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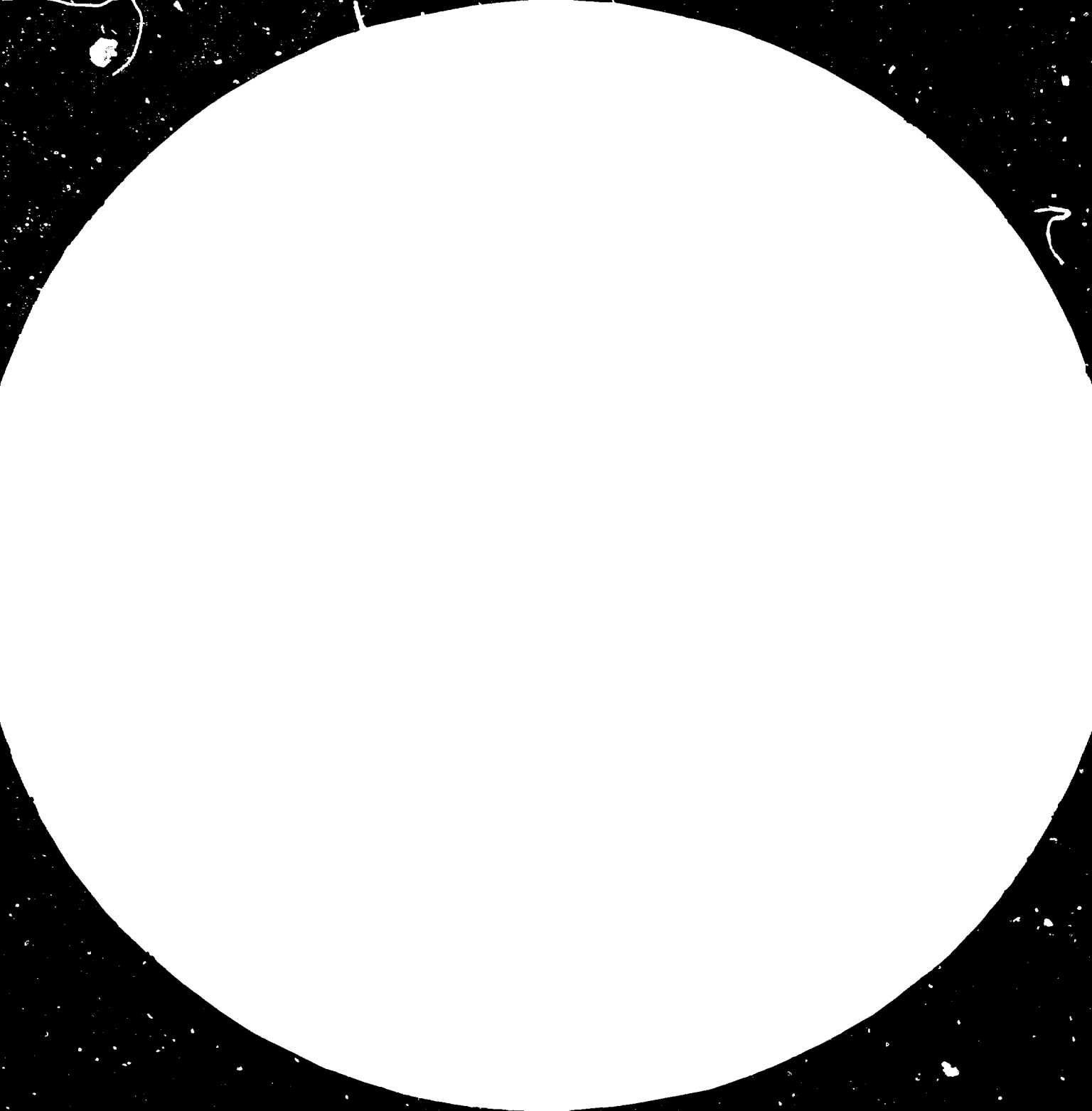
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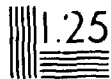
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RESEARCH AND DEVELOPMENT IN FOOD
PROCESSING AND PACKAGING TECHNOLOGY

DP/MEX/82/010

MEXICO

Technical report*- Programs to consolidate LANFI
from the technical and performance points of view

Prepared for the Government of Mexico
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of William C. Simms,
expert in marketing and information

527

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Vienna

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C O N T E N T S

	<u>Page</u>
I. INTRODUCTION	3
II. SUMMARY AND RECOMMENDATIONS	3
III. OBJECTIVES OF THE PROJECT	5
IV. ACCOMPLISHMENTS	6
V. ANNEXES	7

ANNEXES

A. LOOKING AHEAD IN PACKAGING	8
B. OTHER DEVELOPMENTS	12
C. PLASTICS AND MEXICAN PACKAGING	14
D. SHRINK AND STRETCH WRAPPING	26

I. INTRODUCTION

Two major areas were designated for emphasis in this one-month project carried out between 21 November and 21 December 1982. These were:

1. Review all the consultative reports that had been submitted to date; prepare an over-all condensed summary of these; provide an evaluation based on this overview; and, finally, consolidate recommendations from available sources.

2. Work with the Industrial Design Department on specific projects involving:
 - a) domestic packaging materials supply, and

 - b) package development, design, marketing considerations and transport packaging for export.

II. SUMMARY AND RECOMMENDATIONS

A significant shift has taken place in Mexico affecting the UNIDO/LANFI program. The domestic economic climate changed during the final months of 1982 from rapid expansion and ambitious projects to a program of austerity and belt-tightening. Central to this change, were financial actions required by the Mexican government and measures taken by the new administration of President Miguel de la Madrid to cope with the economic problems.

LANFI responded quickly to recognize the new circumstances and to shift priorities so that there would be no loss of

momentum and so that certain very practical and greatly needed programs could be accelerated. In an important sense, the practicality and soundness of previous LANFI projects was proved by the way in which they could be so rapidly and effectively adopted to the new conditions.

Among the shifts in the new LANFI objectives are these three priorities:

1. Institute a program of identifying domestic materials that could be used to replace restricted, excessively costly or unavailable imported packaging materials, containers and equipment. An ensuing step is to guide Mexican suppliers and users into increasing improvement of the availability and application of these materials.
2. Provide guidance and support activities to Mexican industry for a program of accelerated and greatly expanded exports of manufactured goods, food products, chemicals and handicrafts. The reason for this priority is to improve the balance of payments in foreign exchange and also increase employment of workers supplying products for export. Central to this program is new emphasis on package design; package development, including appropriate labelling and marketing features; development of transport packages suitable for export, and, finally, testing of transport or shipping packages.
3. A new program of shifting LANFI support projects to a pay-as-you-go basis whereby industry will pay for needed services and thus help offset LANFI budget restrictions. This program has had to be moved ahead in the LANFI timetable, because of the belt-tightening that is necessary. However, in view of the advantages to industry in solving problems of materials shortages and of expanding exports

it should be possible to put many activities on a self-sustaining basis; and the sooner the better.

The Industrial Design Department of LANFI has been most alert in developing these new activities and has moved rapidly to get them started.

III. OBJECTIVES OF THE PROJECT

1. Consult and advise regarding programs for industrial, shipping and transport design of packages, with emphasis on packaging for export of Mexican manufactured goods, food products, chemicals and handicrafts
2. Consult and advise regarding programs for developing domestically produced packaging materials with a view to finding solutions for materials shortages brought about by inflation, devaluation and international problems.
3. Consult and advise regarding the development of programs for designing, producing packaging and food processing machinery to meet future needs of Mexico's developing packaging industry.
4. Participate in planning and implementation meetings regarding the development of programs for export, production of domestic packaging materials and design of packaging machinery.
5. Review work of UNIDO participants to date. Prepare summary report and help advise regarding options for future programs.

6. Conduct seminars on latest trends in packaging to selected groups of packagers.
7. Make plant visits to firms packaging for export, packaging foods, packaging pharmaceuticals, packaging household products.

IV. ACCOMPLISHMENTS

Four presentations were prepared and given at an all-day seminar on using domestic materials versus imports and packaging for export.

The presentations covered: 1) Trends and New Developments in Packaging; 2) Plastics and Mexican Packaging; 3) The Growing Importance of Shrink and Stretch Packaging; and 4) Thermoforming - A Good Method for Export Packaging.

The twenty-four reports submitted by UNIDO experts were carefully reviewed and a summary report was prepared to show the scope of the total project and accomplishments to date. Included were an evaluation and recommendations.

A series of planning sessions was held with members of the design group to identify problems of materials shortages brought about by fiscal belt-tightening and resulting restrictions on imports. Solutions involving shifts to domestic materials, especially plastics, were discussed.

A series of planning sessions was held with members of the industrial design group to consider export packaging for specific items. Recommendations for methods, equipment and procedures were made.

A visit was made to Plasticos Division, Papel y Carton to observe the manufacture of plastic bottles and discuss state of the art in Mexico.

A visit was made to Sharp, Merck and Dohme to observe packaging of drugs and pharmaceuticals.

A visit was made to the Grand Bazaar shopping center to study packages being used. Slides were taken for use in the seminar presentations.

V. ANNEXES

Seminar papers-

- A. Looking Ahead in Packaging
- B. Other Developments
- C. Plastics and Mexican Packaging
- D. Shrink and Stretch Wrapping

A. LOOKING AHEAD IN PACKAGING

By William C. Simms

I want to talk to you about packaging trends and new developments - especially in regard to ways in which they may affect your operations. I want to touch on ways that may help you where imported materials may be restricted and supplies cut off or made too expensive. I intend to discuss packaging methods that offer opportunities for increasing your export of foods, handcrafts, chemical products and manufactured goods.

Less than a month ago, I was in Chicago to attend Pack-Expo, the large and important U.S. packaging show held every two years. I will try to review for you some of the interesting materials, methods, equipment and trends that were on exhibit.

However, to set the stage for what is happening package-wise in the United States, let me refer to an event that took place shortly before the exposition. This event, in my opinion, changed packaging drastically and irreversibly for years to come in the U.S. and probably throughout the world. A fundamental change occurred. Where previously consumers (and often government, the media and even package users) took packaging for granted, attacked it, claimed overpackaging and unnecessary proliferation of cost - there was overnight a realization at all levels that packages can be ever so important.

The event I refer to, as I am sure you know, was the Tylenol trouble. In a small town near Chicago someone had opened packages of Tylenol capsules and had inserted the deadly poison, cyanide. As a result seven people tragically died. Moreover, there were copy-cat imitations. Acid was placed in an eye lotion. Laxatives were mixed with vitamins. Foods were contaminated. It was like the rash of sky jackings, which course changed the way people travel by air, causing great inconvenience and much added expense.

The Mac Neil Division of Johnson and Johnson had to recall all the packages of their product. The costs and the losses amounted to millions of dollars. The loss from negative advertising is almost beyond calculation.

The problem, of course, concerned a drug, but the implications for foods, cosmetics, health care and even household products were just as great - for foods such as peanut, butter, jellies and edible oils, even greater.

The only conclusion for most companies in the U.S. was that they could not afford to be without the protection of a tamper-guard tamper, evident on tamper-resistant package.

Because of immediate public clamour the Food and Drug Administration in cooperation with the pharmaceutical associations quickly adopted regulations and recommendations. One reason this was done so fast was to head off a host of local ordinances and regulations that would have created an additional nightmare for national distribution.

Following is a definition of a tamper-resistant package by the U.S. Food and Drug Administration:

DEFINITION OF TAMPER-RESISTANT PACKAGE

(by the Food and Drug Administration)

"A tamper-resistant package is one having an indicator or a barrier to entry which, if breached or missing, can reasonably be expected to provide visible evidence to consumers that tampering has occurred."

SOME EXAMPLES OF TAMPER-RESISTANT PACKAGING

<u>PACKAGE TYPE</u>	<u>TAMPER PROTECTION</u>
1. Film Wrappers	A transparent film with distinctive design is wrapped securely around a product or product container. The film must be cut or torn to open the container and remove the product.
2. Blister or Strip Packs	Dosage units (for example, capsules or tablets) are individually sealed in clear plastic or foil. The individual compartment must be torn or broken to obtain the product.
3. Bubble Packs	The product and container are sealed in plastic and mounted in or on a display card. The plastic must be torn or broken to remove the product.
4. Shrink Seals and Bands	Bands or wrappers with distinctive design are shrunk by heat or drying to seal the union of the cap and container. The seal must be cut or torn to open the container and remove the product.
5. Foil, Paper, or Plastic Pouches	The product is enclosed in an individual pouch that must be torn or broken to obtain the product.
6. Bottle Seals	Paper or foil with a distinctive design is sealed to the mouth of a container under the cap. The seal must be torn or broken to open the container and remove the product.
7. Tape Seals	Paper or foil with a distinctive design is sealed over all carton flaps or a bottle cap. The seal must be torn or broken to open the container and remove the product.
8. Breakable Caps	The container is sealed by a plastic or metal cap that either breaks away completely when removed from the container or leaves part of the cap attached to the container. The cap must be broken to open the container and remove the product.
9. Sealed Tubes	The mouth of a tube is sealed and the seal must be punctured to obtain the product.
10. Sealed Carton	All flaps of a carton are securely sealed and the carton must be visibly damaged when opened to remove the product.
11. Aerosol Containers	Aerosol containers are inherently tamper resistant.

There are several lessons to be drawn from this experience in the U.S.-

1. MacNeil had an excellent code marking system for its packages. This was ever so important in the emergency. It helped prove that the contamination did not occur in the Tylenol packaging operation. It helped head off threatened lawsuits.
2. Whereas, consumer activities were attacking products as being "overpackaged", the new Tylenol package with "triple" protection has been welcomed by government, media, distributors and consumers.
3. Packaging has moved into a new environment, where it is recognized that packaging's main job to protect the product has great value to the consumer. A good package is like a "watchdog", which people may regard as unnecessary until an intruder comes and the faithful watchdog barks a warning.

It must be admitted, on the other hand that a certain amount of panic and hysteria arose as a result of the deaths and the "copy cat" imitators.

Actually there have long been tamper-evident packages. Perhaps the best examples are the glued folding carton and the heat-sealed pouch. A great many packages were tamper-evident because the packager was concerned first with protecting the product.

Now certainly in the United States, at least, there will be some new and improved tamper-guard packages and that will be good. There will also be improved equipment for certain seals, sleeve and inner closures to meet the needs of food and pharmaceutical lines for relatively high speed.

In Japan where there has long been a greater concern with product integrity, some bottled products are sold in heat-sealed pouches. Many

bottled products have sleeve labels that cover the closure.

In many instances, tamper-guard packaging, as in the case of Tylenol, will cost more money - a cost that the consumer will have to pay and probably will do so willingly. However, in many instances, tamper protection will not, and need not, cost anything extra. Many packages, as previously pointed out, are tamper-evident - aerosols, metal cans, glued cartons, blister packs, heat-sealed packages, etc. etc.

One point to be made, if you have a tamper-guard package or if you are going to have one, you should call this to the attention of the consumer and take credit for the fact that you have his or her welfare in mind and have gone to extra lengths to provide a protected product. It is good consumer relations, good promotion and good insurance should unexpected trouble arise.

B. OTHER DEVELOPMENTS

Among the dramatic shifts in packaging is the move to aseptic paper-board containers to replace metal and glass juice containers. Two methods are in the news - a form-fill seal technique and method using flat sleeves that are set up into cartons, filled and sealed.

There is also interest in aseptic processing which allows flexible materials to be used in applications where hot-filled rigid containers previously have been preferred.

Developments have continued in the effort to engineer an institutional size retort pouch to replace the No. 10 can for both entrees and commodity items such as vegetables. Some of the most dramatic gains in institutional food packaging will involve the vacuum packaging in barrier bags of all different kinds of institutional foods, including examples such as scrambled eggs of truly superior quality and having great potential to reduce costs in restaurants, hospitals and schools.

The coextrusion of films is showing much progress. The same is true for metallizing. And a major packager of chewing gum is using a method whereby the metallizing is applied to a plastic (reusable) carrier web and then applied to the paper wrapper. The method offers several advantages including costs savings.

Major developments are occurring in the packaging machinery field involving computers, programmable controllers, lasers and robots. Many of these developments are probably a bit farther down the road insofar as Mexican packaging is concerned. However they are on the way and will become increasingly important as attention to inspections and quality control grows.

At the packaging exhibition in Chicago there were many examples of improvement involving cans, glass, labels and folding cartons. However, it was in the field of plastics where the most newsworthy and exciting advances could be observed. And it is in the area of plastics where I want to concentrate my remarks.

First of all, I think plastics will solve many of your packaging problems and enable you to innovate and provide packaging leadership. My succeeding material will deal with:

1. An overview of plastics in packaging and what it can mean to you.
2. A close-up and concentrated look at what is happening in shrink and stretch. I believe it is the most exciting and potentially most rewarding area to develop in packaging since thermoforming.
3. A review of thermoforming and why it, along with flexible film packaging and molded plastic containers, are your best bets for 1) avoiding material shortages, 2) becoming leaders in the skills of export and transport packaging and 3) pioneering ways to improve food packaging and save costs.

C. PLASTICS AND MEXICAN PACKAGING

By William C. Simms
Editor, The Packaging
Encyclopedia

Plastics are the fastest growing part of all the new developments in packaging. This is true in most countries of the world. However, plastics are especially important in Mexico for these reasons.

Mexico is very rich in petroleum resources and petroleum is the source for the most important plastics - polyethylene, polypropylene, polystyrene and PVC - used in packaging. During this period when imports of certain packaging materials face serious restrictions, it is only natural that Mexican packagers should look to plastics as a means of avoiding shortages of needed packaging materials

Plastic packages are particularly well suited to the needs of the export market, and Mexico has great need to export products to improve its balance of payments and also provide employment for the many workers who can serve this field.

The field of plastics packaging is constantly growing and improving. It thus offers packagers in Mexico great opportunities to innovate and benefit from the considerable rewards that can be expected when a successful new package is developed.

Over all, Mexico has great need to improve its packaging - of foods, health care and personal products, pharmaceuticals, household supplies, industrial and institutional supplies, and transport packages. Plastic packages hold great promise for doing this - with savings in materials, improvement of methods, reduction in spoilage or breakage, increased sales, and packaged products that are more satisfactory and better liked by consumers.

Paper and paperboard packages, metal and glass containers will always be very important in Mexico's packaging. However it is plastics that holds the greatest potential for the greatest variety of products. And that is why, I want to review with you now some of the basics and, at the same time, take an over-all view of the subject.

The raw materials used to produce plastic resins include coal, air, water, petroleum, natural gas, salt, limestone, sulphur and certain agricultural products. These in turn are formed into products called "intermediates" and from these plastics are produced.

Plastics, being a creation of the chemical industry, employ many terms common to that science. Those the packager encounters frequently are monomer, polymer, and copolymer.

The basic unit in chemistry, of course, is the molecule and when thousands of molecules of a gaseous or liquid substance, say ethylene, are chemically and physically modified by heat, pressure and catalysts - they can be joined end to end to produce a solid, in the form of a long-chain (giant), molecule or polymer. The smallest repeating structural unit of this giant molecule is called "mer"; thus one mer is a monomer. In the case of the polymerized ethylene molecules, the monomer in long-chain form is called polyethylene.

When monomers of different molecules, say ethylene and propylene, are chemically joined - polymerized - the resulting compound is copolymer. If they are simply mixed together in polymer form, the result is a "blend".

Plastics are divided into two divisions. The class employed for most packaging applications is thermoplastic-polyethylene, polystyrene, vinyl. These can be softened again and again by heat. The thermosets - phenolic, urea and melamine, once molded into a cap, lid or package cannot be heat softened for further processing or for scrap recovery.

The structure of a molecular chain is rather complicated. The polyethylene chain is three dimensional in shape with hydrogen atoms arranged along an inner zig-zag chain of carbon atoms. This basic chain has a number of shoots and long side branches. These branches determine the variations in properties such as density, flexibility, hardness, transparency and the like.

In some areas the molecular chains are parallel and lined up in an orderly crystalline fashion. In other areas the arrangement is random or amorphous. To make proper end products, the resin producer depends on the right mixture of crystalline and amorphous regions.

Copolymers result when one or more dissimilar monomers are added to a polymer to modify its molecular structure providing added or improved properties such as resiliency or flexibility. A copolymer that is increasingly important in packaging, for example, is ethylene vinyl acetate because it provides tougher, more flexible films.

Chemical engineering thus permits the plastic industry to build many desirable characteristics and combinations of characteristics into plastic polymers and copolymers.

Plastic resins are usually produced by chemical companies. Petroleum companies have also become involved in the manufacture of plastics with their ranks including major names among oil companies.

The raw materials such as crude oil and natural gas are relatively plentiful and easy to obtain and process - at least when compared to forest resources and capital investment for paper mills, the mining of iron ore and the production of steel, or the complex facilities required for producing glass containers.

Resins are manufactured in the form of pellets or powders for conversion into film, sheet, foams, coating, adhesives or moulded products.

Plastic resins are usually only one of the products produced by the parent manufacturer. For example, the petroleum industry has the option to offer any one or all of a family of products including gasoline, fuel, oils and other lubricants, detergents and plastics of several different types.

The advance of plastics into packaging stems in large part from the variety of resins available and the many ways in which they can be formed and fabricated. Resins can be converted into films, sheet packages and many kinds of rigid forms including bottles, tubes, trays and boxes. To a greater extent than is possible with other materials, plastics have potential for being processed into containers in the packager's plant. This could have a far-reaching effect on future packaging production.

Special properties can be built into plastics during formulation and processing. Plastics can be blended to provide special qualities of transparency or barrier properties. Two or more films can be coextruded to combine a strategic choice of properties. Films can be oriented to provide shrink and other special characteristics. Resins can be foamed to provide cellular structures that excel from the standpoint of light weight, cushioning, insulating and other types of protective properties.

Some plastics are relatively expensive, but others are quite economical. Polyethylene film, for example, is the lowest cost transparent film available to packagers. A long-term trend in plastic costs once was down, but in recent years many of the prices reached a level and started back up, responding to the same inflationary pressure that all materials have had to share.

Of course, a very important role for plastics will always be in partnership with other materials such as coated paper, glass and metal, or plastic liners or closures teamed with metal or glass.

The Major Types

POLYETHYLENE

A polyolefin or petrochemical-derived polymer is the resin used in greatest volume for packaging applications - films; sheet; coatings; moulded containers; components such as lids, closures and liners, and also foams, netting and spun bonded or non-woven materials.

Polyethylene is produced by subjecting gaseous ethylene monomer ($\text{CH}_2 = \text{CH}_2$) to heat and pressure. Most ethylene is derived from a natural gas feedstock; however, the use of gas oil and naphtha is increasing.

There are three classifications: low density, including linear low pressure low density, medium density and high density. They offer a wide range of desirable properties and characteristics for packaging applications, including (especially) toughness, low cost, barrier properties, heat sealing, relatively good transparency and grades suitable for use with foods and drugs. They process well, and packages made from polyethylene run well on available packaging equipment.

For example, polyethylene film is the major plastic material for flexible packaging and is used for wraps, bags, pouches, stretch wrap, shrink wrap. A cross-linked polyethylene film, produced by radiation or chemically, offers superior properties for shrink wrapping. Polyethylene film is widely used in laminations or coextrusions because of the toughness, heat sealability and low cost.

Polyethylene is the most widely used resin for coating on a wide range of packaging substrates because of processability and functional

characteristics including heat sealing and barrier properties.

High density polyethylene is the largest volume resin for blow moulded bottles. In the United States, it dominates the market for milk bottles and containers for house-hold products such as liquid detergents and many industrial products.

The reasons for the large market share (about 80% poundage) of HDPE in the bottle field in the United States are excellent physical and chemical strength properties, ease of processing and favourable costs.

Polyethylene is widely used in film gauges for skin packaging and in sheet for thermoformed trays, cup and a unique cube-shaped container used for liquid, industrial products and for wines.

Polyethylene is also used in film and also in moulded shapes as a box, pail or drum liner.

Other uses include foamed pads and wraps; netting for produce, Christmas trees and pallet loads; moulded pallets and spun bonded, non-woven materials for sterile pharmaceutical packaging.

POLYPROPYLENE

Also a polyolefin; is produced by stereospecific polymerization of propylene monomer. Its special advantage is light weight (it is the lightest in weight of the plastics used in packaging). It has high rigidity and a relatively high softening point - in some applications above the temperature of boiling water. Polypropylene is finding increasing use as a packaging film, as a sheet for thermoforming and as a resin for blow-moulded containers. A very special property for packaging is its "living hinge" characteristics, which permits closures and containers to have hinges that will open and close throughout the intended use life of a container.

Polypropylene has good chemical and stress cracking resistance. Water vapor transmission rates and water absorption rates are low. Its toughness falls off at lower temperatures.

THE STYRENIC MATERIALS

They include polystyrene, modified or high-impact polystyrene and acrylonitrile butadiene styrene (ABS). Benzene, derived from crude oil, is the main petrochemical basis for styrene monomer.

Styrene monomer is polymerized into high molecular weight polystyrene by means of a free radical mechanism. Controlled temperature and pressure and use of catalysts determine polymerization rate, molecular weight and physical/mechanical properties.

Polystyrenes have light weight, good processability, rigidity, high gloss, and relatively low cost. General purpose polystyrene combines sparkling transparency, high dimensional stability, high tensile, moderately high WVF and fair to good chemical resistance. It is odourless and tasteless. It tends to be brittle, but modified or impact grades have improved strength, flex and chemical properties.

Polystyrene cups and trays have captured large shares of the markets in the food field, including single use. One of the more innovative applications involves extruded foamed polystyrene sheet used for thermoforming.

Polystyrene is the largest volume plastic for boxes and thin wall containers or trays, both injection moulded and thermoformed sheet.

Polystyrene foam (expanded polystyrene) is the major foam used in packaging. It is produced in moulded trays, boxes and pads. In both

moulded and fabricated form EPS has revolutionized industrial and shipping packaging on the basis of its very light weight, contour fit, cushioning and insulating properties and favourable economics. Major uses include packaging for typewriters, radios, instruments and the like.

In sheet form, foamed polystyrene is thermoformed into cups, trays and egg cartons, competing strongly with paperboard and moulded pulp in those markets.

VINYL CHLORIDE

(PVC) is produced by reacting ethylene (from natural gas or petroleum) with chlorine derived from sodium chloride (common table salt). It was first produced in commercial quantities in the early 1940s. A great many resin types now are tailor-made to meet a wide range of specific applications.

There are two general classifications: rigid, unplasticized, and flexible or plasticized. A wide range of properties, including toughness and flexibility is available. WVP is moderately high for flexibles, moderate for rigids. Vinyl films have excellent properties for wrapping of fresh meats and for shrink or stretch wrapping a wide range of products or containers, including bundle wraps and pallet-load wraps.

PVC sheeting is widely used for thermoformed blisters because of its clarity, high stiffness, good impact strength and favourable economics. In film gauges, vinyl is an excellent material for skin packs.

For bottles, PVC's glass-like clarity, good chemical resistance and impact strength make it a preferred candidate for a variety of products including cooking oils, syrups and personal products such as shampoos.

Other Resins

CELLULOSICS

Include cellulose acetate, cellulose propionate and cellulose acetate butyrate. Chief use in packaging is: in sheet form for fabrication into boxes, trays or tubes and for thermoforming into blisters. This is because of clarity, dimensional stability and ease of fabrication or forming. Major applications include transparent boxes for jewelry and gift items. Cellulose acetate film is used for wraps and also in laminations.

ETHYLENE VINYL ACETATE

(EVA) resins are excellent extrusion coating materials for paper, paperboard and other substrates. EVA films have excellent impact strength, softness and flexibility. As a result use of EVA has been increasing.

IONOMER

It is a thermoplastic polymer that is "ionically cross-linked". A principal ionomer resin used in packaging is derived from ethylene methacrylic acid copolymers. Four variables - molecular weight, methacrylic acid content and the amount of either sodium or zinc ion type cross linking allows resin properties to be tailored for specific applications.

Principal uses of ionomers in packaging are for films, especially co-extrusions, and for coatings. They have exceptional toughness, good clarity, oil resistance, high melt strength and low temperature sealability. Principal applications include deep-draw thin wall containers for vacuum packaged processed meats, skin packaging and coatings. The toughness of ionomer film is observed in skin packages used for items such as fishing lures or other sharp-edge items.

Ionomer contributes to faster running and stronger heat seals - two very desirable and much sought-after characteristics for packaging. Ionomer has high melt strength or "hot tack" making seals less likely to fracture when stressed before cooling. Ionomer seals at a relatively cool temperature increasing the speed of sealing. Other characteristics provide wider processing latitude.

NITRILE POLYMERS

They are thermoplastic resins resulting from the controlled reaction of acrylonitrile monomer with itself or other monomers. Nitrile polymers are used in blow-moulded and stretch blow-moulded containers; for chill roll casting of sheet for thermoformed containers and for cast or blow oriented and non-oriented films. Coatings and adhesives are also produced. A principal property of nitrile polymers is their excellent barrier to oxygen, carbon dioxide, propellant gases, perfumants and essential oils. They are thus a candidate especially in coextrusions for packaging various food products, beverages, aerosol products, cosmetics, extracts and the like.

NYLON POLYMERS

They have specialized uses in packaging - as a laminate with polyethylene for vacuum packaging of processed meats, cheese and boil-in-pouch frozen foods. In moulded form they find applications for lids and for aerosol valve components. Nylon is a good gas barrier, has moderate water vapor permeability and excellent resistance to a range of chemicals.

POLYCARBONATE

Being produced from benzene derivatives, is a special purpose, high-clarity plastic. It is very tough, rigid and dimensionally stable. It maintains its properties through a wide temperature range. It is used for milk bottles, nursing bottles and other containers that require its superior characteristics, including returnability for multitrip use.

POLYESTERS

Polyethylene terephthalate (or PET) are condensation polymers that are synthesized by reacting one or more diacids with one or more glycols. Polyester is a versatile polymer with widely varying properties.

In selecting a polyester material for a package, properties of amorphous oriented and crystalline polymers must be weighed to determine which properties can be obtained for end use performance.

For soft drink bottles a principal property is a high strength to contain carbonated beverages at high pressure. For blister packs such as those used for processed meats, PET offers clarity, ease of forming and toughness. Film produced from polyester resin is characterized by excellent strength over a wide temperature range. Biaxially oriented, it offers excellent barrier properties against odour and oil. It can be coated to provide heat sealing and improve handling, barrier or laminating properties. A recent use is as a coating for ovenable board.

POLYVINYLIDENE CHLORIDE

(PVDC or saran). Resin is used for films and coatings. Its outstanding moisture and gas barrier properties make it a very useful material for applications in packaging products such as candies, cheeses, baked goods and processed foods.

Thermosets

MELAMINE, PHENOLIC, UREA

These three thermosetting resins are used in packaging mainly for closures. They are characterized by good strength and chemical resistance properties. Melamine and urea are available in a good range of colours and are used for cosmetics and luxury items where attractive

appearance is important. Phenolics are offered chiefly in dark colours and are used for closures for utility items, where the resin's mechanical properties, high torque strength and superior heat resistance may be required.

Special types

Other plastics that have uses or potential uses in packaging include acetals, acrylic, polyallomers, polybutylene, polysulfone, polyurethane and styrene-acrylonitrile (SAN).

D. SHRINK AND STRETCH WRAPPING

Shrink wrapping and stretch wrapping are two different methods of placing a tensioned wrap around a product, a container, groups of products or containers or around a pallet or other transport load to improve the packaging operation and save costs. There are few if any areas of packaging methods and equipment that have seen more advances in recent years, including some important shifts in methods where specific applications are concerned. And there is probably more potential for improving many packaging operations in the next few years via shrink or stretch wrapping than in almost any other area.

Among the reasons for this is increased sophistication of equipment and methods and higher speeds. This is especially true in stretch wrap. Also newer films designed specifically for shrink or stretch are being offered. Whole new fields of opportunity are believed to be opening up where bundling is concerned. And there is certainly greater demands being placed on the users and prospective users of shrink equipment or stretch machinery to keep abreast of developments in these two fields. Output speeds, efficiency, quality, economics and payback are all likely to be greatly affected by the user's expertise in selecting and using the methods, materials and machinery that are now evolving. An extra thrust that has been injected into this field is the rather frantic new interest in tamper-evident packaging resulting from the Tylenol trouble.

An important consideration is the high production speeds needed to make this type of shrink wrap practical for pharmaceutical or food lines. Such speeds are being offered by systems for shrink wrap of individual containers (bottles, cans, boxes) with a total wrap or sleeve, employing horizontal form, fill, seal (or cut wraps) at speeds to 300 packages a minute.

For heat shrink tamper-evident neck bands, a continuous motion banding machine has just been introduced to fit existing high speed bottle filling and capping lines for OTC drugs and foods. It has a multi-station turret with patented cam-operated heads and will apply 180 to 360 bands a minute, it is claimed. Opaque or printed tubing from roll stock is perforated, cut and applied to containers with 5/8 inch to 4 inch diameter caps.

Shrink and stretch both vary in method, but produce similar results. Both are relatively uncomplicated in concept. Shrink packaging usually involves two very simple steps: first, wrapping the product, container or pallet in either a full or a sleeve wrap and second, applying heat to shrink the film tightly and neatly around the product. This is done most often with a wrapper and a shrink tunnel. There are important variations, including bagging, use of hot plates, heat guns and hot water baths. The many advantages of this process are basically derived from the wide variety of shrink films available with a range of properties and characteristics to allow many options for providing needed performance and desirable economy. Basically, the advantage of shrink stems from the "memory" built into a film so that it will shrink when subjected to heat. As a result the film has built-in "muscles" or capacity to do useful work conforming to shape, gripping and holding. The tightness of the wrap enhances see-through or visibility in many applications.

In stretch wrapping, an elastic film is stretched and applied under tension to a single item, a bundle or group of items or to a transport or pallet load.

The stretch and cling of plastic films makes them quite practical for wrapping many types of individual products such as poultry, cuts of meat or produce. Machines ranging from semi-automatic to full automatic have been devised for these and similar applications.

Major developments in stretch wrapping have, up until the present, been concerned with individual wraps, mainly for supermarkets and with pallet load or shipping load wraps. However, some authorities in the field predict that the stretch bundling field, which is only now beginning to develop, promises to revolutionize this segment of the packaging field. Stretch wrap for individual units and for grouped items has great potential, because stretch films can cost as little as 1/3 as much as shrink film. Machinery designed especially for stretch, the availability of suitable films and the growth of technology could make this a most promising area to explore.

Stretch wrapping depends on the elasticity that exists in many films or that can be built into them. Again, the basic concept is simple. The film is wrapped under tension around a product, container or pallet load. A major advantage is the fact that heat is not involved. This eliminates need for a tunnel, heat gun or other device, which is an added cost to install and maintain. Also the cost of heating and conservation of energy are factors that are not involved if stretch is used.

Shrink film systems are generally used for high profile packages, soft perishables such as baked goods and when wrapping products on clear plastic trays. (Shrinking eliminates film tear on tray edges). Shrink wrapping and bagging are employed for vacuum packaging of poultry, fish, cheese, frozen food and sub-primal cuts of meat.

Automatic shrink and stretch wrappers are used for packaging fresh meat, poultry, seafood, produce and baked goods in supermarkets and central packing houses. Advances in stretch film systems technology have made stretch wrappers the preferred method for prepackaging fresh foods in the supermarket.

Automatic wrappers provide considerable labour-cost savings, and, in many cases, yield a payback period of less than one year, it is reported. High production capability helps the supermarket respond to out-of-stock conditions, peak periods, off-schedule deliveries and other conditions where prompt wrapping of perishable products is necessary.

For operations where explosion-proof conditions must be observed, stretch wrapping is the method of choice and same is true for certain products that might be affected by exposure to the heat of the shrink tunnel. Stretch wrapping is also indicated if the wrapping is to be done in a refrigerated or air-conditioned area.

Beyond these considerations, choosing between shrink and stretch, usually requires careful study and can only be resolved on an individual product and company basis. The advantages and potentials of both methods are significant. There is a very good choice of methods, materials and equipment available, and innovation and improvements are constantly being introduced and have, in fact, been one of the striking features of every major packaging show for the past ten years or longer. Of course, shrink has had the advantage of a head start, but in recent years, particularly in pallet-load wrap, stretch has made very significant gains on the basis of simpler operations, energy considerations and lower costs.

There are many existing applications of shrink and stretch, a fair number of which have been reported in the packaging press, and new lines are constantly being introduced. The packager faced with choosing equipment or improving existing operations, can thus find numerous models to guide him.

SHRINK EQUIPMENT FOR INDIVIDUAL ITEMS

Semi-automatic, automatic and special wrapping equipment are offered in single or two-web models. Major considerations are whether product input will be vertical or horizontal; the pattern, whether center-fold, sleeve or a bag; the size range, cycles per minute; special features such as registered printing, custom design, in-feed conveyors and, of course, cost.

As for tunnels, important considerations are : size of tunnel or ring opening; speed in feet per minute; heating method, hot water, gas fired or electric including wattage; controls for temperature, air velocity, conveyor speed; operator skills; automation; and, finally, cost.

Basic methods of wrapping with shrink film employ (1) a single web (2) a centerfold single web or (3) two webs of film.

If the single web is formed into a sleeve it can have a back seam or lap seal and seals at both ends (H-seal). The centerfold film can be sealed with a right-angle or L-trim-and-seal blade. The two-web package has seals on four edges.

Sealing can be done by various means including hot blade, hot wire, thermal impulse or a radiant type sealer. The impulse, or radiant types are said to provide the widest latitude in handling the broadest range of shrink films.

The fastest growing area in shrink equipment involves horizontal form, fill, seal machines because they make excellent packages, use less film and, in general, can be run at higher speeds with no film trim.

Shrink bags are a preferred method for vacuum packaged poultry, hams, cheese, sub-primal cuts of meat and prepared institutional foods. The latter are reported to be growing in use at a fast rate and offer very significant potential for better quality, savings in labor and handling costs and offer new opportunities in the food service field.

There are now new generations of rotary vacuum systems for shrink wrapped meats. The rotary vacuum chamber is designed to increase throughput. Use of a heat seal, permits shorter bag lengths for material savings. Elimination of operator judgment results in consistent high vacuum levels. For certain types of products produced in high volume

where high speeds are desirable a roll-stock laminate machine can be used. However, the laminate is said to require an excess of film wrap method, resulting in a package of less appeal.

Specialized models of shrink wrappers are available for almost every type of product and level of output employing vacuum-shrink. The choices are very wide and are increasing.

SHRINK BUNDLING

Grouping of multiple produces or containers presents one of the potentially most rewarding areas in shrink packaging including the bundling of (knock-down or filled) cartons, books, canned goods in trays, multiwall bags (empty or filled), suspension packs, industrial parts, picked orders, dealer packs, inner shippers and sets. Advantages include material, labour and tare weight savings; improved product protection; improved handling display, merchandising and product identification.

Technology and methods for shrink bundling have therefore been moving ahead. (The same is expected to be true for stretch bundling). Special machinery for trayed canned foods and bottles have been developed and models have been designed to operate at very high rates of speed.

A special category of wrapping systems has also been designed for very large items, including lumber, rolls of textiles, wall board, mattresses and even such products as bathtubs and bicycles.

SHRINKING THE FILM

After the film is wrapped around the product, the wrapped load (or bagged item) is customarily moved immediately into a shrink tunnel, which is essentially a conveyORIZED recirculating hot-air chamber. Hot air exposure of a few seconds duration does not ordinarily affect the product, but does cause the film to shrink tightly around the product or package.

Typically a shrink tunnel employs a conveyor, generally offering variable speed features and equipped with special belts of Teflon, silicone-coated fibre glass, metal or mesh rollers or powered rollers.

Heat chambers vary as to method of directing the hot air, the air pattern control system, the number and configuration of air ports and insulation. The heart of the shrink tunnel is its recirculating hot air system. Important considerations are accurate thermostatic control and very high variable velocity air systems to contribute versatility as needed.

Special types of tunnels include those designed to provide good end lock in sleeve wrap applications; and those designed for high speed operations with cooling chambers or preheat sections needed for specific applications.

PALLET WRAPPING

The use of bags that are manually placed over the pallet load is one of the simplest methods. In some operations, the bags can be fed from a reel and drawn over the load. And some systems form a gusseted bag and apply it. Some form a sleeve.

An alternate approach is to wind film from a reel around the load, either by turning the pallet load on a turntable or by circling the reel around the load, or forming a vertical sleeve with two webs of film.

PALLET SHRINKING

There is a very wide range of equipment offered for shrinking wrapped pallet loads. For lower production rates of up to 12 loads an hour, there are manually held shrink guns. At the other extreme there are complete systems designed for high output.

The typical method employs a tunnel; and models are available to meet a wide range of pallet shrink wrapping requirements regarding size of load, shape and types of film that can be used. Units with controllable air pat-

terns and temperature and velocity controls for uniform shrinking are offered. In some models the pallet enters and exits through the same door. Other models feature pass-through chambers, including mechanical or air-current doors. Output up to 100 or more pallet loads an hour can be obtained in the larger, more sophisticated and therefore more costly systems, where these are desired. A very important consideration is the choice of conveyor, which can be gravity or powered rollers, double or triple chain, open or flush, U-shaped, flat or a combination of these. The conveyor should match the heat conditions, speeds, tunnel, load configuration, pallet type and other factors to provide for maximum efficiency for your specific operation.

An alternate method of shrinking pallet wraps is with a ring or frame that descends from top to bottom of the pallet and returns, applying radiant or other heat that causes the film to shrink around the pallet load.

PALLET LOAD STRETCH WRAP

It is in the field of pallet-load or shipping-load stretch wrap where major advances are being made and where attention must be paid to new opportunities to improve operations and lower costs.

In a relatively short period of time there have been many innovations, and some stretch equipment has become quite sophisticated. Because heat and heat tunnel are not required, there is a saving in the cost of equipment and energy. For example a typical shrink pallet load reportedly might cost \$1.00 - 80¢ for film and 20¢ for energy. Stretch film (at about 65¢ a lb) for the same load might cost 37¢ - 35¢ for film and 2¢ for energy.

There are two basic methods of stretch wrapping: with a full-web application (as tall as or taller than the load); or with a narrower web (usually 18 or 30 inch width) wrapped spirally around the load, or in bands. Spiral wrapping allows the wrap to be patterned so that multiple windings

can be overlapped strategically in areas where greatest strength is needed. This can contribute to economical use of film. Also, in some instances only partial areas of a load need be wrapped or banded.

Stretch bagging employs tubular film that is stretched and pulled down over the load. The top can be sealed to produce, if desired, a five-sided, weather-tight "tent", or the sleeve can be left open. Bags are desired for certain loads; for example, those that might tear a wrap-around film.

TYPES OF PALLET STRETCH WRAP EQUIPMENT

These include:

Hand Held units. This involves a hand held reel for spiral wrap, or caster-mounted reel for full-web wrapping. These are for low output. The wrap is tucked into the load and the operator walks around the load; or, he can activate a turntable to rotate the load.

Platform or Turntable Units. Most of these are powered to rotate and pull the film from the reel. Some equipment is built to rotate around the platform or load. In either case the wrap can be full web, band or spiral wrap.

Rotary stretch wrappers can be modified to handle stretch netting, which offers advantages for certain types of loads, including those that need air circulation- loads to be cooled or frozen or where moisture in the load must be able to escape. Methods have been devised for anchoring or fastening the leading edge of the netting and for fastening the end of the laps with a clip.

With semi-automatic rotarys, the load is brought to the platform and indexed into position. An operator can start a preprogrammed cycle and cut film at the end of the cycle. The load is then removed by truck or conveyor. Special consideration, of course, must be given to equipment and methods used to feed the load to the platform and remove it after

wrapping, especially when dollies or hand lift trucks must be used and when unusual or unstable loads must be handled.

In full automatic systems, the load is fed into position; wrapped as programmed and conveyed from the system without operator assistance.

Pass-through Systems. The load is advanced or ploughed into the web of film, heat sealing the film at the front and back of the load. The film is relatively heavy in gauge (0.001 to 0.003 inches and stretches about 20 to 35 per cent). These systems, available in semi-automatic and automatic models, are generally designed for constant-size loads and where high throughput is desired. Various conveyor layouts and methods can be specified.

One unit has a "sled conveyor" to move the load smoothly from powered in-feed to powered out-feed with no conveyor gaps. This is designed to permit handling/wrapping of non-palletized loads, slip-sheeted loads as well as pallet loads.

Pass-through systems are on the increase because of numerous advances in what they can do and how they do it.

Important considerations in stretch wrapping, of course, are performance requirements and how those can best be met through proper choice of film and stretch method. This in turn will influence the choice of equipment as well as the load or product configuration and the output level needed. Consideration of the loading and feeding system and amount of automation is vital to efficient economical operation. A wide variety of makes and models is available.

PRE-STRETCH

A recent advance has been the development of pre-stretch methods (for both rotating and pass-through systems) as opposed to the older frictional-

braking stretch method. The braking device generally employs a core, surface control or tension bar to restrict the film unwind. The turning or advance of the load pulls the film against the restrained, tensioned film.

Pre-stretch can be non-powered or powered. Both operate on the same principle of stretching the film before (not during) application to load. The purpose is to provide greater stretch levels than can be obtained with braking or frictional methods.

Pre-stretching makes the film longer and thinner, increasing the yield, but decreasing the load holding power or strength of the film. Most of the pre-stretch devices consist of two rubber-covered rolls rotated at different speeds. Various speed ratios of the rollers produce a proportional percentage of stretch. Various devices are used to obtain a speed differential between the rubber-covered rollers.

The objectives sought with pre-stretch are greater control of the amount of stretch force applied to the load and the percentage of stretch applied to the film. This in turn can lead to savings in the cost of film used for each load-savings, reportedly, as much as 25 to 60 per cent, depending on methods used; and also the extent to which sophisticated electronics are employed.

Pre-stretch has its limitations as well as benefits. If the stretching is excessive or improperly done, films can lose cling, holding power and can unwrap or become brittle. Pre-stretch is more favourable, reportedly, for loads requiring light tension to avoid crushing. It is less useful for loads requiring heavy tension.

However, improvements in films, in controls and in tensioning systems are being developed and made available to help overcome these and similar problems. One system, for example, gathers the final laps into a kind of rope, knots it and applies a metal clip to overcome the loss of cling problem.

Another system employs an air-loaded dancer roll. Wrapping tension is isolated from pre-stretch by means of air pressure applied to the low inertia dancer roller.

When rotating tables turn a load that is rectangular with four corners, film feed must speed up for the corners and then slow down for the sides, causing peaks in film tension and complicating braking operations. The film manufacturers have done much to provide films that perform under these adverse conditions. However, with turntable speeds being increased to 10 or more RPM, the problem is magnified and has placed higher demands on both the film manufacturer and machinery manufacturer to address the problem, which otherwise can be a cause of film breakage.

OTHER PROBLEMS

Stretch films tend to relax after they are applied. Films that have been pre-stretched more than 100% relax significantly more than if stretched only 20 to 35%.

Most films except PVC, lose cling at certain pre-stretch levels and show significant loss of strength when stretched or pre-stretched more than 100%. (PVC can be pre-heated to improve pre-stretch). Films specially designed for pre-stretching in heavier gauge and with improved cling characteristics are being developed to make pre-stretch more successful.

SUMMARY

From the foregoing, it can be recognized that stretch wrapping methods and equipment for transport loads are in a rapidly changing field. Equipment models and options are expanding at a rapid pace. The field for many applications is becoming more sophisticated and more complex. The newer systems can do more, save more, but they also can bring new engineering responsibility since they may involve micro-chip technology, integrated circuits, tension controls, and controls for soft starts and slow stops.

Automatics can involve considerations of conveyer ingress and out-feed slip sheets, pallets, handling equipment, load stabilization, top sheet dispensers, fastening the wrap (at start and finish) wipedown devices, robot operation and more.

The options, the innovations, and the unexplored ways to use or improve stretch wrapping all add up to major opportunities for packagers. It would appear that there are important challenges and some not insignificant pitfalls.

