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LATEST DEVELOPMENTS ON PACKAGING TECHNIQUES 1/

by

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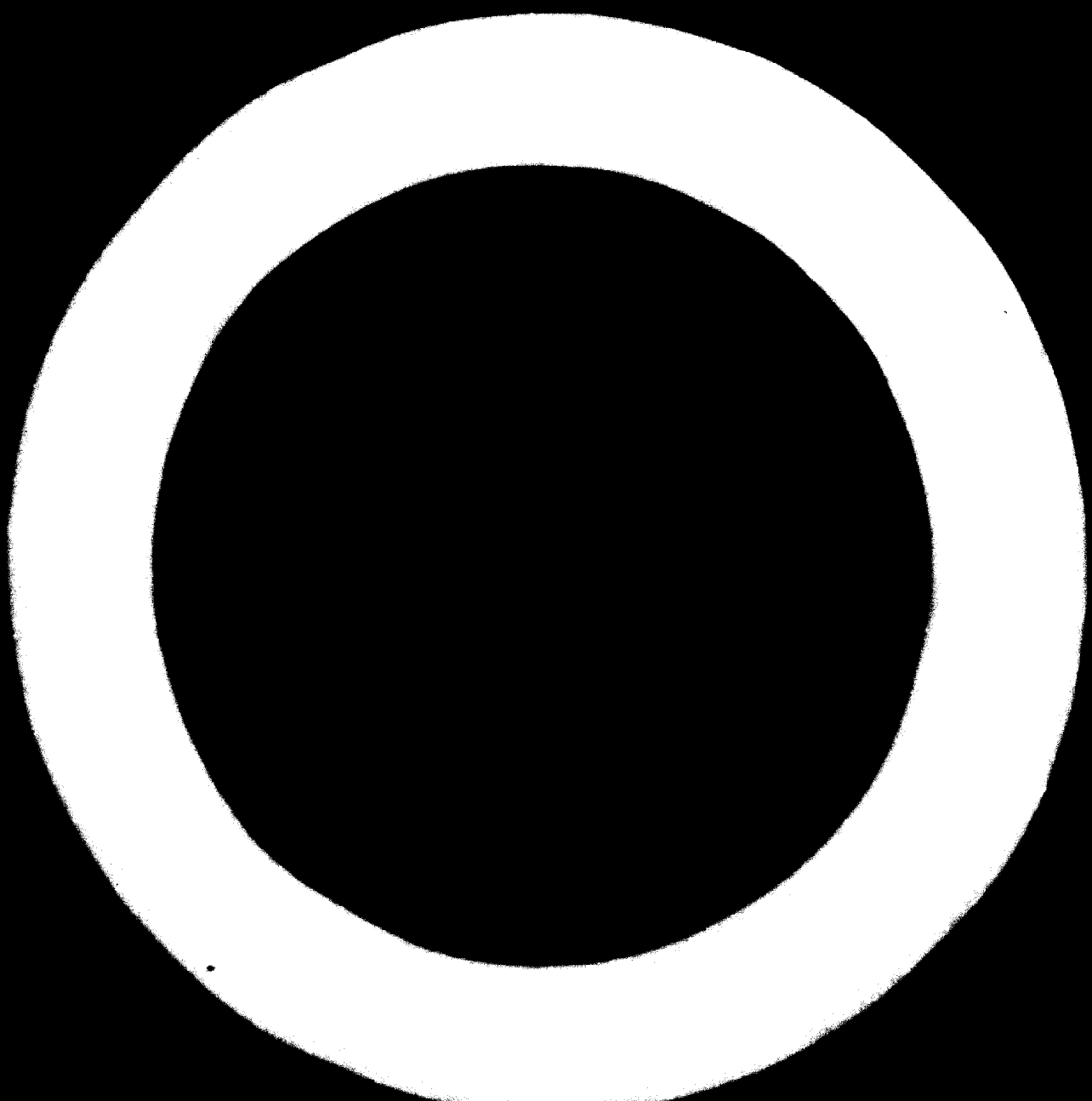

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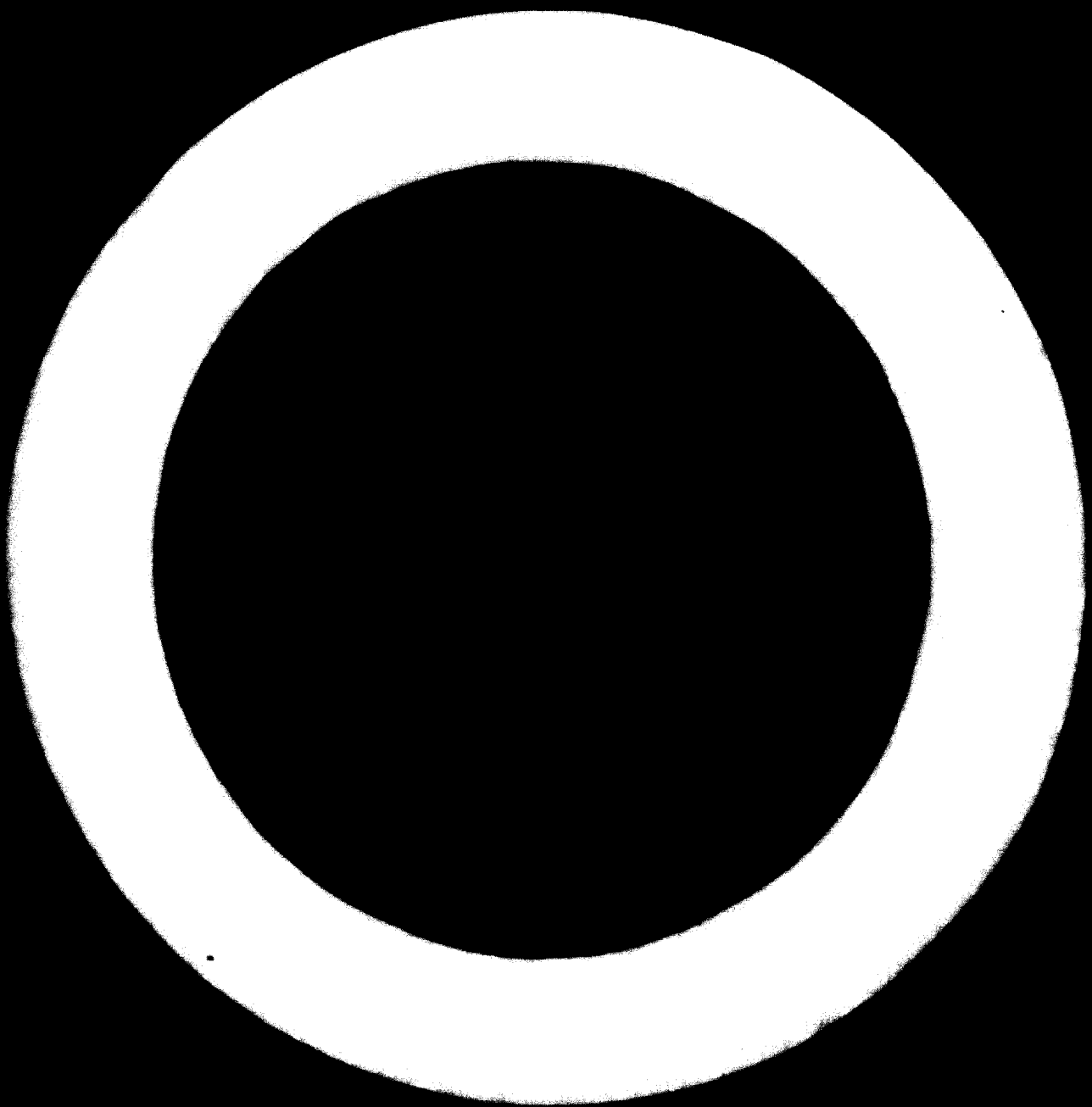


CHAPTER 1

A TO MOTOR

Fifty years ago in the western world, the market for industrial products was enormous. Industry was virtually completely production-oriented. So little existed that anything that was made could be sold. All products were virtually stock items and sold themselves. Over-production was virtually unknown and the whole basis of business was geared to producing.

This situation existed for something like 25 to 30 years, during which time real wealth increased and more people acquired real leisure time. Customers were no longer necessarily satisfied with exactly what the manufacturers produced and began to ask for different items. The old Henry Ford maxim that "you could have any colour car you liked providing it was black" was no longer good. By the time the depressions of the late 20s and early 30s were over, selling became almost of equal importance to production and the sales director became an important member of the management team.

Nowadays the western world is in a marketing era and the marketing approach demands that consumption is the only end of production and the interests of the producer are only to be attended to insofar as it is necessary to promote the interests of the consumer. All decisions are made in a marketing situation only after their impact on the ultimate customer has been studied. They are based on the answer to the question "What can we sell?" and only after this has been decided by the consumer do questions of "How can we make it?" arise.

Marketing thus covers the whole field from conception to consumption. In these days it perhaps goes even further and deals with disposal as well. Figure 1 illustrates this and shows the various

1/ Figures 1-4 will be presented in slide form at the lecture

areas with which we are concerned. It can be seen that packaging is one of the principal tools employed in marketing. The package must be considered soon after the idea of the product has been formulated and leaves the product only after the customer has removed it, presumably satisfied with her purchase.

CHAPTER 2

THE FUNCTIONS OF PACKAGING

A package has to do a number of jobs. The main ones are listed under the following twelve headings:

1. The package must contain the product efficiently at all times during its life.

2. The package must provide protection against external climatic conditions and contaminants. It must also protect fragile goods from breakage and shock.

3. The package must be compatible with the product. That is to say, it must be capable of remaining in contact with the product and doing it no harm; for example, it must not promote the rusting of iron and steel, nor cause flavour changes in food products.

4. The package must be easily and efficiently filled either by hand or by fully automatic machine as necessary.

5. The package must be convenient in all respects - the right size, the right quantity, and so on.

6. The package must be easily handled by the appropriate means - mechanical or otherwise.

7. The package must remain closed in transit but must open easily and, when required, be capable of efficient and secure reclosure whenever the contents are not used at once.

8. The package must in many instances be able to dispense the product in the right amount.

9. The package must communicate to everybody; the retailer, the carrier and the customer, and sometimes the manufacturer as well.

10. The package may, particularly for dangerous goods, have to be virtually indestructible.

11. The package must be safe; for example, it must not produce problems if handled by children, or have sharp cutting edges to damage the people concerned in moving the goods.

12. The package must be inexpensive - it must cost no more than is absolutely necessary to do the job for which it was designed.

Finally, in many instances the package must be disposable in such a way as to cause the least inconvenience. Alternatively, it may be re-usable so that a second journey can be obtained from it.

Such is the situation existing in the western world and as countries become more and more industrialised and sophisticated, so they move from the production-oriented situation; through production and sales in partnership; into the marketing situation where everything is dependent on answering the question "How will the consumer be affected?" These three stages, however, only exist today in parts of the world to a different extent. Many of the developing countries are still in the production era, others are part way through "production and sales", and only a few of the sophisticated countries are fully practising true marketing. For this reason, it is very important that developing countries do not copy their western neighbours because they may thereby select the wrong tactics. Usually, it is better to study the reasons why a particular development took place rather than to copy it unquestioningly. Having found out why it occurred, then the development can be examined for application. In many instances, however, suitable circumstances will not exist, in which case the solution will not be valid. In others, while the circumstances exist, the answer for the developing country may be different.

CHAPTER 3

[illegible]

Development trends today may be divided into three areas under specific headings. These are:

A. Using more of less,

B. Providing convenience for all, and

C. Improving processes and quality control.

Let us look at these in turn, illustrating each by convenient examples which have taken place in packaging development in the recent past and relating them to the packaging cycle of production and use, from raw material to disposal. Figure 2 schematically shows the packaging cycle, while Figure 3 elaborates and defines some of the terms used.

CHAPTER 4

A [illegible]

The Light-weighting of Glass Containers

During the last decade, the prices of glass containers of all types have risen in the United Kingdom rather more slowly than the rise in materials and labour costs would suggest. Their price has also been more stable than that of many other packages. This has been due, principally, to the technological advances made in producing lighter-weight containers. For example, the milk bottle has been reduced in weight by over one-third, (1)1/ (2) and the jam jar by a similar amount, (3) (4) thus making more containers from less glass. There is a limit to what can be achieved merely by reducing the weight of a container. (5) If the shape can also be changed, then the amount of glass that can be saved is greater. At the same time, surface treatments of glass containers, to reduce abrasion, (6) (7) have also had considerable effect on the strength of containers permitting light-weighting to take place without loss of strength. Glass-to-glass abrasion is one of the principal causes o this loss. An increase in glass strength is brought about by treating the hot glass with metal organic compounds of high thermal stability. Initially, organic compounds with titanium were used, but tin compounds have been subsequently employed since about 1965.

The glass industry is also developing composite packages of electric light bulb thickness, (9) using an entirely new manufacturing process. This is basically a spherical shaped glass container permanently set in a polythene base, with a simple convenient closure. Such a development will permit light-weighting even further and this type of container could be produced at one-third of the weight currently used for the already light weight one pint milk bottle. Since it will also be capable of being filled at high speeds, it should enable bottle users to operate extremely economically.

1/ Numerals in parenthesis refer to <u>References</u> which appear at the end of the report.

The Development of Double-Reduced Plate and "Tin-Free" Steels

Another development analogous to the light-weighting of glass containers has taken place in the can-making industry. By cold reduction, it is now possible to produce plate of almost half the thickness of that previously used for the production of cans.(10) Additionally, developments in coating techniques using a chromium oxide/chromium treatment can eliminate the use of tin as a coating.(11) The latter development required a means of welding, or seaming the side edges of cans together to form a tube. This, coupled with the use of aluminium ends capable of tearing with predetermined precision, has led to the easy-open rip-cord can.

Initially produced for carbonated beverages,(12) the possibilities of extending its use into fields other than soft drinks and beer are being explored. The rip-cord easy-open device is already being used for processed food of many kinds, particularly fish products.

Developments in Corrugated Board, Including Triple-Wall Boards

In common with glass and tinplate, corrugated board has also been the subject of much technological development and the production of boards more suited for the performance they are required to give. The industry quotes production in tons of paper material used, but this gives very misleading impressions on the growth rate, since lighter-weight boards are making the area of board used a much better guide.

The relevant strength properties of fibreboard,(13) particularly corrugated, are related to the total caliper of the board, which is itself determined by the efficiency of the fluting medium in keeping the liners apart. The flexural rigidity of corrugated board contributes largely to the resistance in stack, and can be reduced considerably if the board is crushed. Better fluting media with higher stiffness characteristics have enabled liner calipers and weights to be reduced and, moreover, standardised. Manufacturing developments have also enabled packs in triple-wall boards,(14) (15) of various combinations of fluting, to be produced. These are much lighter in construction than the heavier wooden cases which they are replacing.

Over the last ten years, in the United Kingdom, a miniature boom has taken place in the corrugated field. This is due to the overall trend to the use of lighter-weight, one-trip containers making more of less.

Shrink-wraps (15) - (20)

All through the decade, plastics shrink-wraps have been potential competitors to corrugated cases. So far, however, they have not made much impression and penetration of the case market still is still less than 2% in tonnage terms. Nevertheless, it is likely that competition from shrink-wraps will grow. The advantages of shrink-wraps compared with corrugated cases are lower cost and transparency, enabling the product to be identified, hence permitting easier stock control in retail outlets.

Unpacking and subsequent disposal of the packaging material is also easier and less bulky. Against this, however, shrink-wrapping has a number of disadvantages. It gives less protection against physical damage; it is more difficult to handle in the manufacturer's works unless special equipment is put in; stacks are less stable and speeds of packing can be lower. All these disadvantages, however, can be overcome and the next ten years are likely to introduce the means of overcoming them.

Steel Drums

Another package where light-weighting has played an important part in making more of less, is the steel drum. For many years the work-horse of the chemical and pharmaceutical industries, the steel drum has recently come under attack due to cost and weight. The Van Leer development of the "Hoop-Stress" drum (21) reduced the steel thickness required from 18 SG to 24 SG (1.25 mm to 0.625 mm); the tare weight from 23 Kg to 13 Kg, while at the same time the new drum was capable of withstanding more stress in transit than most of the heavier drums preceding it. In particular, it withstands 4 falls from 1.25 m, as required by international regulations.

Plastics drums

Plastics drums have also been developed. Mauser-Werke GmbH, in Germany now produce a 120 litre drum [30] weighing only 4½ kg made in blow-moulded, high-density polyethylene, which is fitted with a special flexible closure and is capable also of withstanding the hazards of transport satisfactorily. 4½ kg costs less to transport than 25 kg and on a 200 kg pack is a reduction from over 10% to almost 2% in unnecessary weight.

Carry-Home Retail Packs

The same ability to make more of less has also been extended to consumer packages, and there are many carry-home bulk packages on the market now which provide less packaging cost per unit of product. Commodities such as lawn dressings and weed killer, fertilisers, detergents and the like are now conveniently purchased in 2, 5 and 10 kg. packages whereas previously they were rarely sold in over 1 kg quantities until the 25 kg sack or drum was reached.

Kegalls [31]

The ability to get more product into the same delivery vehicle is also a source of package development. One of the big advantages of the Kegalle pack for beer is that approximately twice as much beer is carried in the transport vehicle as with conventional glass bottles or cans. The Kegalle pack was the first plastics package capable of giving a satisfactory shelf-life to a carbonated beverage.

It consists essentially of three parts: the main body of the container fabricated of thin pvc, coated with pvdc, is a cylinder with a hemispherical end. This is welded to a special top which is cone-shaped and contains a quick-release opening. The thin-walled cylinder with its hemispherical end is protected from puncturing and rendered rigid for transport by placing it within a paperboard tube, spirally wound, which carries design and print for the product. These containers do not need packing into crates; they fit closely together, are held with straps and can easily be carried. The strapped units have good stackability and approximately twice as much beer can be carried in the vehicle compared with bottles or cans.

Finally, design developments can also reduce the material costs. Two examples of this are a Swedish package[32] for protecting long, fragile objects, such as thermometers or pipettes and a development in bottle separation[33] produced in Germany for glass bottles of a high class drink.

The first is very simple and entails placing the long, fragile objects at suitable intervals in a rectangular piece of single-faced corrugated board. Polythene is then "skin-packed" on top of the sheet to hold the thermometers or pipettes firmly in position. When the sheet is rolled up, every pipette is separated completely and firmly from its neighbour and the united strength of the roll, like the proverbial match-sticks, is high. As a result, packaging and freight costs are considerably reduced, since the new package occupies less than one-third of the volume.

The simple form of corrugated divider devised for packing three, four or six bottles of drink is also an example where standardisation and the ability to achieve longer runs can produce an economic advantage.

CHAPTER 5

5. CONVENIENCE PACKAGING

In the past this has almost always meant consumer convenience and has been associated with opening and reclosure techniques.(34) Tear tapes, perforations, ties, rip-cords and the like have been developed for products ranging from detergents to biscuits and beer.(35) It has also been concerned with dispensing(36) and again, some of the first dispensers were associated with drink. Devices to fit bottles to enable the right quantity of whisky to be fed into a glass are commonplace. The aerosol container(37) has, wherever the product can be supplied in dispersed form, provided almost the acme of perfection in dispensing, but at a price which means that aerosols are only adopted where there is a real advantage.

In the last four or five years, however, more and more convenience has been supplied to retailers, transporters and, in some instances, to the manufacturing operations. Card packaging systems, for example, whether blister packs,(38) thermoforms,(39) skin packs(40) or plain boxes, have provided a vertical selling system to enable the retailer to reduce staff and still provide satisfactory display to his customers. At the same time, they make it more difficult to pilfer small objects. The use of shrink packaging of pallet loads for display is a recent innovation for the larger stores, and the Scandinavian development of special modular packs, which are used to transport the goods from warehouse to retail store, are used as display units in the store, and then returned for refilling; represents probably the most sophisticated development so far.

Many developments have taken place in the movement of goods. Freight containers and modular packages, together with the palletisation system, are the major examples. These are combined easily with automatic warehousing, which the larger companies in the sophisticated areas of the world are beginning to adopt. An example of the importance of convenience in the manufacturing operation is the development of a series of polythene cans for chemicals, produced by the Geigy Company.(41) This development

commenced in 1962 when the company was using an aluminium package. This had the disadvantage of being difficult to empty and also gave trouble with its pilfer-proof closure. In Germany, in the Far East particularly, there were a larger number of thefts than the manufacturers liked, in which the sheet metal container was opened in ingenious ways and the product diluted.

The package was produced originally for the Marketing Director of Agrostuffs Division, after agreement that the material used should be plastics and inexpensive. The design team included a designer, a packaging engineer, and a purchasing specialist. The brief - to develop a range of plastics containers of from 1 to 10 l capacity which would conform closely with the customers' wishes, enable packaging to be performed rationally, and satisfy storage and transport requirements, whilst at the same time costing less than the old method. Studies of the varying bulk density of products and of their freight costs resulted in eleven suggested capacities: 1, 1.5, 1.6, 2, 2.5, 3, 4, 5, 6.5, 8 and 10 litres. After various studies, a model series, of rectangular base area, made it possible to combine the packs for shipment in all desired combinations. The dimensions of the three sides were selected so as to be repeated as often as possible throughout the series. Only three different sizes of filling opening were chosen and three sizes of master shipping case would accommodate all necessary combinations of packages fitting the ISO Standard 1200 x 800 mm pallet. Moreover, the cost of this new series of packages made in polythene was lower than the earlier metal cans. The series was introduced in 1967 and won a Duvetor at the end of that year.

One final example of the development of packaging to provide manufacturing convenience is the Philips package for transistors[42] and the like which are moved from the production site to the plant where they are built into the equipment for which they were designed. Instead of travelling "loose" where considerable losses and damage can occur, they are packed onto a band of paper which is fed from its box to the operator at bench height. This delivers transistors at the right time, in the right place, for the proper purpose and everyone can be accounted for.

CHAPTER 5

5. PACKAGING PROCESSES AND QUALITY CONTROL

There are three areas of development here which must be considered - converting operations - use and re-use - disposal and/or recycling. All three have produced developments in the last decade. Considerable work has gone into tamper-proofing of all kinds of packages.(43) This includes pilfer-proofing(44) and proofing against insects(45) and rodents. Developments have taken place in co-extrusion(46) to produce composite films without the necessity to laminate. The blow-moulding field has increased the capacity of containers from what were relatively small ten years ago to the 120 l capacity and more in certain instances now. Rotational moulded containers(47) can go even higher than this. In the fields of carton making, developments have taken place in the manufacturers' dies as well as in the stripping operations(48) to separate the cartons one from another automatically at the end of the cutting operation. The use of laser beams(49) for cutting the plywood used in diemaking, or alternatively, the use of high-speed dental drills to cut diebeards made in specially formed plastics,(49) are examples of the former. Considerable improvements have taken place in the making of bags and pouches in all types of film, foil, and laminated material, and additionally here considerable work has been done on understanding the reasons why some materials run more efficiently(50) than others on such machines. In the field of plastics foams, development has also taken place, notably in the ability to produce foam in situ,(51) (52) as a means of providing very good protection to difficult, odd shaped, and heavy objects which could not be protected simply without the considerable expense of making a special die for a relatively small number.

At the first national conference on packaging waste held in San Francisco in September, 1968, Dr. Dangelmayer(53) postulated the law of the conservation of wastes. "We do not get rid of anything, we merely redistribute it, either as produced or in changed form." He likened the earth to a closed space capsule which admits only sunlight and virtually nothing leaves. Hence, the capsule gets more dirty and untidy everyday. Continually, we discharge wastes into the air, the waters and spread it on the land. The awareness of these facts is now having a big influence on packaging in the design stage and ultimately it will

affect, very much, the re-use of packages, their disposal and the recycling of the materials from which they are made. There are four areas where research and development of interest to both manufacturers of products and their packaging suppliers must be carried out:

A. Problems of waste collection;

B. Problems of waste disposal;

C. Problems of waste recovery;

D. Studies of packaging and distribution, to reduce the quantity of material requiring disposal.

A. With waste collection we have two major possibilities - either collect everything together and separate any recoverable material centrally, or attempt separation of the more valuable or more difficult materials, at source, before collection.

B. Disposal by land fill or burning should be reduced to a minimum, and preferably be concerned with land reclamation and useful heat rather than soil and air pollution.

C. The recovery of material, such as metal, glass and paper, will become increasingly necessary and the possibilities of recovering or utilising plastics in some way must be studied. (See Figure 4.)

All these will require co-operative research and development, co-ordinated centrally, and will involve local authorities and central governments.

D. The reduction of the packaging material, used to protect products, to a minimum will provide problems specific to each product, package and distribution system, and each must be solved by the package design team which, in its best form, must involve user/supplier/distributor co-operation.

(1) Lockware lightens pinta bottles.
Anon. Bottler and Packer vol 30, no. 3, March 1962 p LXIII

(2) Milk marketed lighter pints in for the smaller dairy.
Anon. Packaging News vol 11, no. 9, Sept. 1964, p. 76

(3) Glass jars are lighter without strength loss.
Anon. Food Process and Market, Chicago, vol. 28, no. 5, May, 1967, p. 134

(4) Lockware show complete range of one trip bottles.
Anon. Packaging vol 30, no. 447, June 1957, pp. 42-3

(5) "Non-nonsense" wine in light bottle.
Anon. Packaging News, vol 14, no. 11, Nov. 1967, p. 3

(6) Add strength to glass with surface coating.
Anon. Food and Drug Packaging, vol. 13, no. 1, July 7, 1966, pp. 1, 27

(7) Glass: Fighting back with new strength.
Anon. Food Packaging vol. 40, no. 5, Jun. 1967, pp. 112-6

(8) Glass containers sales.
Mills, R. Package Rev. vol. 87, no. 11, Oct. 1967, pp. 6-9

(9) U.S. Ltd. Packaging Forum, July, 1969, pp. 1-4

(10) Packaging Technology 1969, vol. 15, no. 104, pp. 10, 12, Co Melbourne and J. Bevern

(11) Y Iwamoto etal. Tokyo Inst. Pt Technol. 1966, vol. 37, p. 51

(12) D. A. Prime. Food Process Market 1968, vol. 37, p. 303
and

Anon. Packaging 1963, vol. 38, no. 439, p. 25

(13) Fire report - Predicting the performance of fireboard crates, March, 1969

(14) Packaging without product disassembly
Anon. Packaging Engineering, vol. 6, no. 1, Jan. 1961, pp. 60-1

(15) Triple wall corrugated containers cut costs for heavy engines.
Anon. Package Engineering, vol. 13, no. 1, Jan. 1968, p. 23

(16) Transport packaging for glass products.
Anon. Verpackung Wirtschaft, vol. 15, no. 5, May, 1965, pp. 13-15 (German)

(17) Palletised units loads of glass containers.
Anon. Packaging, vol. 39, no. 459, June 1966, pp. 27-29

(18) Shrink packaging as a material handling and warehousing aid.
G. J. Flatman, Packag. Technol., vol. 14, no. 102, Sept. 1968, pp. 21, 4 and 6

(19) Shrinkwrapping problem posers.
J. Kriston, Packag. Dev., vol. 30, no. 1, June 1963, pp. 16-17

(20) Trays and films for shrinkwrapping ovens.
U Brand Verpackung, vol. 70, no. 9, May 1965, pp. 371-375 (German)

(21) Choosing a pre shrink film.
G. E. Layne, Packag. Engng, vol. 11, no. 12, Dec. 1966, pp. 37-42

(22) The role of shrink packaging.
J. G. Prochaszky. Packag. Technol., vol. 14, no. 102, Sept. 1968, pp. 14-

(23) Heat shrinkable flexible plastics film.
S. Sacharow. Plast. Design Process, vol. 6, no. 6, June 1966, pp. 24-6

(24) Shrink film for transport and packaging.
P. L. Simon, Plast. Infs., no. 403, 1 Feb. 1966, pp. 3-8 (French)

(25) Current progress in the mechanization of packaging with heat - shrinkable films.

P. L. Simon, Emballages, Vol. 36, no. 235, Oct. 1966, pp. 233, 5, 7, 9 and 90 (French)

(26) Modern shrink films - theory and practice.
W. Hufnagel and M. Jobcosky. Verpackungs Mag. No. 3, 1966, pp. 34 etc.

(27) Choosing the right film for the job.
D. J. Shorten, Packag. Technol., vol. 14, no. 102, Sept. 1968, pp. 17, 19 and 37

(28) Pira Survey, Shrink Wrapping - The State of the Art.
Revised September, 1967

(29) Development of lightweight drums.
F. M. Ullman, Packag. Engng. 1969, vol. 14, no. 3, pp. 104, 7, 9-10, 113, 6, 8

(30) Plastics drum with removable lid and closure.
Mauser Werke GmbH, Package Technol., 1970, Vol. 16, no. 112, p. 35

(31) Rigello Pack
Anon. Packaging, 1968, vol. 39, no. 460, p. 80

(32) Method of packing long, fragile articles.
Auszüge, 1966. Hellpap-am-Lech GmbH.

(33) Partition-nest.
Auszüge, 1966, Rhein-Main. Wellpappe GmbH.

(34) Pira Bibliography No. 126. Resealable closures for bags and pouches.

(35) Pira Bibliography No. 411, Bottle closures.

(36) Pira Bibliography No. 419. Powder dispensing devices and closures.

(37) Aerosols - The instant answer with enormous potential.
A. B. Reeve, Engineer 1969, vol. 22, no. 9916, pp. 22-25.

(38) Pira Bibliography No. 185, Blister Packaging.

(39) Pira Bibliography No. 223. Thermoforming including vacuum and pressure forming.

(40) Pira Bibliography No. 384. Skin packaging including machines.

(41) Case study on a series of Geigy polybenes for small quantities of pigments and chemical powders.
L. Koch, Paper at World Packaging Congress, Utrecht, Holland, April, 1970

(42) Dutch Contest - Euro packs get top award.
Amer. Packaging News, 1968, vol. 15, no. 6, suppl., pp. 6-10

(43) Pira Bibliography No. 452, Tamper proofing/pilfer proofing.

(44) Pira Bibliography No. 303. Pilfer proofing.

(45) Pira Bibliography No. 447. Insect-proofing.

(46) Pira Bibliography No. 417. Co-extrusion.

(47) Rotational moulding - Production of large containers.
G. Forsyth. Plastics 1968 vol. 33, no. 370, pp. 887-890.

(48) In-line stripper increases production and cuts costs.
Amer - Canad Container 1970, vol. 77, no. 7, pp. 77-81

(49) Papers at conference held in York, March 1971 by Ilm. Rotting, Ltd.

(50) The Machine/Material Interface in Flexible Package Production.
Packag. Technol. May 1971, Vol. 17, no. 118, pp. 26-30

(51) Foaming liquid forms made-to-measure cushion in 50 seconds.
Amer. Packag. News 1966, vol. 13, no. 11, p. 4

(52) Pira Bibliography No. 334. Foam-in-place packaging.

(53) First National Conference on Wastes.
Amer. Proceedings - University of California, Davis

APPENDIX I

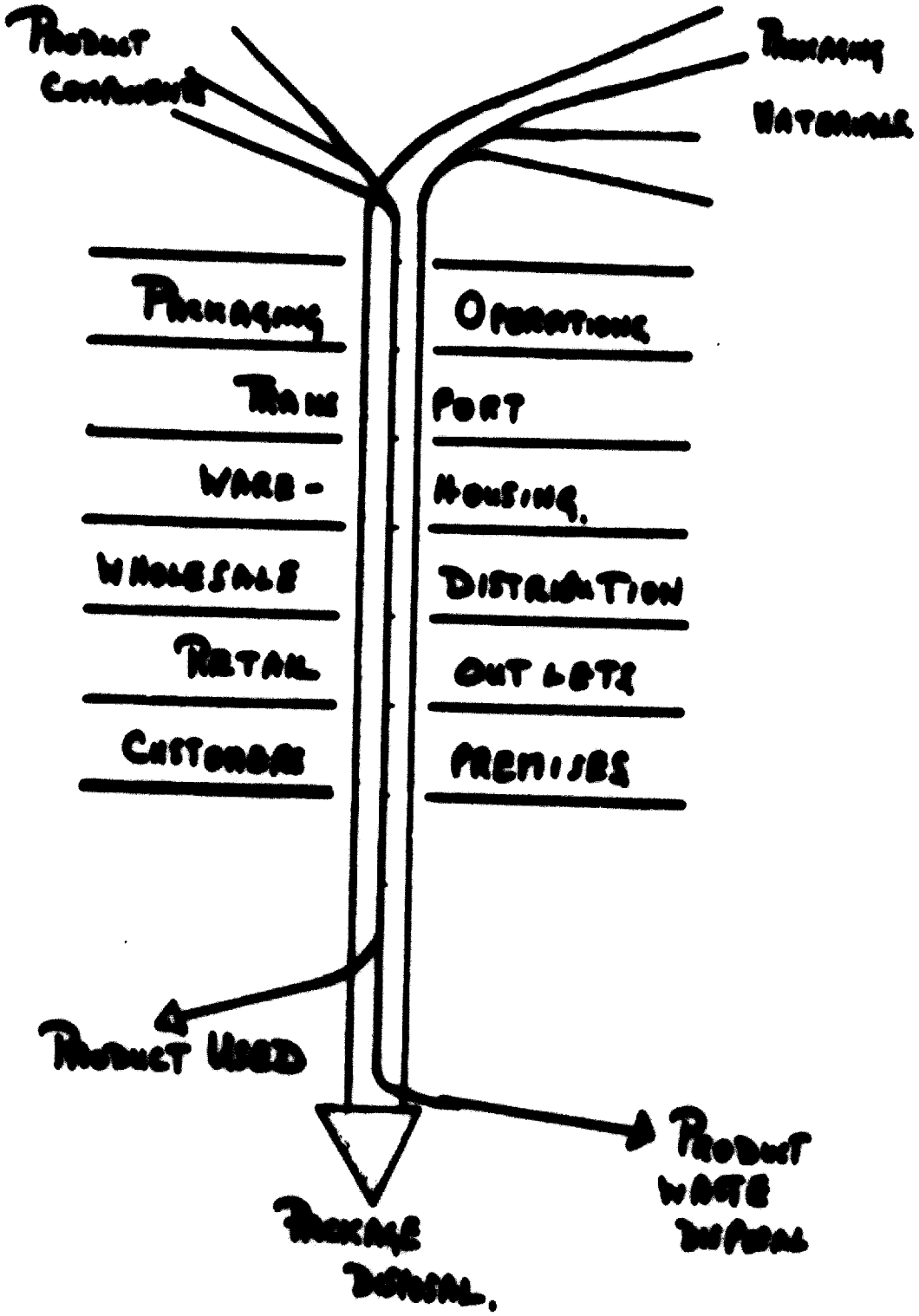


Fig. 1 THE PRODUCT/PACKAGE LIFE HISTORY

APPENDIX II

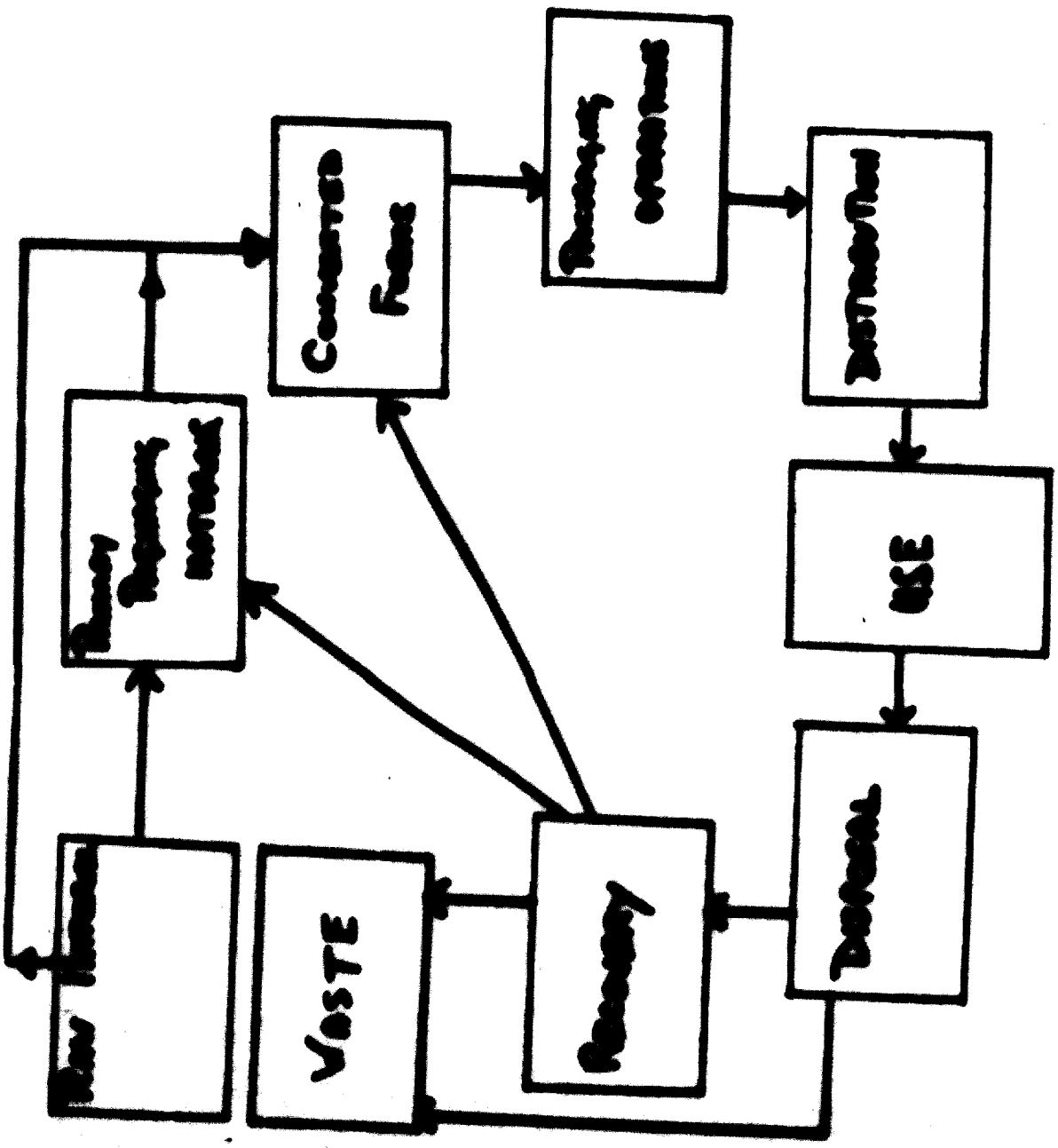


Fig. 2 The Packaging Cycle.

APPENDIX III

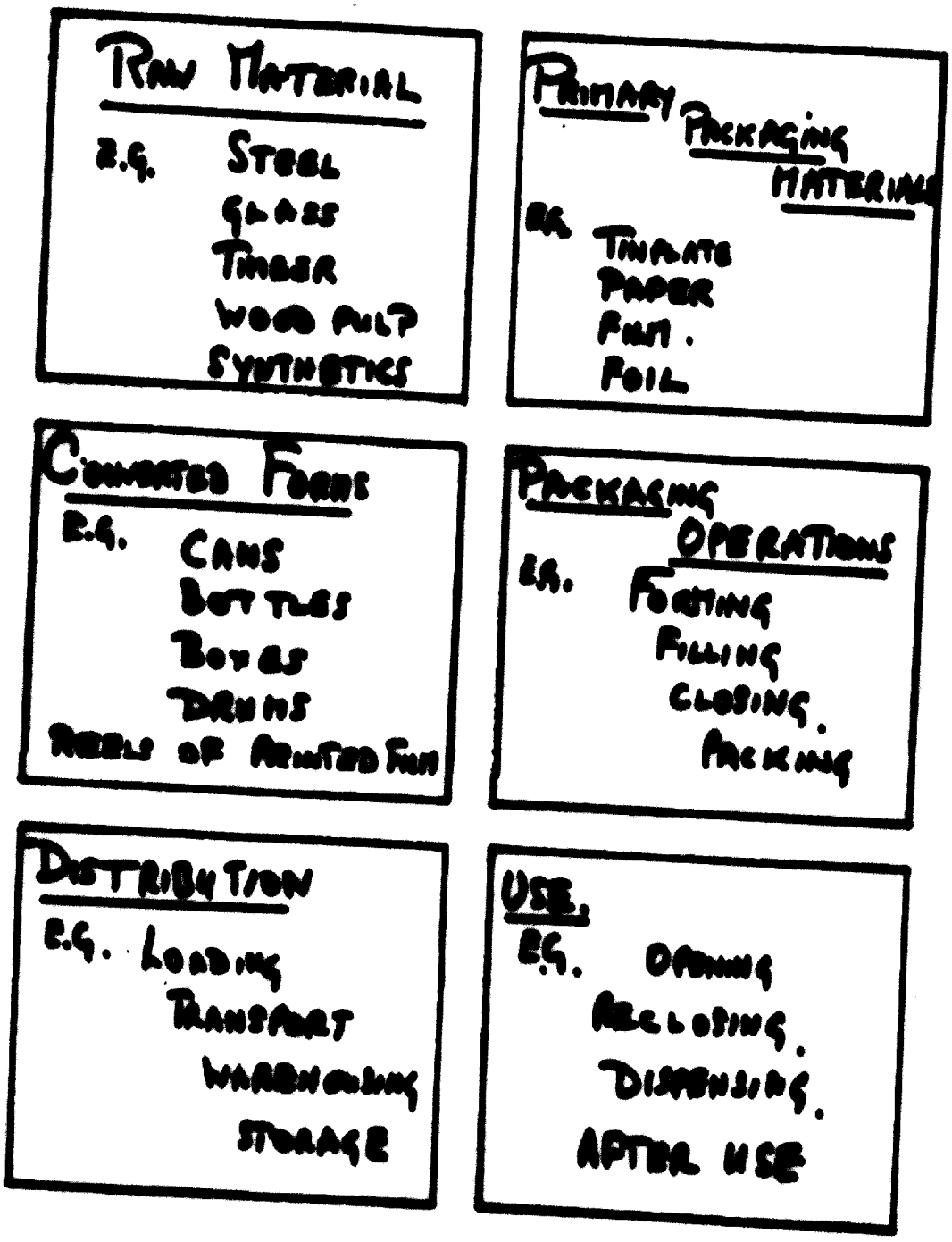
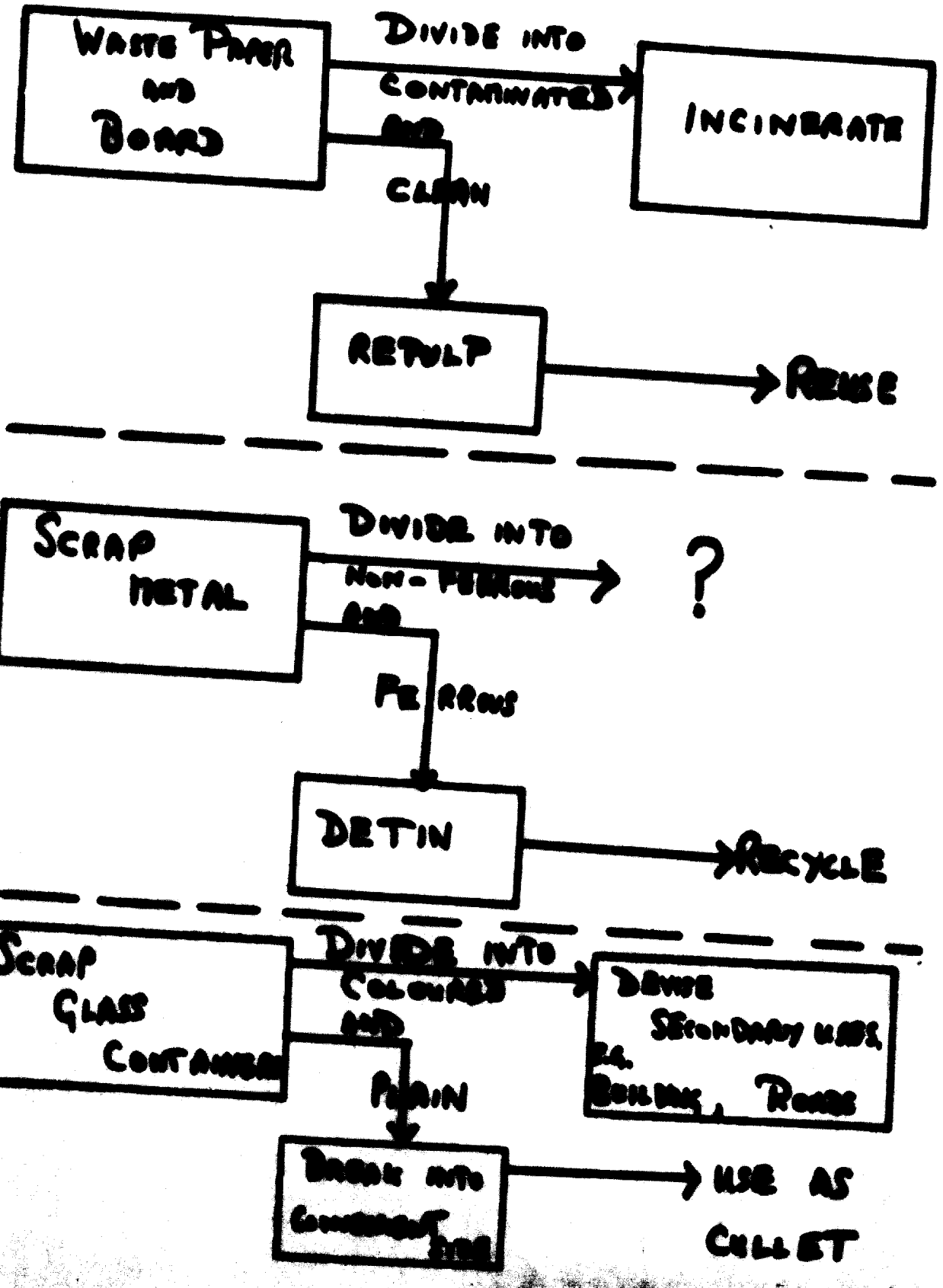


FIG 3 EXAMPLES FOR THE PACKAGING CYCLE

Fig 4 Disposal Pathways



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