyestuffs.
PLASTICS & ADDITIVES CO, Tenax Road, Trafford Park, Manchester.	061-872-2323	Surfactants.
DIAMOND SHAMROCK PO Box 1, Eccles, Manchester M30 OBH.	061-789-7300	Detergents - full range product formulations.
DOW CORNING LTD Barry Glamorgan, Wales	0446-732350 Dr.G.Sawicki	Silicones (agreement for joint development.)
D.P.V. Schulstrasse 33, D-6234, Hattersheim, West Germany.	061-90-8011 M. Becker	Aerosol valves (pumps/triggers).
DRAGOCO (GB)LTD, Lardy Lane Ind. Estate, Hadleigh, Ipswich, Suffolk.	0473-822011/4 G. Clarke	Perfumes

SUPPLIER	CONTACT & PHONE	AREA(S) OF SPECIALIZATION
ESSO CHEMICAL LTD, Arundel Towers, Portland Terr, Southampton SO9 2GW.	0703-34191 T. Peterson	Solvents, Polymers, Adhesive R.M.´s.
FIRMENICH & CO LTD, Hayes Road, Southall, Middlesex.	01-574-0911 J. Chauliat	Perfumes
GIVAUDAN & CO LTD, Whyteleafe, Surrey.	088-32-2241 S. Grave	Perfumes
HENKEL CHEMICALS LTD, Merit House, The Hyde, Edgeware Road, London NW9 5AB.	01-2050-6004 James Westwood	Detergents - derived from natural sources.
HOESCHT UK LTD Hoescht House, Salisbury Road, Hounslow, Middlesex.	01-570-7712 R. Miller	Waxes - major contact. Surfactants) minor interests Dye stuffs)
IFF (GB) LTD Crown Road, Southbury Road, Enfield, Middlesex.	01-804-5331 J.Micklewright	Perfumes
MARCHON (A & W), Whitehaven, Cumbria.	0946-3131 M. Parr	Detergents - full range builders.
NAARDEN UK LTD, Lower Farm Road, Moulton Park, Northampton.	0604-46631 G. Brown	Perfumes
NOVO Dk Boyastaerd, Denmark.	029823-33	Enzymes.
P.F.W. Fragrance Division, Greenford, Middlesex.	01-998-5060 B. McCandless	Perfumes
PPF INTERNATIONAL Ashford, Kent.	0233 25777 D. Williams	Perfumes
REWO Crown House, London Road, Morden, Surrey.	01-543-3335 R. Cohen	Detergents - full range.
ROHM & HAAS LTD Lenning House, 2 Masons Ave, Croydon, Surrey.	01-686-8844 C. Nicholls	Polymers, Surfactants especially nonionic, Preservatives.
SHELL CHEMICALS, Villiers House, 41-47 Strand, London.	01-836-1234 01-839-9070	Solvents. Some detergents.

SUPPLIER	CONTACT & PHONE	AREA(S) OF SPECIALISATION
SUMITOMO CHEMICAL CO LTD, 107 Cheapside, London.	01-283-2588 G. Hellings	Insecticides.
THE WELLCOME FOUNDATION Cooper House, Ravens Lane, Berkhamsted, Herts.	04427 3333 J. Shipp	Insecticides. Formulation assistance (Computer aided).
UNION CARBIDE UK LTD Union Carbide House, Rickmandsworth, Herts.	Rickmansworth 77366	Surfactants (nonionic). Solvents, Silicones.
ZSCHIMMER & SCHWARTZ Postfach 2179, D5420 Lahnstein/RH, West Germany.	070-503800 F. Prins (Represented by ICN Holland)	Detergents - full range.

UK GOVERNMENT RESEARCH INSTITUTES

1. Atomic Energy Research Establishment - AERE,
Harwell, Didcot, Oxfordshire, OX11 ORA.
Commercial Director: Dr R.G.Sowden.

2. British Technology Group,
101 Newington Causeway, London SE1 6BU.
Head of Scientific Division: Dr D. Schaeffer.

3. Building Research Establishment,
Garston, Watford, Hertfordshire WD2 7JR.
Deputy Director: M.E.Burt, BA, FRAeS, CEng, MICE.

4. Computer Aided Design Centre,
Maddingley Road, Cambridge, CB3 OHB.
Head of Centre: Dr P.I. Freeman.

5. Laboratory of the Government Chemist,
Cornwall House, Stamford Street, London SE1 9NQ.
Deputy Director (Customer Services): D.C.Abbott BSc,FRIC.

6. National Engineering Laboratory - NEL,
East Kilbridge, Glasgow G75 OQU.
Head of Marketing Division: M.M.Daniel.

7. National Environment Research Council - NERC,
Polaris House, North Star Avenue, Swindon, Wiltshire SN2 1EU.
Information Officer: Dr D.S.Davies.

8. National Physical Laboratory - NPL,
Teddington, Middlesex, TW11 OLW.
Head of Information Services: G.H.Booth.

9. Overseas Development Administration Centre for Overseas Pesticides Research,
College House, Wrights Lane London, W8 5SJ.
Director: Dr P.T.Haskell, CMG, PhD, FIBiol.

10. Pest Infestation Control Laboratory,
London Road, Slough, Berkshire.
Deputy Director: Dr G.H.Burgess.

11. Rothamstead Experimental Station,
Harpenden, Hertfordshire, AL5 2JQ.
Director: L. Fowden, PhD, FIBiol, FRIC, FRS.

12. Science and Engineering Research Council - SERC,
Central Office, North Star Avenue, Swindon, Wiltshire SN2 1ET.
Secretary: B.W.Oakley.

13. Social Science Research Council - SSRC.
1 Temple Avenue, London EC4 OBD.
Secretary: Dr C.S.Smith.

14. Technology Report Centre -TRC,
Orpington, Kent BR5 3RF.
Head: M.J.Hammond.

PRIVATE RESEARCH INSTITUTES

1. British Industrial Biological Research Association - BIBRA,
   Woodmanstern Road, Carshalton, Surrey SM5 4DS.
   Secretary: M.D.Clarke, FCIS, ACIArb.

2. British Leather Manufacturers Research Association,
   Kings Park Road, Moulton Park, Northampton NN3 1JD.
   Director: R.L.Sykes, BSc, PhD, CChem, FRIC.

3. Building Services Research and Information Association - BSRIA,
   Old Bracknell Lane, Bracknell, Berks, RG12 4AH.
   Head Information Centre: A.R.Eaves ALA.

4. Cutlery and Allied Trades Research Association,
   Henry Street, Sheffield S3 7EQ,
   Information Officer: R.H.Bingham, AIM.

5. ERA Technology Limited,
   Cleeve Road, Leatherhead, Surrey KT22 7SA,
   Market Development: D.W.Brooks, BSc.

6. Fabric Care Research Association Ltd,
   Forest House Laboratories, Knaresborough Road, Harrogate HG2 7LZ.
   Director: E.J.Davies, BSc, MSc.

7. Furniture Industries Research Association - FIRA,
   Maxwell Road, Stevenage, Hertfordshire SG1 2EW.
   Head of Research: M.Charity, MA.

8. Leatherhead Food RA,
   Randalls Road, Leatherhead, Surrey KT22 7RY,
   Director: Dr. A.W.Holmes.

9. Paint Research Association,
   Walldegrave Road, Teddington, Middlesex TW11 8LD,
   Enquiry Officer: M.J.Haines.

10. International Tin Research Institute - ITRI,
    Frazer Road, Perry Vale, Greenford, Middlesex UB6 7AQ,
    Enquiries to: Dr C.J.Thwaites.

11. Packaging Industries Research Association - PIRA,
    Randalls Road, Leatherhead, Surrey KT22 7RU,
    Director of Information & Training: B.W.Blunden, FRPS, AMBIM, MIOP,
    MInstPkg.

12. Production Engineering Research Association - PERA,
    Melton Mowbray, Leicestershire LE13 OPB,
    Secretary: D.W.J.Foster, FCIS, FSCA.

13. Rubber & Plastics Research Association - RAPRA,
    Shawbury, Shrewsbury, Shropshire SY4 4NR,
    Director Technical Development, Dr M.M.Hall, BSc, PhD, FInstP, FPRI.

14. Shirley Institute,
    Didsbury, Manchester M20 8RX,
    Director of Research: L.A.Wiseman, OBE,BSc, ARCS, FTI.

15. SIRA Institute Ltd,
    Southill, Chislehurst, Kent BR7 5EH,
    Marketing Director: D.J.Berry, BMet.

16. Woollen Industries Research Association - WIRA,
    Headingley Lane, Leeds LS6 1BW,
    Director: Dr. Brian E.King.

17. British Ceramic Research Association,
    Queens Road, Penkhull, Stoke on Trent, Staffordshire ST4 7LQ,
    Enquiries to: D. Murfin, PhD.

TECHNOLOGY TRADERS

NAME OF COMPANY	SPECIALITIES	COMMENTS
1. British Technology Group Group (UK Government)	Chemistry, Bio-sciences, Engineering	Have previously linked with Johnson on development projects.
1. Ideas & Resources Exchange (I.R.X.) (01-633-0424)	None - clearing house for subsidiaries.	Just launched. Financed by merchant bank.
3. Booth/Smith Associates (St Albans) 0727-57621	Speciality foods.	Small private company Little evidence of success.
4. Cadogan Consultants 01-589-9778	Licensing, engineering, chemical processing.	London based group mostly dealing with chemical processes.
5. Industrial Aides Ltd 01-828-5036	Market research, licensing and technology acquisition.	Has prominent UK consultant chemist/ engineer on board.
6. A.D.Little Ltd 01-493-6801	Project Management and technology acquisition.	International organisation - London branch.
7. EVAF International - UK Chapter 01-623-5131	Chemical and manufacturing processes mostly from USA.	
8. Dr K. Whittle Ltd Bridlington, Yorkshire.	Novel Pharmaceutical products.	Retired Technical Director of UK Wellcome Foundation. Acts as search agent.
9. Proplan Marketing A.G. London 01-239-6666.	Toiletries, Pharmaceuticals, Innovative packaging.	Already utilised by Johnson Wax Ltd for packaging products.

PRODUCT DEVELOPERS

NAME OF COMPANY	SPECIALITIES	COMMENTS
1. A.I.D. Allied Int. Design 01-439-0921	Household products.	Previously used by Johnson Wax Ltd on Aircare projects.
2. Applied N.P.D. (MJ Peters) 01-995-9502	Toiletries Household products.	Have used MJ Peters design resources successfully for Italian & UK project.
3. Presight 01-240-5187	None	No information on this company.
4. Creighton, Lodge & Knight 01-370-6054	Advertising consumer products, Market Research.	Have been used.
5. "Brand New"	Unknown	
6. D.R.Management Consultants, Stanford le Hope, Essex.	Unknown	
7. Peter Kraushar K.A.E. Group	Consumer Products	Major agency with UK marketing specialist as head.

Johnson wax
Research & Development Centre
.Milton Park, Stroude Road, Egham, Surrey TW20 9UH
Telephone Egham (0784) 34333 Telex 8953140

APPENDIX VI
LETTER TO SUPPLIERS

Dear

As you have been one of our major suppliers for some years now it is probable that you are already quite familiar with our range of interests. For your further information I have enclosed a small booklet which confirms what these are at the present time. However, you may not be aware that Johnson Wax in Europe have embarked on a campaign to expand and diversify their range of interests in the field of consumer products. This comes as a result of strategic planning sessions aimed at ensuring the company's continued growth and future success in this region.

Naturally some of this future growth is expected to come from the on-going research and development activities already taking place at our Milton Park centre. However, a second programme has just been initiated directed at pursuing selected new ideas and technology from key suppliers, various Universities and other research institutions. The purpose of this letter is to make you aware of this programme and, as one of our valued business associates, give you the opportunity to consider any areas that you may feel are worthy of at least some further discussion with Johnson Wax. To assist you in this I should state that we are initially interested in new or developing technology which would primarily relate to our current consumer product range. However, as the programme has just started there is no intention to limit the search entirely to this objective and other ideas applicable to the household product market would also be of interest.

As a first step, may I suggest that you consider this proposal and perhaps the possibility of following it up with a non confidential discussion in the near future. To this end, I would be most happy to visit you in your offices or to meet you at Milton Park in the near future to explore this further.

I hope that the above is of interest to you and I look forward to hearing from you.

Yours sincerely,

JMC ROBERTS
Product Research Manager

Milton Park

Johnson wax
Research & Development Centre

Milton Park, Stroude Road, Egham, Surrey TW20 9UH
Telephone Egham (0784) 34333 Telex 8953140

LETTER TO UNIVERSITIES AND OTHER RESEARCH INSTITUTES

Johnson Wax Ltd. is launching a campaign to expand and diversify their range of interests in the field of consumer products in the U.K. and Europe. In order to provide the broadest possible resource base for this development, we are offering the opportunity for selected research workers in higher education establishments and research organisations to participate in this exercise. To familiarise you with our Company, a leaflet is enclosed, describing some of our activities and products.

As a first step, we would like to hear about any current or proposed research, or ideas, that you and Johnson Wax might exploit to mutual benefit. If you feel that you have an idea, project, product or development that would be of interest to us, please send a brief non-confidential description to our Product Research Manager, J.M.C. Roberts, at the above address, using the guidelines on the attached sheet.

Every reply will be carefully reviewed by a panel of technical and commercial experts, and those considered to be of interest will be followed up promptly. Typically, we first envisage non-confidential discussions usually at the proposer's place of business, held in order to determine if the ideas can be progressed on a mutually satisfactory basis. The precise way in which such a project will develop from this point will depend on a number of factors, but at some stage more in-depth evaluations will be necessary. To facilitate such an evaluation, the proposer may be invited to make a more formal presentation to our technical/commercial panel.

I do hope that we shall be hearing from you shortly.

Yours sincerely,

J.M.C. ROBERTS
Product Research Manager

Milton Park

division of Johnson Wax Limited, Frimley Green, Surrey Registered no. 177819
ectors: (Australian) GR Hudson, Managing, (USA) SC Johnson, W K Eastham, WJ Shively,
nadian) JD Crabb, (British) M J Black, JE Bolton, TPE Curry, VG Nash, The Lord Orr-Ewing OBE.

Johnson wax
Research & Development Centre
Milton Park, Stroude Road, Egham, Surrey TW20 9UH
Telephone Egham (0784) 34333 Telex 8953140

GUIDELINES FOR PROPOSAL TO JOHNSON WAX LTD.

It would be helpful if you would summarise your proposal as briefly as possible. Doubtless you will know already that projects such as this must be handled carefully in their initial stages for the protection of the proprietary technology of each party. Therefore, please do not send at this stage any confidential information or materials. Send only a description of the technology or its application that would permit a preliminary exploration of interest.

Please include the following non-confidential information :

Name
Address
Telephone Number
Co-workers
Subject of proposal (about 10 words)
Stage of development
Directly relevant publications
Current funding agency, if active
Patent protection, or assignation of any rights
Your estimate of funds and/or resources needed
Your estimate of time required for proposal to be ready for commercialisation.

Please send this proposal to J.M.C. Roberts, Product Research Manager, at the above address, as soon as possible.

APPENDIX VII: STUDY RECOMMENDATIONS

INTRODUCTION

Productivity in research is very difficult to measure: Some useful and valuable results will invariably arise from any research and development programme but the frequency and size of beneficial results are not predictable; nor is it necessarily true that research is a profitable activity. There is no way of designing a foolproof process for achieving or guaranteeing success, but it is, however, possible to create the most favourable circumstances for optimal results in an R & D organisation. A major but intangible factor is the generation, adaptation and implementation of novel ideas which is known as Innovation. Enhancement and encouragement of this idea generation process will help to create the most favourable environment for effective R & D. There are a number of stages:

- Firstly there needs to be recognition of the so-called "innovation process" which provides successful results
- Secondly - the realisation that improvements in innovation are needed and can be achieved
- Thirdly - identification of the most encouraging circumstances to improve innovation
- Fourthly - implementation of these circumstances.

This report considers what innovation is, the factors affecting it, general observations for improving innovation and finally some specific recommendations for Johnson Wax Ltd.

CONCLUSIONS

This report has the objective of complementing the M.I.C. report by J.M.C. Roberts. There are many potential benefits arising from an improved innovation identification and enhancement programme although it is not possible to specify what these will be at this stage. Motivation is believed to be a key factor together with an improved environment and a wide range of aspects are described above. A firm grasp of the Innovation Process will almost certainly result in benefits to the Company and employees. Arising out of the discussions in this report a number of general recommendations are made relating to policy, followed by specific recommendations for establishing an innovation process which develop some of the key general points.

GENERAL RECOMMENDATIONS

1. There must be a whole-hearted commitment to the innovation process development throughout the company, with clear support from the top executives.
2. Opportunities must be provided for everyone in the organisation to learn about the innovation process, particularly why it is needed, how it works and what is in it for them.
3. Set aside a (nominal) budget for innovation and/or a long term horizon and without constraints or justification. Allocation should be at the discretion of one or more senior executives and be unconditional.
4. Set up a small working group to develop an incentive scheme. This is a particularly important activity and should include representatives from as many groups as possible.
5. Encourage publication of articles at conferences and in journals.
6. Organise in-house conferences/seminars for training, dissemination of information and explaining the operations of different parts of the Company.
7. Develop maximum confidence between all levels of staff by greater interaction on social and professional levels. This is more likely to be effective in a relatively small organisation like Milton Park.
8. Develop an in-house publication to draw more attention to new ideas and products with personality profiles and prize-winners.
9. Set up a working group to examine the feasibility and "modus operandi" of mobility between research, manufacturing and administrative centres. This should ideally include one representative from each centre in each country, although costs may impose restrictions such as geographical constraints.
10. Redeploy creative and innovative talent into areas which can benefit most from such talents (see also (7))
11. Use idea generation sessions sparingly and to best effect by careful planning to maximise interest, enthusiasm and opportunity. Provide follow-up sessions for feedback.
12. Traditional "rights" may need to be sacrificed, at least in part, but with some compensation. An example is marketing where, apparently, much of the kudos is laid for the successful launch of a new product.
13. Encourage informal creativity/innovation by group activities and exploit good personal and working relationships and discourage fruitless activities.

14. Involve outside but sympathetic individuals/organisations to occasionally assess research programmes and current activities. An independant objective judgement can often prove invaluable.

15. Establish a formal idea screening/assessment procedure with a management committee consisting of some elected representatives of the organisation and some nominated management representatives; supplemented with appropriate representatives from complementary external groups. Elected representation will encourage confidence and trust, and provide opportunities for the individual to both acquire wider management experience and be assessed for his potential.

SPECIFIC RECOMMENDATIONS FOR INTRODUCTION OF AN INNOVATION DEVELOPMENT PROGRAMME

1. Establish a task force of middle managers and scientists to devise an incentive scheme for rewarding new ideas. The composition should be interdepartmental and inter-divisional, and if possible some members at least should be elected to provide reassurance of impartiality.

2. Establish internal and external competitions for generating new ideas. This should be handled by a new business generation manager (specific proposals have already been submitted in certain areas).

3. Establish a panel of both internal personnel and external advisers to assess the new ideas. Care is needed not to allow traditional attitudes to exclude potentially attractive new business opportunities, and a very careful balance is needed in the composition of such a panel, and the role of in-company personnel. (Specific proposals on the composition and modus operandi have already been submitted).

4. Establish a programme for professionally qualified personnel to gain experience in as wide a variety of job functions as possible. Scientists, technologists, marketing personnal and managers should all be given the opportunity, and encouraged, to take secondment to other divisions/departments to understand how the complete manufacturing process works, from research through production to marketing. Secondment should be essentially voluntary and typically last a month, although circumstances may

dictate longer or shorter time periods. A position of some responsibility, such as assistant line manager should be associated with the placement. International movement would be useful for more senior personnel. A detailed and critical report should be required on completion of the programme for evaluation of the secondment; innovative developments within the home department and department visited; and personnel assessment for career development. A senior management task force should be established to recommend a procedure and programme.

5. Provide opportunities for, and encourage, publications and presentations at conferences. The less experienced will need advice and assistance which can be provided as a complementary service to the usual publications clearance procedure. It is important that the assistance is seen to be constructive and encouraging. Publication should not only be at trade journal level, but also, whenever possible, at a serious and professional level with in-depth analysis of methods and results. The public relations manager could organise this and establish ad hoc group if necessary.

APPENDIX VIII

BUSINESS SCREEN: DESCRIPTION OF SOFTWARE DEVELOPED FOR THIS THESIS

1. Objectives

An integral part of the proposed search/screen programme aimed at providing new opportunities for Johnson Wax Ltd is project selection. That is the choice of projects which are deemed to be worthy of the investment of R & D resources in order to develop a prototype which can be consumer tested.

Prior to the pilot study, project selection by Johnson Wax Ltd was conducted either on a judgemental basis or via the compilation and subsequent management approval of a hypothetical business proposition formulated using estimated gross profit and market share data. However historical information indicates that both routes are prone to large errors due to their inability to take account of manufacturing and marketing costs [e.g. cost of sales; advertising (T.V., media, promotions, dealing); sales distribution.] The relationship between these parameters and the retail selling price was observed to be of paramount importance in judging a products market potential especially at an early stage i.e. in the absence of any form of consumer data.

Therefore the construction of a 'business screen' was considered to be imperative to the success of the pilot study such that the individual and interactive effects of key parameters on a products performance in the market place could be quickly investigated by the use of a mathematical model. The following objectives were set prior to constructing this model:-

(a) A product will be accepted or rejected on the basis of Operating Profit as defined in Appendix IX (both % and £'s). The rules will be as follows : Operating profit $\% < 15$ = rejection
Operating profit $£ < 10^4$ = rejection

(b) The programme will model the business structure of Johnson Wax Ltd by establishing and utilising the relationships between operating profit and both manufacturing, distribution and marketing costs over the range of current products.

(c) The model will utilise as inputs typical and and readily available marketing data e.g. Retail Selling Price; Market Share; Cost of Sales. - (defined in Appendix IX).

2. Construction of the Johnson Wax Ltd Business Screen Model

This task was initiated by surveying the product files of Johnson Wax Ltd over a ten year period. These "Profit by Product" records were found to contain financial information on the following items:-

Gross Sales	Gross Profit	Advertising Costs	Cost of Sales	Unit Cost
Net Sales	Operating Profit	Promotional Costs	Sales Freight	Cost to Wholesaler
		Deal Costs	Service Fees	Rec. Retail Price
			Other Costs	

It was thus possible to deduce the following information for the model:-

(i) The full range of manufactured costs ('cost of sales') for current and previous products from Johnson Wax Ltd.

(ii) Which costs (incurred in conjunction with product manufacture and marketing) are constant and which may vary.

(iii) Typical profit margins required by both Johnson Wax Ltd and their customers.

(iv) The relationship between Operating Profit and other business parameters. During these investigations and those described in (ii) above, the profit regulation effect of advertising was established together with the details of company policy on the use of advertising namely:- at least 10% of net sales must be directed toward product advertising in order to ensure effective product distribution and subsequent sales.

The flow chart of the business screen model is shown in Figure A. A listing of the software follows as Figure B and a typical run as Figure C. The equations and steps utilised are explained below.

Step 1 - Calculation of Johnson Wax Ltd sales from retail selling price by the equation

$$J = \frac{(C \times 100 \times 100)}{(\quad 115 \quad 150)}$$

Where

J = Johnson Wax Ltd selling price in £'s per unit
C = Retail selling price

Other terms are value added tax and retailer profit margins respectively.

Step 2 - Calculation of the relationship between % Operating profit and % advertising via the equation:

$$Q = [100 - (\frac{U \times 100}{J}) - 22 - A]$$

Where

Q = operating profit as a percentage of net sales during accounting period
U = Cost of sales in 's per unit
A = Total advertising costs as a percentage of net sales during accounting period.

Step 3 - Calculation of the relationship between actual operating profit (£'s) and total advertising costs (£'s) using the equations:-

$$O = \frac{Q \times M \times S}{10^4} \text{ - operating profit (£'s)}$$

and

$$B = \frac{A \times M \times S}{10^4} \text{ - advertising costs (£'s)}$$

Where

O = Actual operating profit achieved in £'s.
M = Input Market value £'s.
S = Input market share %
B = Total advertising costs £'s
A = Total advertising costs %.

Step 4 - A comparison is then made between achievable operating profit (% and £'s) co-incident with an advertising costs of at least 10% of net sales. A recommendation is then given to either accept or regard the product.

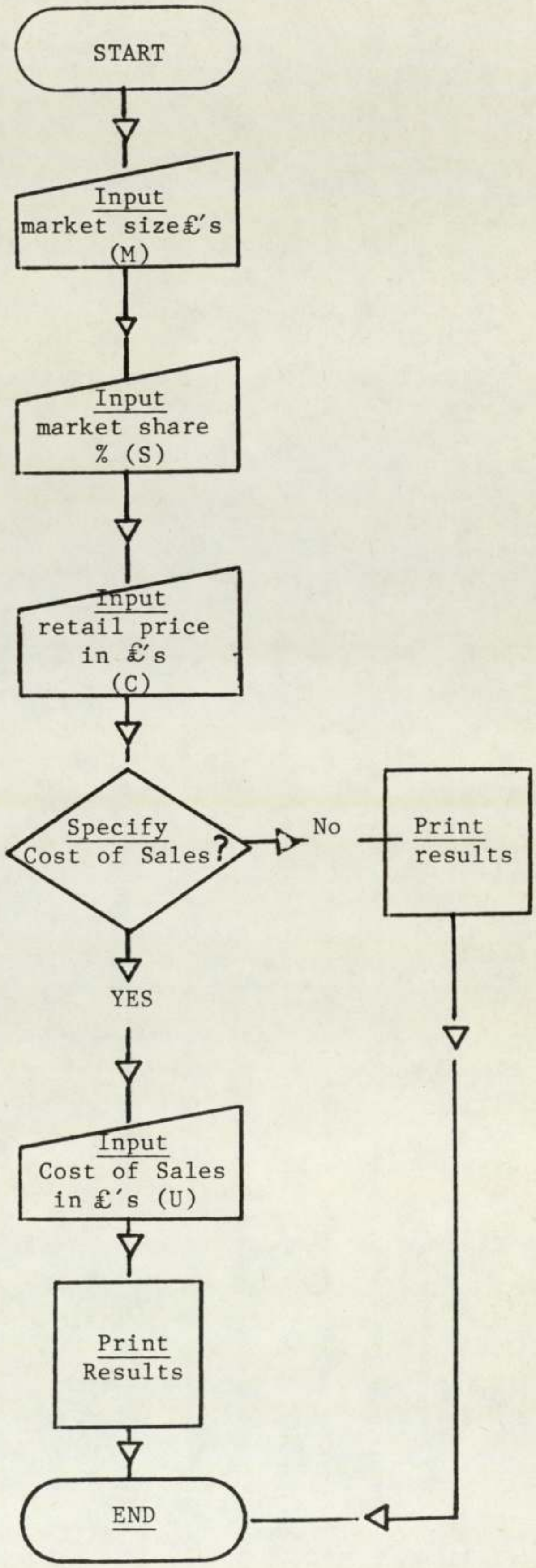

FIGURE A: BUSINESS SCREEN SOFTWARE FLOW CHART

LIST


```
10 DIM U(10),A(10)
20 PRINT "WHAT IS THE MARKET SIZE IN £10^6 ";
25 INPUT M
30 PRINT "WHAT IS THE ESTIMATED MARKET SHARE AS A PERCENTAGE   ";
35 INPUT S
40 PRINT " WHAT IS THE ESTIMATED RETAIL PRICE IN £   ";
45 INPUT C
50 LET T=D=H=I=K=L=0
60 LET J=(C*100/115)*100/150
70 PRINT " DO YOU WANT TO SPECIFY THE COST OF SALES   0=NO, 1= YES";
80 INPUT Z
90 IF Z=0 THEN 130
91 READ P1
92 READ P2
93 READ P3
94 READ P4
100 LET H=H+1
110 PRINT " WHAT IS THE COST OF SALES IN £   ";
115 INPUT U(H)
120 GO TO 180
130 READ U
140 IF U=-1 THEN 180
150 LET H=H+1
160 LET U(H) = U
170 GO TO 130
180 READ A
190 IF A=-1 THEN 230
200 LET I=I+1
210 LET A(I)=A
220 GO TO 180
230 FOR K=1 TO H
235 PRINT
236 PRINT
237 PRINT
238 PRINT
240 PRINT " COST OF SALES = £" U(K)
241 PRINT
242 PRINT
243 LET L=3
244 GO TO 270
250 PRINT "   O.P.%      ADS.%                    O.P.£*10^6          ADS.£*10^6"
251 PRINT
252 PRINT
260 FOR L=1 TO I
270 LET Q(L)= (100-(U(K)*100/J))-22-A(L)
280 LET O(L)=Q(L)*M*S/10000
290 LET B(L)=A(L)*M*S/10000
291 IF D=1 GO TO 300
292 IF Q(3)<10 GO TO 440
293 IF O(3)<0.01 GO TO 460
294 LET D=D+1
295 LET L=0
296 GO TO 250
300 PRINT USING 360,Q(L),A(L),O(L),B(L)
310 NEXT L
315 LET D=0
320 PRINT
330 PRINT
340 PRINT
350 NEXT K
360:  £££.££     £££.££                    ££££££.££££££       £££££.££££££
370 PRINT
380 PRINT
390 PRINT
400 PRINT " END OF RUN "
405 STOP
410 DATA .14,.25,.81,-1,.8,5,10,14,25,30,35,40,45,50,-1
440 PRINT " PRODUCT WILL NOT SUPPORT ADS. "
441 PRINT
442 PRINT
443 IF T=1 GO TO 550
444 LET T=1
450 GO TO 500
460 PRINT " PRODUCT WILL NOT GENERATE SUFFICIENT OPERATING PROFIT"
461 PRINT
462 PRINT
463 IF T = 1 GO TO 550
464 LET T=1
500 PRINT " COMPANY GUIDE LINE SUGGESTS THAT PRODUCTS "
510 PRINT " THAT WILL NOT SUPPORT TOTAL ADVERTISING OF "
520 PRINT " 10% AND GENERATE LESS THAN AN OPERATING "
530 PRINT " PROFIT OF £10,000 ARE NOT WORTHY OF FUTHER "
540 PRINT " CONSIDERATION "
550 PRINT
560 PRINT
570 PRINT
580 PRINT " DO YOU STILL WANT A FULL PRINT OUT 0=NO, 1=YES ";
590 INPUT D
600 IF D=0 GO TO 400
610 LET L=0
620 GO TO 250
630 STOP
640 END
```

FIGURE B: BUSINESS SCREEN SOFTWARE LISTING

WHAT IS THE MARKET SIZE IN £10^6 ?.1

WHAT IS THE ESTIMATED MARKET SHARE AS A PERCENTAGE ?50

WHAT IS THE ESTIMATED RETAIL PRICE IN £ ?.75

DO YOU WANT TO SPECIFY THE COST OF SALES 0=NO, 1= YES?0

<u>COST OF SALES</u> = £ .14

O.P.%	ADS.%	O.P.£*10^6	ADS.£*10^6
45.00	.80	.022500	.000400
40.80	5.00	.020400	.002500
35.80	10.00	.017900	.005000
31.80	14.00	.015900	.007000
20.80	25.00	.010400	.012500
15.80	30.00	.007900	.015000
10.80	35.00	.005400	.017500
5.80	40.00	.002900	.020000
.80	45.00	.000400	.022500
-4.20	50.00	-.002100	.025000

<u>COST OF SALES</u> = £ .25

PRODUCT WILL NOT GENERATE SUFFICIENT OPERATING PROFIT

COMPANY GUILD LINE SUGGESTS THAT PRODUCTS
THAT WILL NOT SUPPORT TOTAL ADVERTISING OF
10% AND GENERATE LESS THAN AN OPERATING
PROFIT OF £10,000 ARE NOT WORTHY OF FUTHER
CONSIDERATION

DO YOU STILL WANT A FULL PRINT OUT 0=NO, 1=YES ?1

O.P.%	ADS.%	O.P.£*10^6	ADS.£*10^6
19.70	.80	.009850	.000400
15.50	5.00	.007750	.002500
10.50	10.00	.005250	.005000
6.50	14.00	.003250	.007000
-4.50	25.00	-.002250	.012500
-9.50	30.00	-.004750	.015000
-14.50	35.00	-.007250	.017500
-19.50	40.00	-.009750	.020000
-24.50	45.00	-.012250	.022500
-29.50	50.00	-.014750	.025000

<u>COST OF SALES</u> = £ .81

PRODUCT WILL NOT SUPPORT ADS.

DO YOU STILL WANT A FULL PRINT OUT 0=NO, 1=YES ?1

O.P.%	ADS.%	O.P.£*10^6	ADS.£*10^6
******	.80	-.054550	.000400
******	5.00	-.056650	.002500
******	10.00	-.059150	.005000
******	14.00	-.061150	.007000
******	25.00	-.066650	.012500
******	30.00	-.069150	.015000
******	35.00	-.071650	.017500
******	40.00	-.074150	.020000
******	45.00	-.076650	.022500
******	50.00	-.079150	.025000

<u>FIGURE C: BUSINESS SCREEN TYPICAL RUN</u>

APPENDIX IX: GLOSSARY OF FINANCIAL TERMS

Accounts Payable

A balance sheet item which represents an amount owed to a creditor (usually from a purchase of merchandise or materials). Appears as a liability account. If Johnson Wax Ltd buys materials from a supplier, the purchase generates an account payable.

Accounts Receivable

A balance sheet item representing a promised future payment. It usually arises from sales or services rendered. If Johnson Wax Ltd sells products to a customer, the sale generates an account receivable.

Allocate

The process of splitting up costs or revenues, spreading them from one account to several accounts, products, activities, or periods. For example, if a department works for the benefit of the entire corporation, some of the costs of running that department may be allocated across all companies since they all benefit from the services. Revenues may be spread in the same manner.

Assets

Any owned property or rights having a money value to the owner. An asset may have a future benefit (an account receivable), a service potential (plant and equipment), or immediate value (cash).

Balance Sheet

Statement of financial position of a company which shown:

Total Assets = Total Liabilities + Owner's Equity

A balance sheet describes the financial health of the company, while the profit and loss (P & L) statement describes the way a company achieves profits.

Cash Flow

A term used to define all of the cash inflows and outflows of an operation over a period of time. Cash flow analysis measures changes in cash-generating or cash-using accounts such as inventory, accounts payable, etc. On an on-going basis it measures a company's ability to maintain continuous operations. When used in conjunction with ROI or MEA analysis, it shows the financial impact of a specific proposal. A convenient shorthand definition that is used in Johnson Wax Ltd is that cash flow is the change in the net cash/loan position. In other words, an increase in cash (or marketable securities) is a positive cash flow. An increase in loans is a negative cash flow. Understanding cash flow analysis is a key point for any manager.

Cost of Sales

The total cost of the finished goods including raw materials; labour; overheads; excluding advertising/promotional expenditure.

Current Asset

Cash, marketable securities, receivables, inventory and other assets that are expected to be turned into cash, sold, or exchanged within the normal operating cycle of the firm, usually one year or less.

Current Liability

A debt or other obligation that must be discharged within a short time, usually one year or less. Current liabilities include accounts payable, short-term borrowing, etc. Current assets and currency liabilities are balance sheet items.

Debt

The sum of short-term and long-term borrowings, plus discounted accounts receivable (accounts receivable sold to a lender).

Debt Ratio

The calculation is: $\dfrac{\text{Total Debt}}{\text{Total Debt + Net Worth}}$

This ratio is used to express long-term financial goals involving the balance between borrowed funds and ownership funds. It is a controlled measure that can also establish the amount of risk that can be assumed in financing certain projects.

In order to adjust for seasonal differences in borrowings, a 12 month moving average calculation is used to determine the actual debt ratio.

Depreciation

A systematic method of charging the cost of an asset over its expected life. It is a non-cash charge for using an asset that affects the P & L. Depreciation taken is accumulated on the balance sheet, thereby reducing the original cost of the asset.

Discount Rate

The rate used to convert future payments to present values. Future payments are not worth as much as cash in hand, and therefore must be discounted. Most often the rate is tied to a firm's cost of capital. See "Net Present Value".

Gross Profit

Net sales minus cost of goods sold.

Inventory Coverage

Describes the amount of inventory available for use in production or sales in terms of how long, at expected production or sales volumes, that inventory will last. It is usually expressed in "weeks coverage". For finished goods, the coverage is calculated as the amount of finished goods inventory divided by expected sales volume as expressed by the equivalent cost of sales.

Literally, inventory coverage means that, based on a projected sales pattern, one has enough inventory to cover "x" weeks of sales if production was halted.

Investment

An expenditure to produce future revenues.

Johnson Wax Selling Price

This is the price that Johnson Wax charges for its products usually to retail outlets.

LIFO

"Last in first out". A LIFO adjustment refers to an accounting adjustment on inventory that takes into consideration the changing values of purchased inventory due to such things as inflation.

Loan

An arrangement where the owner of property (lendor) allows someone else (borrower) the use of the property for a specified period of time. The borrower promises to return the property plus make a payment for the use of the property. Generally the property is cash and the payment for its use is interest.

Major Expense Authorisation (M.E.A.)

The M.E.A. is an accounting procedure utilised by Johnson Wax Ltd which attempts to look at projected product performance from a commercial viewpoint considering return on investment; payback; required advertising and operating profit. It does this on the basis of estimated data and unlike the 'Business Screen' fails to take account of the realistic manufacturing cost.

Market Share

This is the value of the gross sales accredited to a company e.g. Johnson Wax Ltd expressed as a percentage of the total sales in the country concerned.

Net Income

The excess of all revenues and gains for a period over all expenses and losses in the period. Also called net profit.

Net Present Worth

The discounted or present value of all projected cash inflows and outflows of a project or from an investment at a given discount rate.

Operating Expenses

Expenses incurred in the course of normal activities of a business. They include both direct and functional expenses, such as advertising, deals, sales freight, field and office warehouse, financial, International Resource Management (Computer).

Operating Profit

One of the key profit measurements. It is calculated as gross profit less direct and functional expenses or gross profit less total operating expenses.

Overhead Costs

Any cost not specifically or directly associated with the production of identifiable goods and services. The cost of security guards is an overhead cost.

Payback Period

The amount of time that must elapse before cash inflows from a project equal the cash outflows.

PBSI - Profit Before Special Items

Calculated as operating profit less contributions, profit sharing, net interest expense, income taxes and equity in earnings of unconsolidated subsidiaries. PBSI LESS lifo adjustments and foreing exchange gains/(losses) equals net profit. (Special items are significant, non-recurring, non-operational items.)

Retail Selling Price

This is the price paid by the consumer for a product. It includes the profit margins of Johnson Wax Ltd the wholesaler and the retailer.

ROI - Return On Investment

Measures the amount of total investment committed to attaining profits. Total investment includes debt and equity so ROI is an effective way of examining the complete relationship between the P & L and the balance sheet.

Working Capital

Basically, working capital can be thought of as current assets minus current liabilities. Companies make minor adjustments in the calculation to take into consideration particular circumstances of the company. At Johnson Wax Ltd, working capital is defined as:

  Current Assets (excluding cash)

\+ Accounts Receivable Discounted

\- Current Liabilities (excluding short-term loans)

= Working Capital

REFERENCES

(1) Molina, M.J. and Rowland, F.S., Nature, 249, 810 - 812.

(2) Frost and Sullivan Inc., Market Research Report for SCJ - 1978.

(3) Johnson Wax Ltd., Central European Purchasing Reports.

(4) Chemical Specialities Manufacturing Association, "28th Pressurised Products Survey", Washington, USA, 1978.

(5) Wolfe, H.C., "Hostaform C for Aerosols", Australian Packaging, 25, (3), 33 - 34.

(6) Johnson Wax Ltd., Costing Department Estimates.

(7) "Report of the British Aerosol Manufacturers Association on Aerosol Propellents", B.A.M.A., London, 1978.

(8) Kendall, P.M.H., Bevington, C.F.P., and Crayston, J., "Social and Economic Implications of Controlling the use of Chlorofluorocarbons in the EEC", - 56, Metra Consulting Group, London, 1978.

(9) "Stratospheric Ozone Depletion by Halocarbons: Chemistry and Transport", National Academy of Sciences, Washington, USA, 1979.

(10) Chlorofluorocarbons and their Effect on Stratospheric Ozone, 2nd Report, Pollution Paper No. 15, H.M.S.A., London.

(11) Technical Bulletins from Martridge Pack, Aerofill, Pamasol on Modifications for CO_2 Propellent Useage.

(12) Aerosol Age, December, 1982, 34 - 42.

(13) Green, J.E.T., Packaging Review, 89, (12), December, 1969, 19, 21.

(14) F.E.A. Bulletins on Aerosol Statistics, 1977/1978, 1978/1979, 1979/1980, 1980/1981, 1981/1982. European Aerosol Co-ordination Centre, Brussels, Belgium.

(15) British Aerosol Manufacturers Association, B.A.M.A. Annual Reports, 1960 - 1982, London, England.

(16) Chemical Specialities Manufacturers Association Annual Reports, 1969 - 1982, C.S.M.A., Washington, USA.

(17) The Petroleum (Consolidation) Act, 1928.

(18) The Petroleum (Mixtures) Order, 1929.

(19) The Petroleum (Inflammable Liquids) Order, 1971.

(20) The Highly Flammable Liquids and Liquified Petroleum Gases Regulations, 1972.

(21) Roberts, D.J., "Aerosol A,B,C.", B.A.M.A., London, 1975.

(22) Gunn-Smith, R.A., Simpson, A., "The Value of Aerosols in Daily Living", 12th FEA International Aerosol Congress, Nice, France, September, 1979.

(23) UK Marketing Manual, 1970 - 1979, B 10. 6; International Publishing Corporation, London, England.

(24) Mintel Market Intelligence Report on UK Haircare Products, Kraushar, Andrews and Eassie, London, 1982.

(26) Mintel Market Intelligence Report on Deodorants, December, 1981, Kraushar, Andrews and Eassie, London.

(27) Ibid, August, 1981, Shaving Products.

(28) Ibid, July, 1980, Furniture and Floor Polish.

(29) Grocery Trade Audits Report, Furniture Polish, Nielsen Company, London, January, 1983.

(30) Mintel Market Intelligence Report, Insecticides and Air Fresheners, January, 1982, Kraushar, Andrews and Eassie, London.

(31) B.A.M.A. Warehouse Committee Report to Members, November, 1982.

(32) Mintel Market Intelligence Report on Car Care Accessories, June, 1979, Kraushar, Andrews and Eassie, London.

(33) Ibid, October, 1980.

(34) "Aerosol Figurama", Metal Box Ltd., Reading, England, 1965 - 1982.

(35) Roberts, D.J., Aerosol A,B,C., 5 - 13, B.A.M.A., London, 1975.

(36) Helbing, H. and Pertsch, G., US Patent 628,463, (1899).

(37) Gebauer, C.L., US Patent 711,045, (1902).

(38) Moore, R.W., US Patent 746,866, (1903).

(39) Mobley, L.K., US Patent 1,378,481, (1921).

(40) Lemoine, E., British Patent 532,194, (1926).

(41) Rotheim, E., US Patent 1,800,156, (1931).

(42) Idim, US Patent 1,892,750, (1933).

(43) Midgley, T. et at, US Patent 1,926,396, (1933).

(44) Bichowsky, R.R., US Patent 2,021,981, (1935).

(45) Rotheim, E., US Patent 2,128,433, (1938).

(46) Goodhue, L.D. and Sullivan, W.N., US Patent 2,321,023, (1943).

(47) Aerosol Review 1968, 11 - 13.

(48) Goodhue L.D., Aerosol Age, 12, (2), December, 1969.

(49) "Freon Aerosol Report A69. Historical Background of the Aerosol Industry". E.I.Du Pont de Nemours and Co., Wilmington, USA 1966.

(50) Manufacturing Chemist and Aerosol News, April, 1980, 24 - 27.

(51) Hafel, H., Aerosol Review, 1968, 11 - 13.

(52) Mintel Market Intelligence Report, July, 1979, Fast and Convenience Foods.

(53) Ibid, Aerosols, July 1982.

(54) Manufacturing Chemist and Aerosol News, November, 1965, 130 - 136.

(55) Market Research Information Compiled by Johnson Wax Ltd. Subsidiaries in Various World Countries and polled by this study.

(56) "The Aerosol Handbook", 3rd Edition, E.D.Johnson, M.A., W.E.Dorland Company, N.J., USA.

(57) Kubler, H., Verpackungs, Rundschau, 2, 1976, 136 - 140.

(58) A.V. Kjemiingenior, H.H., Emballering, 5, 1977, 28 - 31.

(59) Mintel Market Intelligence Report on Aerosols, June, 1977, Kraushar, Andrews and Eassie, London.

(60) The Economist Diary, 1975 - 1982, The Economist Newspaper Ltd., London, 1982.

(61) United Nations Statistical Year Book, 1975 - 1980, United Nations, New York, USA.

(62) SC Johnson International Report, "Exports to Eastern European Countries", December, 1982.

(63) Least Squares Curve Fit Programme, Hewlitt Packard, Stanford, USA, 1982.

(64) Morisirgi, N., Report of Japanese Aerosol Manufacturers Association, Kanagawa, Tokio, December, 1981.

(65) Simpson, A., (Metal Box Company), Aerosol Age, November, 1981, 12 - 32.

(66) SC Johnson Internal Estimates of Aerosol Demand in Asian Countries, December, 1981.

(67) Weir, R., Aerosol Education `Down Under´, Aerosol Age, September, 1979, 46 - 48.

(68) O´Sullivan, M.P., Aerosol Statistics, New Zealand, Auckland, January, 1981.

(69) Correspondence with SC Johnson Companies in Australia and New Zealand, February, 1981.

(70) Johnson, M.A., Soap Perfumery, Cosmetics, November, 1979,585 - 560.

(71) Gunn-Smith, R.A., and Simpson, A., The Value of Aerosols in Daily Living, Presentation at International Aerosol Congress, Nice, France, September, 1979.

(72) "Hiss! Peril in a Spray.", Daily Mirror, 15th May, 1979.

(73) Ruptured Aerosol Cans Caused K-Mart Fire", Bucks Courier Times, 30th June, 1982, Pennsylvania, USA.

(74) "Ban Those Cans, Call", Evening Chronicle, Newcastle-upon-Tyne, 28th May, 1979.

(75) Media Reports to Members Companies. British Aerosol Manufacturers Association, London, UK.

(76) Press Cuttings Service to Members, Chemical Speciality Manufacturers Association, London, UK.

(77) Code of Practice of the British Aerosol Manufacturers Association, 4th Edition, 1980, B.A.M.A., London.

(78) "Hydrocarbon Propellents, Considerations for Effective Handling in Aerosol Plant and Laboratory", Chemical Specialities Manufacturers Association, Washington, USA, 1976.

(79) Chemical Week, 28th January, 1976, p 16.

(80) Simpson, B.W., and Roberts, J.M.C., A Control Chart Scheme for Reducing Electrostatic Charging Hazards associated with the Manufacture of Antiperspirant Aerosols, Internal Report for Johnson Wax Ltd., and M.Sc Dissertation, 1978.

(81) Roberts, J.M.C., and Hughes, J.F., "Elimination of Electrostatic Charging in Punctured Aerosol Cans", I.E.E.E. Industry Applications Symposium, 11th Annual Meeting, Chicago, USA, 22 - 28, 1978.

(82) Reports of the B.A.M.A. Electrostatics Group, B.A.M.A., London December, 1981.

(83) Roberts, D.J., Minutes of 1st B.A.M.A. Warehouse Safety Committee, B.A.M.A, London, 1981.

(84) Fratz. D.D., Associate Director Scientific Affairs to Chemical Specialities Manufacturers Association, Memorandum to Members, "Aerosol Storage Task Force", C.S.M.A., Washington, 27th July, 1981.

(85) Valentine, J.F., "Report on the Work of the B.A.M.A. Warehouse Committee", Paper presented at B.A.M.A. Forum, London, 21st October, 1982.

(86) Engel, R., President C.S.M.A., Memo to Members Companies, "Update on the Factory Mutual Initiative", C.S.M.A., Washington, USA, November, 1981.

(87) Roe, A.E., Secretary to Director B.A.M.A, Memo to Fire Protection Association, London, "Incidence of Fires and Explosions in the Aerosol Manufacturing Industry", 19th August, 1980.

(88) Valentine, J.F., (Chairman), "Survey of Aerosol Warehouses in the UK", Report to B.A.M.A. Warehouse Committee Members, 12th February, 1982.

(89) "Press Cuttings Circulation", B.A.M.A., London, February, 1983.

(90) Fratz, D.D., (Director C.S.M.A.), "Factory Mutual Loss Prevention Data Sheets", Report to C.S.M.A., Aerosol Storage Task Force, Washington, USA, 27th July, 1981.

(91) Craven, A.D., (Burgoyne and Partners), to Valentine, J.F., (B.A.M.A.), Hazard Areas Around Injured Aerosol Cans, 14th October, 1981.

(92) Roberts, J.M.C., "Reducing the Flammability of Hydrocarbon Propelled Aerosols", Internal Report to Johnson Wax Ltd., December, 1980.

(93) Wagenaar, J., "Flammability Reduction of Aerosols Containing over 60% Flammable Ingredient", Paper Presented to SC Johnson Technical Symposium, Racine, USA, March, 1978.

(94) Meuresch, H., (D.P.V.), "Considerations at the Change-over to New Aerosol Systems", Paper Presented to S.A.T.A. meeting, Atlanta, USA, October, 1981.

(95) "Fire Fighting Gear a Scandal - Claim", Skegness Standard, 11th May, 1979.

(96) "Wife's Lucky Escape in Aerosol Blaze", London Evening Standard, 26th January, 1979.

(97) Roberts, D.J., Human Toxicol, (1982), 1, 231 - 238.

(98) Clark, D.G., and Tinston D.J., Human Toxicol, (1982), 1, 239 - 247.

(99) "Aerosols, Airways and Asthma", Transtleim, J.J., Editor, S.P. Medical and Scientific Books, New York, USA, 1981.

(100) Mokler, B.V., et al, "Inhalation Toxicology Studies of Aerosolised Products", Lovelace Biomedical and Environmental Institute, New Mexico, USA, July, 1979.

(101) "The Inhalation of Particles from Consumer Aerosol Sprays - A Review", B.A.M.A. Scientific Panel, London, April, 1981.

(102) The Home Accident Surveillance System, Consumer Safety Unit, Department of Trade, London 1981.

(103) "Spray of Disaster", Hendon Times, 9th November, 1978.

(104) "US warns of Cancer Threat", London Evening Standard, 9th November. 1979.

(105) "Warning on Aerosol Propellent", The Guardian, 24th October, 1979.

(106) "Question and Answer", Liverpool Echo, 19th August, 1978.

(107) ENDS Report II, October, 1978.

(108) Bridgwater, A.V., PhD. Thesis, University of Aston, 1971.

(109) Metal Box Annual Report, April, 1982.

(110) "Bonfire `Bomb´ Blows up Boy", Evening Mail, Slough, 19th April, 1979.

(111) "Threat in an Aerosol Can", Evening Sentinel, Stoke-on-Trent, 6th April, 1979.

(112) Report on Aerosol Flammability, B.A.M.A. Flammability Committee, R.E.Raggit, Chairman, December, 1976.

(113) "Waste Derived Fuel", Information on Tollemache Equipment, Newell Dunford Engineering Ltd., Surbiton, Surrey, UK, March 1980.

(114) Roberts, J.M.C. "In at the Deep End", A review of the consequence of transition from CFC to Hydrocarbon propellent, presented at the B.A.M.A. Forum, "Aerosols in the Eighties", London, May 1980.

(115) Ibid, Bailey, P., Alternative Propellents.

(116) "Attitudes to Housework and Furniture Care", a pilot study for Johnson Wax Ltd., The Tavistock Institute for Human Relations, November, 1982.

(117) "Survey of Household Cleaning Products", Economist Intelligence Unit, London 1981.

(118) Kotler, P., "Marketing Management", 4th Edition, Prentice-Hall International, London 1980.

(119) O´Donnovan, M., "Aerosol Marketing in the 1980´s", B.A.M.A. Forum, London, October, 1980.

(120) "International Market Research Study on Consumer and Governmental Attitudes to Aerosol Products", SC Johnson & Son, August 1982.

(121) Palda, K.S., "The Measurement of Cummulative Advertising Effect", Prentice-Hall, NJ, USA, 1964.

(122) Lucas, K., and Britt, A., "Measuring Advertising Effectiveness", Prentice-Hall, 1978.

(123) Dhalla, N.K., Harvard Business Review, January/February, 1978, 87 - 95.

(124) SC Johnson & Son, Worldwide Aerosol Review, December, 1982.

(125) Chambers,, J.C., Mullick,S.K., and Smith, D.D., "An Executives Guide to Forecasting", John Wiley and Sons, NY, USA, 1982.

(126) Fildes, R., et al, "A Bibliography of Business and Economic Forecasting", Gower Publishing Company, Hants, UK, 1981.

(127) De la Mare, R.F., Engineering and Process Economics, 3, (1978), 129 - 140.

(128) Berensen, C., "Product Life Cycles", paper given at short course, "Marketing for the Process Industries", University of Aston/ Institute of Chemical Engineers, July, 1981.

(129) Turner, R.E., "Methods of Long Range Forecasting", Longman, London, 1975.

(130) Donohue, J., "Soap, Cosmetics, Chemical Specialities", July, 1982, 38 - 40, and 91 - 92.

(131) Schmidt, H., "Alternative Propellent Study". Internal Johnson Wax Ltd., Report, August, 1982.

(132) Waagenar, J., "Alternative Propellents". Internal Johnson Wax Ltd. Report, May, 1982.

(133) Roberts, J.M.C., Johnson Wax Ltd. Internal Report, "Dimethyl Ether as an Aerosol Propellent". February, 1981.

(134) Archer, W.I., and Roberts, J.M.C., A.C. Impedance Measurements as a means of Predicting Corrosion in Aerosol Cans", 3rd meeting of the Electrochemical Society University of Newcastle-upon-Tyne, England, May, 1983.

(135) Bohnen, L.J.M., "D.M.E. Pure - A Review". Aerosol Age January/ February, 1981.

(136) Continental Can Technical Reports prepared for SC Johnson on "Sepro" containers, April 1982.

(137) Crown Cork Ltd., Technical Bulletins on "Sepro" Container Trials, February, 1980.

(138) Lechner Barnier Pack System, Aerosol Service. A.G. Mahlin Schweiz.

(139) US Patent 2,136,801 - June 1965, "Self Foaming Shave Gel", assigned to SC Johnson.

(140) SC Johnson Internal Evaluation Report on Levy Vacuum Container Cup, January, 1983.

(141) Vario Dispenser, Technical Bulletin from Englas Dispensers, Leicester, England, May, 1983.

(142) Hanlon, J.F., Soap/Cosmetics/Chemical Specialities, April, 1982.

(143) Ibid, May, 1982, 42 - 48.

(144) Schicker, M.R., "Alternative Spraying Methods - both Aerosol and Non-Aerosol". Paper presented at International Aerosol Congress, Nice, France, September, 1979.

(145) Nielsen, Market Monitor Report.

(146) Mintel, Information Services.

(147) Economist Intelligence Unit Report - Consumer Non Durables, August, 1981.

(148) "Marketing Pocket Book - UK". The Advertising Association, London, 1982.

(149) ERL Statistics.

(150) Johnson Wax Ltd., Corporate Plan, 1983/1984, March, 1983.

(151) Hicks, H.G., Gullet C.R., "Modern Business Management". McGraw-Hill Koga Kusha Ltd., Tokio, 1974.

(152) Kraushar, P.M., "New products and Diversification". BB Books, London, 1970.

(153) Booz-Allen and Hamilton, "Management of New Products", 4th Edition, NY, USA, 1968.

(154) "New Product Development", Eastlack, T.O., (Editors), American Marketing Association, Chicago, 1968.

(155) White, R., "Consumer Product Development", Longman, London, 1973.

(156) Heppner, M., "The Realities of New Product Organisation", Admap, August, 1969.

(157) Tauber, E.M., "HIT: Heuristic Ideation Technique - a Systematic Produce for New Product Search", Journal of Marketing, January, 1972, 58 - 70.

(158) Sampson, P., "Can Consumers Great New Products", Journal of the Market Research Society, Vol. 12, (1), January, 1970.

(159) Lloyd, L.E., "Techniques for Efficient Research", Chemical Publishing Company, NY, USA, 1966.

(160) Ayres, Robert U., Technological Forecasting and Long Range Planning McGraw Hill N.Y. USA, 1969.

(161) Jantsch, E., Technological Forecasting in Perspective; O.E.C.D. 1967.

(162) Frost, W.A.K., and Braine, R.L., "The Application of the Repertory Grid Technique to Problems in Market Research", Journal of the Market Research Society, Vol. 9, (3), July, 1967.

(163) Barnett, N.L., "Beyond Market Segmentation", Harvard Business Review, January/February, 1968.

(164) Christopher, M., "Chester Analysis and Market Segmentation", British Journal of Marketing, Summer, 1969.

(165) Booz, Allen and Hamilton, Inc., The Management of New Products, 1966.

(166) Kraushar, Andrews and Eassie Ltd., New Products in Grocery Trade, - A UK Study, 1970, 1971.

(167) A.C. Nielsen and Company, "A Solid Base", Nielsen Researcher, January/February, 1969.

(168) Idem, "The Realities of New Product Marketing", Ibid, 1970.

(169) Hayhurst, R., "The Dynamics of Innovation", British Journal or Marketing, Summer, 1968.

(170) Jewkes, A., "The Sources of Invention", Macmillan, 1957.

(171) Von Hippel, E.A., "Users as Innovators, "Technology Review, January, 1978, 3 - 11.

(172) O´Meara, J.T., Jr., "Selecting Profitable New Products", Harvard Business Review, January/February, 1961, 83 - 89.

(173) Richman, B.M., "A Rating Scale for Product Innovation", Business Horizons, Summer, 1962, 37 - 44.

(174) Tauber, E.M., "Reduce New Product Failures; Measure Needs as well as Package Intention", Journal of Marketing, July, 1973, 61 - 64.

(175) Bass, F.M., "A New Product Growth Model for Consumer Durables", Management Science, January, 1969, 215 - 217.

(176) Fourt, L.A., and Woodlock, J.N., "Early Prediction of Market Success for New Grocery Products", Journal of Marketing, October, 1960, 31 - 38.

(177) Blattberg, Rand Golanty, J., "Tracker - An Early Test Market Forecasting and Diagnostic Model for New Product Planning", Journal of Marketing Research, May 1978, 192 - 202.

(178) A.C. Nielsen and Company.

(179) Mintel, Kraushar Andrews and Eassie Ltd.,

(180) Applied New Product Development, Michael J. Peters Agency, Nottinghill Gate, London.

(181) "Research in British Universities, Polytechnics and Colleges", Vols I, II, III. The British Library, Wetherby, 1982.

(182) Hodgson, F., "Industrial Research in the UK", Longman Group, Harlow, Essex, 1982.

(183) B.L.A.I.S.E. Online Information Search Computer Data Base, British Library, London.

(184) Roberts, J.M.C., Johnson Wax Ltd., Internal Report by "Consumer Research Project Administered by University of Surrey Home Economics Department", November, 1982.

(185) Perry, M., and Woods, P., "Proposal to Complete Consumer Research on behalf of Johnson Wax Ltd.", December, 1982.

(186) Mintel Information Services - Consumer Products Reports, 1982.

(187) SC Johnson, International Communications Network - 24 Hour "Qwik", Telex System.

(188) Dialogue Information Services Inc., Washington D.C., USA.

(189) SC Johnson Internal Report, "European New Products Review" January, 1983.

(190) "Aerosol Handbook", Johnson, M.A., Editor, 4th Edition, C.S.M.A. 1982.

(191) Roberts, J.M.C., Johnson Wax Ltd., Internal Report - "Software for Business Analysis on New Projects via Honeywell 6000 System", January, 1983.

(192) Johnson Wax Ltd, Milton Park R & D Centre Corporate Plan, 1980-1983 incl.

(193) Nystrom, H., "Creativity and Innovation"; John Wiley & Sons Ltd., Woking, UK, July 1980.

(194) Sanders, P.A., "Handbook of Aerosol Technology", Van Nostrand Reinhold, New York USA, 1979.

(195) Sciarra, J.J., and Stoller, L., "The Science and Technology of Aerosol Packaging"; John Wiley & Sons Inc., USA 1974.

(196) Wiener, M.V., J.Soc. Cosmet. Chem; 9, 289; 1958.

(197) Tauscher, W., Aerosol Report, 15, (12), 377-390, 1976.

(198) Shay, J.J., and Falkowski, D.R., Aerosol Age, (20), 52-60, December 1975.

(199) Roberts, J.M.C., MPhil Thesis, University of Aston in Birmingham, 1977.

(200) Roberts, J.M.C., "A Comparison of the Atomisation Efficiency of Liquefied and Compressed Gas Propellents", Internal Reort for Milton Park R & D Centre September, 1983.