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rompa

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Contents

Abstract	iv
1. Introduction	1
1.1 Company profile	
1.2 Thesis definition	
1.3 Problem approach	
2. Design core: Market	6
2.1 Overview of the through sight packaging in the market	
2.1.1 Plastic transparent packaging	
2.1.2 Carton & Plastic transparent packaging	
2.1.3 Glass & Plastic transparent packaging	
2.3 Common manufacture processes and plastic materials	28
2.3.1 Main manufacture processes for transparent packaging	
2.3.2 General plastic materials for transparent packaging	
2.2 New material introduction	39
2.2.1 Several new materials introduce to Rompa for through sight plastic packaging	
2.4 Relationship of the transparent plastic packaging products, manufacture processes and plastic materials	
3. Conclusions	46
4. Acknowledgements	48
References	49

Abstract

In 'Insight in the market of 'through sight' packaging', nearly all of the transparent packaging in the Netherlands market will be presented. According to the tasks of thesis and Pugh's Total Design framework, I have researched different sorts of existing transparent packaging in the market. Depend upon these existent products, I also went to do some new research such as materials and consider their manufacturing possibility at Rompa. Firstly, I was going to market in the Netherlands and collected the main subsistence through sight packaging. Secondly, these transparent packaging were classified into different sorts by their material property. Then they also will be explained by their concept, manufacturing technique, material, face value and Rompa possibility. True-life photos for each of different through sight packaging and some details are going with most of products. Thirdly, several new materials are mentioned into this thesis and Rompa. To compare and consider their manufacturing possibility, price and application scope, the new materials may be hopefully apply to the new packaging production at Rompa. Insight through sight packaging can help me to understand and study them more, and focusing on the new material would support some new choices for Rompa.

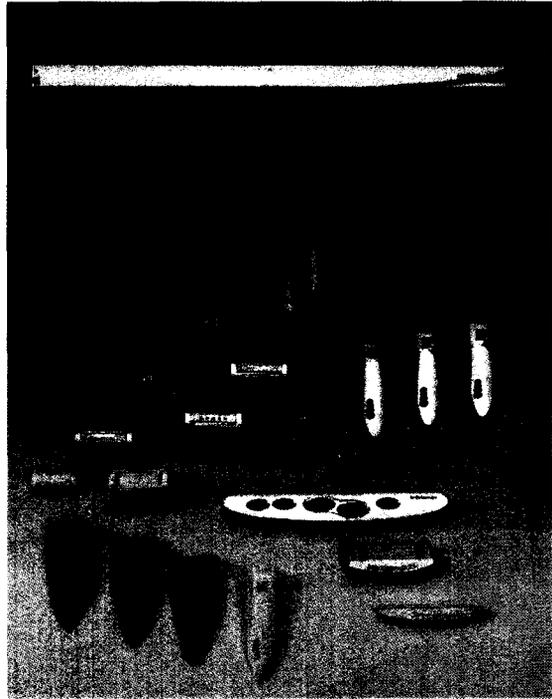
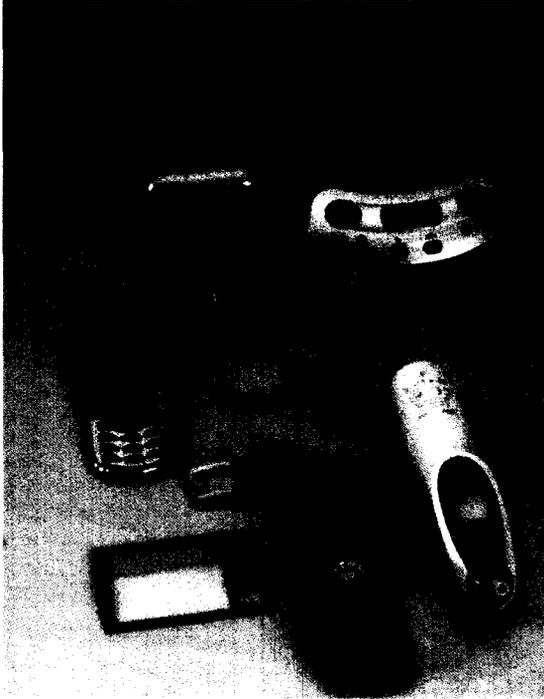
1. Introduction

1.1 Company profile

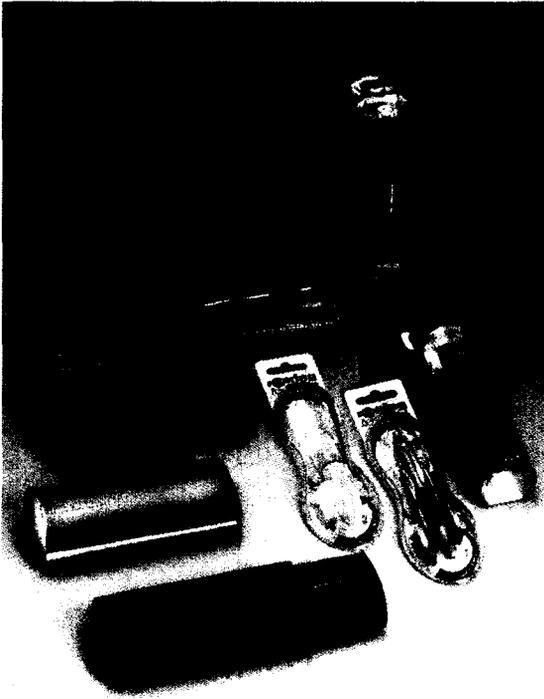
Because of the rapid development in plastic industry, the plastic packaging is one of the main packaging in the market and applied into all fields of our daily life. Compared with other sectors, the packaging sector remains the largest consumer of plastics. In 1999, 13 464 000 tonnes of plastics, approximately 40 per cent of total plastics applications, was used for packaging [APME, 2001]. In the era of fierce competition, people are looking for a product not only high quality but also cheaper in the market. For product manufacturers, to get a plastic packaging for their goods above the average either price or quality is not easy. On the other hand, packaging suppliers must continually earn the business of even their most long-standing customers. Rompa Kunststoffprodukten is a modern company, which is qualified in many aspects and ensures that customers always get more than the expected standard solutions. Rompa offers a range of production solutions, not only from a single source, such as injection molding, extrusion, and turning to assembly of finished machines. The company is also well recognized as a leader in the field of decoration: the transfer of intricate print into the product during injection molding. Relatively new technologies are giving your products added value. Listening the specific requirements or enquiry from clients, looking careful at all the different techniques and materials required, afterward to design via CAD/Unigraphics in own studio, and then to make the prototypes till final production process to arrive at an above average solution, The top quality products are manufactured and ensured by knowledgeable, experienced and qualified employees at Rompa. Long term relationships with international clients such as Philips, Grundig, Braun and Parker are the appreciation for a job well done.

Main products are offered by Rompa Kunststoffprodukten:

In-mould decoration:



Thermoforming:



Injection molding:



1.2 Thesis definition

A blister packaging is a normally a-through the process of thermoforming –packaging in (clear) sheet material, this with or without a combination with other material (e.g. carton) in which a product is being sold. The need for a self selling package, in which the buyer can see (and sometimes can feel) what the product really about, is due to large superstores, in creasing. Attractiveness and high face value are the tools for the manufacturer to get the attention of the potential buyer focused on his product.

Make a complete inventory of existing blister packaging.

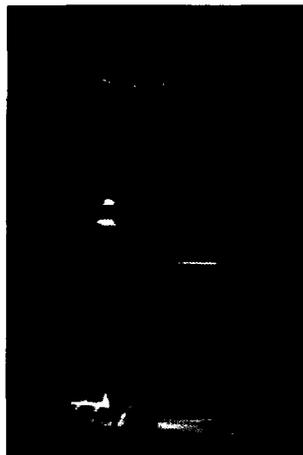
- a) in concept
- b) techniques used
- c) materials and combination
- d) high-low face value
- e) new material research

Targets:

Getting an overview of all packaging in which thermoformed blisters are used. This must result in a standard book/guideline for new developments in pictures and designs.

Use external sources, literature, Internet and suppliers etc.

The project has a profile “Rompa Eyes Only”, which means that results must be kept confidential within the company.

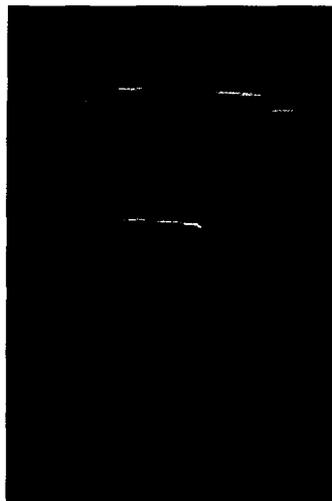


1.3 Problem approach

Nowadays, customers are searching purity and transparency. This tendency has been widened for the packaging of customer products, and especially in the daily domestic products field. This is why through sight packaging composes a diversity of materials, manufacturing methods and product forms. My approach to insight the through sight packaging includes:

1. Review and cite Market/User Needs and Demands [Pugh, 1990] to get the main structure and orientation of this thesis;
2. Overview a set of existing through sight plastic packaging in the market and explain their different concept, production techniques, materials and combination with others;
3. According to new requirements from clients and customers to search some new plastic materials for transparent packaging and compare of their manufacturing possibility at Rompa;
4. To make a face value comparative conclusion for the existing through sight plastic packaging on their different properties.

Through the research in the market in the Netherlands, apply existing sources and literatures and get the real experiences at Rompa on the through sight packaging, I will make a deep insight of the available through sight packaging in the market.



2. Design core: Market

2.1 Overview of through sight packaging in the market

In the past the products was the first to be made and then its packaging, today the packaging is being devised together with the product it will contain (and sometimes even before it) and more and more becoming an inside element of whole product, having its own dignity, quite different from the product itself. Packaging transforms and reinvents itself, evolve to meet the changing demands of modern society. Packaging must serve these purposes, and when all requirements have been met, it must be disposable with the lowest possible impact on the environment. Faced with a new contemporary individualism focused on convenience, aesthetics and ecology, packaging producers in industrialized markets are tackling the ever growing need for innovation. Essentially, the first function of packaging is to protect the contents of the package until protection is no longer needed. The packaging cannot contaminate, discolor, shade or otherwise adversely affect its contents. Often packaging must be able to display the contents or to draw attention to itself and its content. Especially in the through sight or transparent packaging, with abundant advantages such as transparent, lightweight, cost effective, preserving longer shelf life, durable and shatter proof, easy recycle and use less material to do more, are utilized for sorts of products among the modern markets around the world. The following instances will be presented a series of main transparent packaging existed in the markets. These transparent packaging will be described into several items:

- Concept: to simply explain what is that packaging product
- Technique: a short introduction of the production method which used for the packaging

- Material: it will show the common plastic material which are applied to the plastic packaging
- Combination: this part is described either the intermediate like insert or assembling procedure
- Face value: give a simple value comment for that packaging which is based on the customers view

2.1.1 Plastic transparent packaging

Clamshell

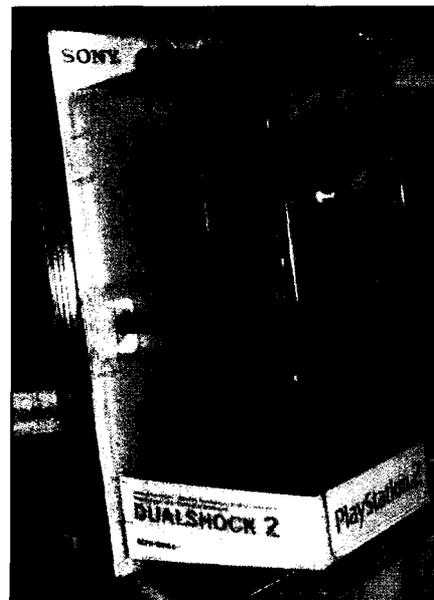
Concept: 3-piece clamshell (clamshell) is a popular design for transparent packaging which is used two pieces of transparent (see the sketch) thermoforming



clamshell, one piece of transparent or translucent product container and one or two intermediate.

Technique: Commonly, the front and rear parts of packaging are thermoformed by the vacuum thermoforming technique and welded together by heater.

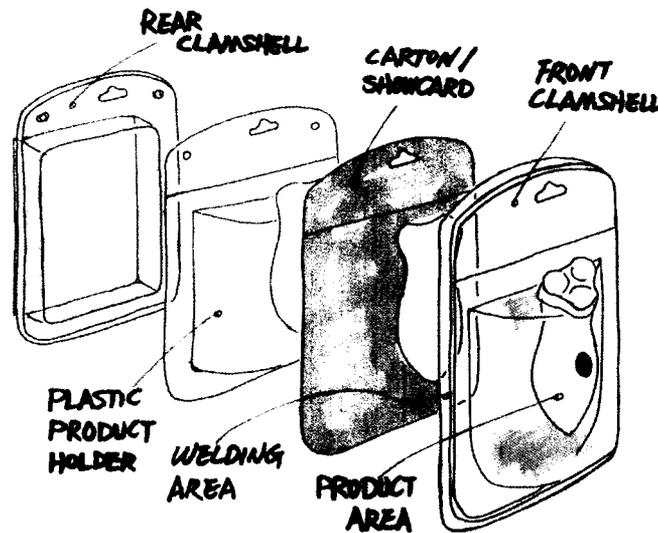
Material: The container may be not transparent, but the material must not react with the material of contents. Producers can choose same or different material such as PET, PS, PP or PVC (few to use as outside packaging because weak of stiffness) for these three plastic parts.



Combination: The third part is the intermediate layer like printed carton paper which is holds the contents between the two transparent parts. Inserts of thermoformed / die cut film or printed board designed to support and enhance product presentation.

Face value: The 3- piece clamshell may not as same as the 2-part blister given the rear view of the contents to customers, but it can show the other sides of the contents to customers more clearly. This kind of clamshell packaging offers a high visibility and clear three dimensions vision to the customers.

Rompa: producing – plastic parts



Clamshell

Box

Concept: Transparent boxes are suitable for playful and inviting retail packages for merchandising a large number of daily goods.

Technique: Boxes are composed by six quite simple planes; therefore, they need not use the thermoforming technique to produce. Before the boxes are used for contain products, they can be



folded to save the storage and transport space.

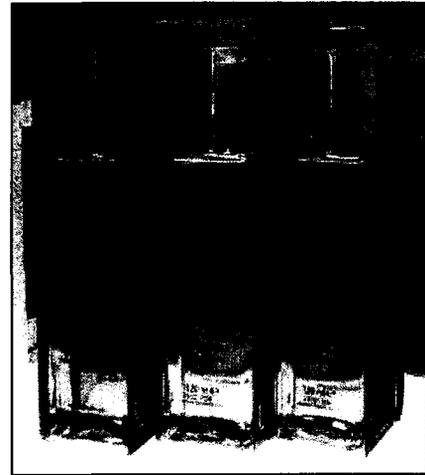
Material: The boxes can be made of PET, PP, PVC or any other material films. These films also can be printed with different colors and letters before forming the boxes.

Combination: Transparent boxes need not any more intermediate for decoration, because they have been printed on the surface. Just fold away

them and fill with candy, golf balls, decorative stuff, toys, or similar type products.

Face value: The plastic box can literally transform your product from an every day item into a gift. They are economical and easy to use. Colored graphics can be added to create an even more visually appealing package and they are available in any desired size.

Rompa: not producing in house



Window box

Concept: Window plastic box with printing is a kind of attractive plastic packaging and a strong trend in the market.

Technique: The box can be manufactured by simple fold or pressure process. And it is applied an ideal technique and concept that

the box is printed during its manufacturing process or printing on the films in advance.

The product holder is designed and shaped from the profile of the contents or according to the requirements from clients, and it can be chosen different thermoforming technique depends on its different requirements. Because of this manufacture process integrate printing and forming, both the production cost and time



are all saved.

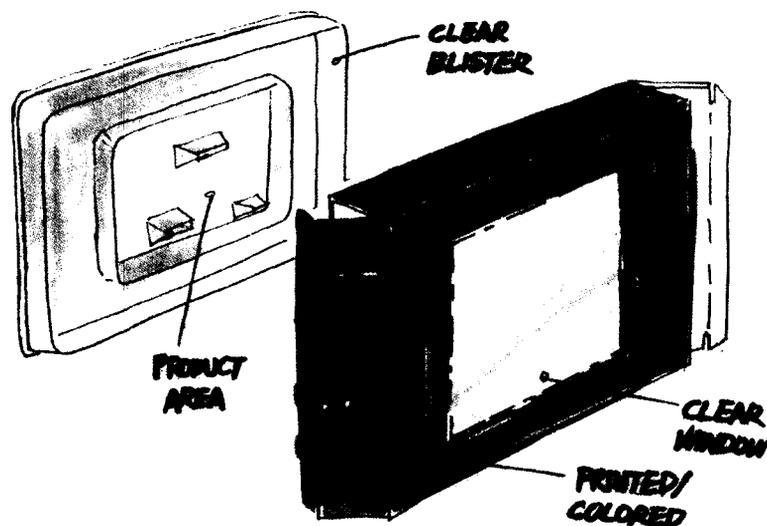
Material: It consists of a printed plastic box and a content holder (see the sketch). The window box and the content holder can be made of PET, PS, PVC or any other materials films.

Combination: At the assembling line, the products are easily to put in the content holders and then insert into the window boxes. The window box may be without any other intermediate to decorate it, because it can be printed on the surface.



Face value: To combine with transparent plastic film and graphic printing, the window box is offered a high visibility and absorbing visual effect for product.

Rompa: not producing in house

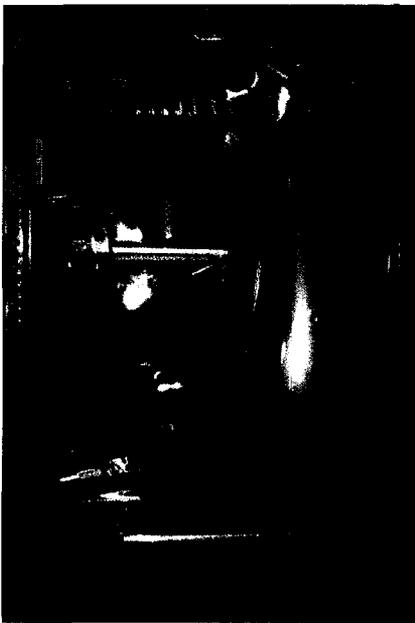


Window Box

Double view clamshell



front view



rear view

Concept: 2-piece clamshell (double view clamshell) is a very popular transparent packaging in the domestic appliance market.

Technique: It is consist of two pieces of transparent clamshell and one piece of printed carton paper (see the sketch). According to the size and structure of the contents, the two pieces of blisters are designed and thermoformed. Many kinds of thermoforming techniques can be chosen for the clamshells manufacturing.

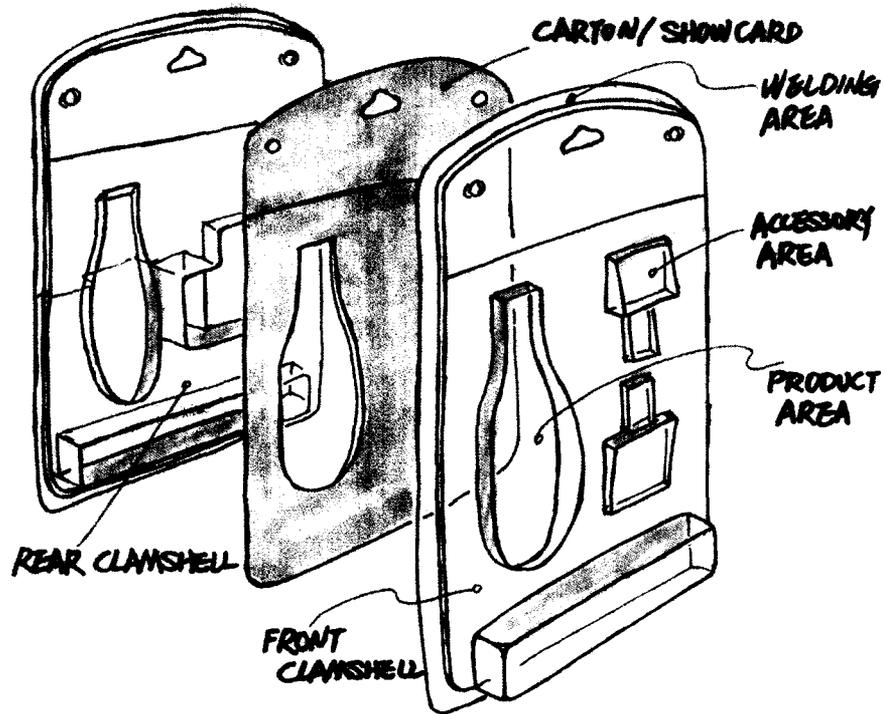
Material: Generally, the clamshell segments can be made of PP, PVC and PET sheets. All these materials can be recycled.

Combination: At the assembling line, the product and accessories are put together with the printed paper between these two transparent clamshells. Inserts of thermoformed / die cut film or printed paper designed to support and enhance product presentation. At the end of the process is the two clamshells welded together around their edges.

Face value: Because of this arrangement, customers can easily to see the product and their accessories what they will buy. It also can furthest to save the

space during the store, transportation and on the shelves.

Rompa: producing – plastic parts



Double View Clamshell

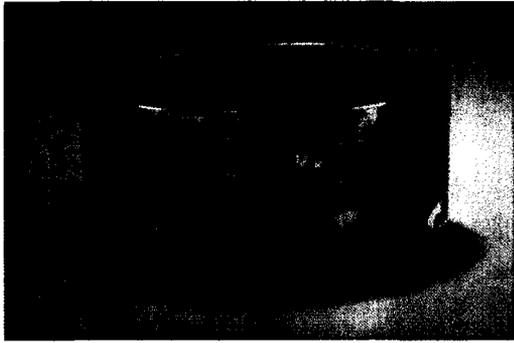
Drum



Concept: Thin wall plastic drum is an ideal packaging for items such as apparel, toys, arts & crafts, posters, cosmetics, bath salts, beads, and calendars.

Technique: Both the drum body and cap can be manufactured by one of the thermoforming techniques.

Material: Depend on different requirements of contents,



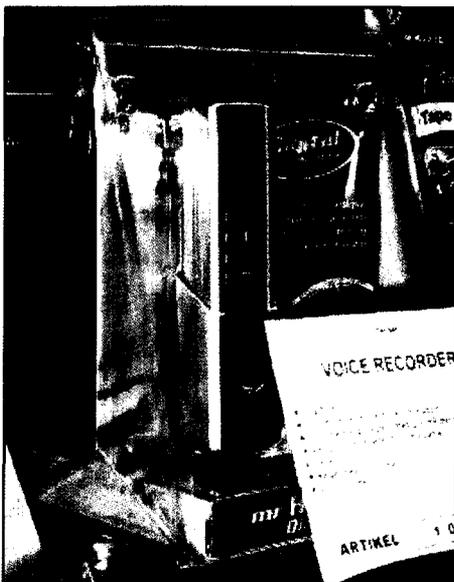
the drums can be chosen any suitable thickness of transparent plastic films like PET, PVC and PP etc. as their material. Print onto film using foil, screen or litho print processes.

Combination: The thin plastic drum provides an excellent barrier to moisture and protects the contents from being scuffed or torn. These features combined with a cap provide a very unique and low cost packaging tube. However, the high visibility still exists.

Face value: Colored graphics can be added to create an even more visually appealing package and they are available in any desired shape. This popular plastic drum has become a contest for many candy, toy, and gift packaging, but its uses are limitless.

Rompa: not producing in house

Tri-fold



Concept: Tri-Fold clam shell is one of unique forms of clamshell packaging. The three parts design typically includes a triangular base that allows the clamshell to stand upright on a shelf.

Technique: The tri-fold transparent plastic packaging can be manufactured by one of the thermoforming techniques.

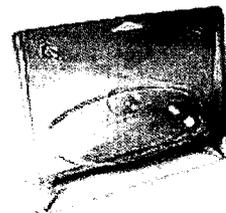
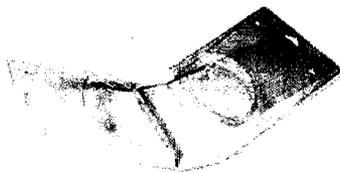
Material: All Tri-Fold clam shells can be made from the same crystal clear PET or other

transparent materials as those standard plastic clamshells. There are sorts of transparent plastic films suitable for tri-fold clamshell, just depend on the special requirements from the contents.

Combination: Generally the tri-fold clamshells are using the snap fastener as their sealing. It is easy to assembling for the producers; on the other hand it is a serious problem for the retailers and supermarkets to prevent the theft. If the sealing method will be improved and exerted, tri-fold clamshell packaging may apply more diffusely.

Face value: Tri-fold clam shells are designed functionally while retail clients have different ways to show the products by hanging it on a peg wall, standing it on a shelf, or sitting it in a display. Because of the base part, tri-fold packaging is waste both material (cost) and space during transportation, inventory and on the shelves. So it is few to use nowadays.

Rompa: producing – plastic parts



Tri – fold

Open state (left)

Close state (right)

Contoured blister



Concept: Blister packaging is an inexpensive option for certain packages that are durable, transparent, and tamper proof.

Technique: The blister packaging is attached to the blister card through a heat-sealing process that allows the product to be displayed in a wide variety of methods.

Material: For the plastic parts, the packaging can be chosen PET, PP, PS or other kinds of transparent thermoplastic sheets.

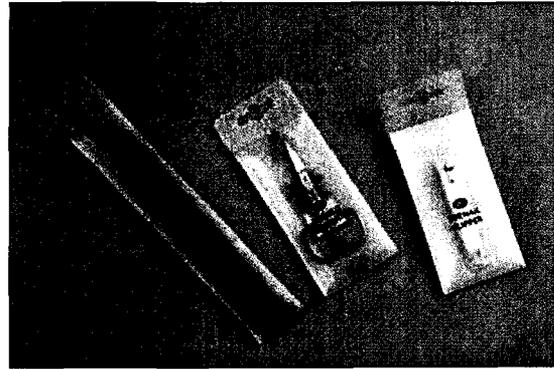
Combination: These contoured plastic blister packs are used in conjunction with a cardboard to keep the contents in full view for the customers to examine. The contoured blister and the printed carton paper can be welded together with heat sealing technique which can be finished by complete automated equipment nowadays.

Face value: Contoured blister is used for those light and handy stuff such as cellphone accessories, stationery, light toys, medical products or cosmetic stuff. It offers a high visibility of those contents for potential customers who want to buy them. Using blister packs is somewhat limited to light weight and/or thick items.

Rompa: producing – plastic parts

Hanging packs

Concept: This clever design enables speed of production, at the same time as allowing speedy packing times for the customer, thus keeping the unit cost to an absolute minimum on the large volume range. This simple principle design may be the most economic to save the space



both for store and transportation, because they can be fold like sheets to stack. On shelves, it can be hanged maximum at the hook.

Technique: This quite simple pack is used to fold away the shape by folding technique, cut out the hang hole by simple cutter machines, weld together at the edges by heaters and printing necessary graphics and/or letters by printing technique and machines.

Material: PET, PVC, PS, PVC or other plastic films all can be chosen as the suitable material of hang pack.

Combination: The hanging pack is a very simple design and product; no more extra part need combine with the hang packs. The essential explanative paper probably can insert in the pack if it is necessary.

Face value: Hang pack is the most popular transparent packaging among our daily life. High visibility and easy handling are the attractive points of this type of packaging. This simple design and product can be saved not only the material (cost) for clients but also the space for sale and store.

Rompa: not available

In-put clamshell



Concept: The in-put clamshell is one of fashionable transparent packaging in the market.

Technique: The structure of in-put clamshell is as same as the double view clamshell; the only difference is in-put clamshell do not use seal technique and just insert the rear sheet. The front clamshell is made by thermoforming and fold. The insert part can be a transparent film, printed carton paper or both of them. Their shape is just cut out the contour little smaller than front part without thermoforming technique. This concept is more attractive for the product producers because its cheaper and easy assembling except with anti-theft aspect. So the in-put clamshell may be saled and proved in the show windows.

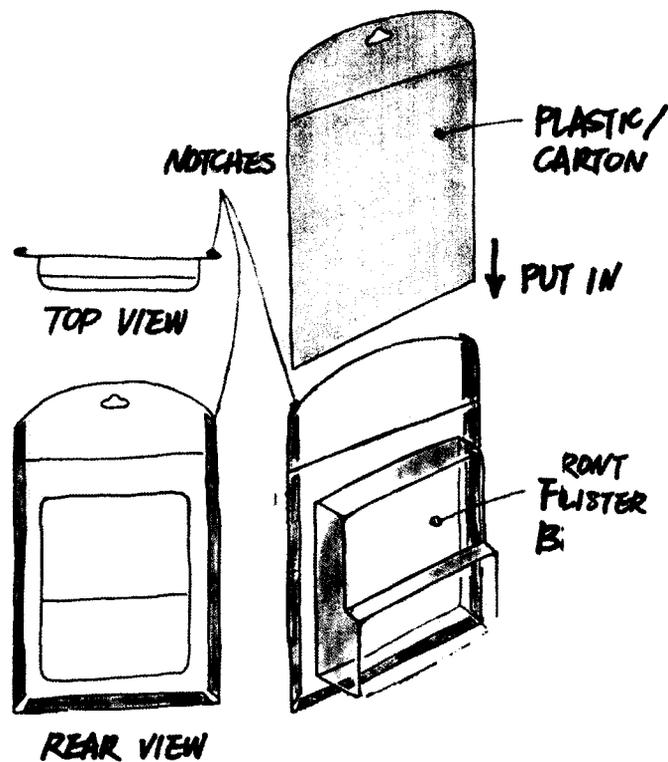
Material: The in-put clamshell can be used the material as same as other clamshells, though the PET, PP, PS and other plastic sheets are all proper.

Combination: At the assembling line, the contents are put in the cavity into the front clamshell, and then add the intermedia such as printed carton

paper, insert the rear part along the notches on the front clamshell. Because of the anti-theft, it may use staple for seal or display in the show windows.

Face value: Because of their structure and transparent, customers can easily watch the product and the accessories which they will buy. Adverse all the convenient factors, the disadvantage of in-put clamshell is easily to be theft its contents. So in-put packaging is limited applying like precise or expensive products.

Rompa: producing



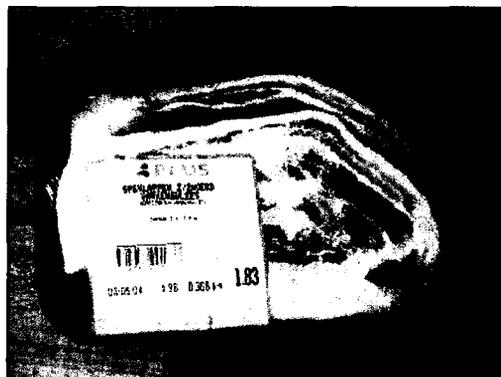
In-put Clamshell

Wrap & Foam packaging

Concept: We have many kinds of methods and materials to pack the meat or poultry. But nowadays, most of the supermarkets and shambles are choosing the transparent wrap and foam packaging to contain the fresh meat and poultry.

Technique: For this kind of containers, the foam technique is suitably for manufacture them.

Material: However, packaging touches considered an is because



because this the food, packaging is indirect additive. That chemicals in

packaging can migrate into the food. So when the packaging producers and users choose the materials for food packaging which must be approved by authority department. Different materials at the different using situation must be considered such as oven cooking, freezing food or long storing.

Combination: Normally, using foaming containers and wrapping transparent plastic films are the most popular packaging for the meat or poultry. Put the contents in the containers, to coil the flexible plastic film around the containers is quite simple production process for this pack at the assembling line. To stick the label or explanation part on the outside of the foam packaging is a quite easy and cheap method.

Face value: Low-cost, protects against moisture loss, but has some oxygen permeability so it allows meat to "bloom" (stay red and fresh looking). Consumers may consider wrap & foam packaging as the ideal and informative container for fresh and processed meat and poultry.

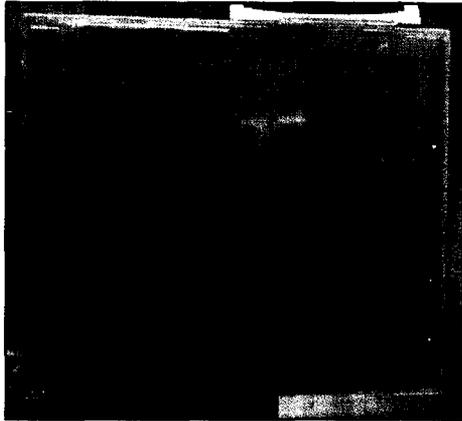
Rompa: not available

Rigid box



Concept: As a hard packaging, the protection effect of the rigid box is undoubtedly. A trait moulded packaging which is common for the precise products and easy breaking stuff such as toys for young children, discs and floppy discs, expensive stationery and gifts etc.

Technique: To use the injection molding technique, rigid box or other rigid packaging can get a desirable



shape as same as required.

Material: Using the transparent plastic materials like PP, PS or others, rigid box can be offered a high visibility which makes it a tempting purchase for the contents with a bright color or attractive shape.

Combination: Because the rigid boxes are entirely packaging for the special contents, they only need insert the necessary explanative carton paper and/or some seal stuff at the outside for conservation.

Face value: This transparent packaging can show all of the views of the contents (except enveloped by printing carton paper). A better solution to protect the contents and a longer using period are existed by the rigid box.

Rompa: producing

Transparent plastics bag



Concept: Plastic transparent bag is also a very simple and through sight packaging for most of cosmetic, food or domestic products.

Technique: The transparent plastic bays can be produced by the extrusion technique or other simple manufacture techniques.

Material: It is made like a bag by transparent films like LDPE.

Combination: Then the bag is sealed up by decorative tape, weld or vacuum fasten. The products, explanation or other stuff will be contained in it.

Face value: Customers will get impression through the clear packaging before they buy the product. Because of the plastic bag, the users can easy to bring the stuff and use them after purchase.

Rompa: not available

Flat bag



Concept: The simplest transparent plastic bag is the most well-liked pack in the market not only for the foodstuff but also for other daily consumption goods.

Technique: Take from roll transparent plastic sheet, these transparent flat bags are extruded and cut the desirable shape at the production lines. Graphics, company's logo or advertisements can be printed on the sheets before or after cutting and welding.

Material: Mostly the bag material can choose from PE, PVC, or other plastic sheets.

Combination: There is no more extra part to combine with the bag. Normally, the product producers will use the tapes, heat seal or stick to seal the packet.

Face value: Flat bag may be the earliest plastic packaging offered in the market. So it



may be the most familiar plastic packaging with the customers. It has not strong attractive impress, but it may the most popular and useful packaging nowadays.

Rompa: not available

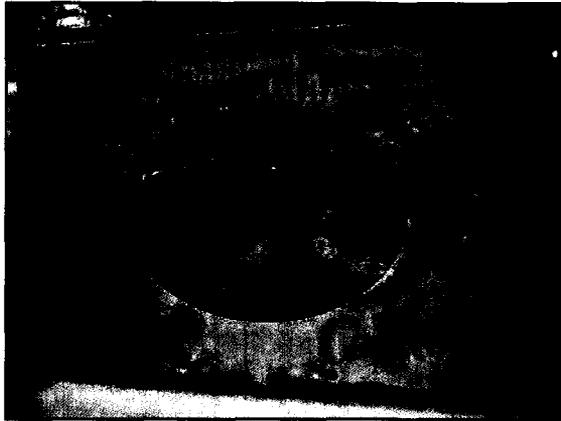
2.1.2 Carton & Plastic transparent packaging



Concept: Using the transparent cover let the customer beware the product and the printed carton box catches more attention on the product.

Technique: This conception is also a simple connection even it is consist with two different materials. The two parts are dividually manufactured by their own particular technique like the plastic cover can be fold or pasted and the carton box can be ink printed.

Material: A broad range of plastic material can be chosen for the covers depend on their individual requirements. And the carton boxes also have various choices of



materials according to the requirements of the content.

Combination: The plastic cover can circle, cover and paste with the carton box without any other complex connect method. This is a wonderful association

with two different materials for packaging.

Face value: To present a strong impression by the beautiful printing box and clear through sight by the plastic cover are the attraction of carton & plastic packaging. In the market this packaging form is still in vogue.

Rompa: not available

Cavity box



Concept: Cavity box is an ingenious concept especially for those expensive but smart products such as optical mouse.

Technique: Cavity box is consisted of two main areas: one is the printing carton box with large beautiful communication area another is the plastic transparent

product holder and cover. For this concept, the plastic part is also quite simple which can choose a simple thermoforming technique like 'straight vacuum forming'.

Material: The normal transparent plastic films such as PET, PP, or PS all can be the

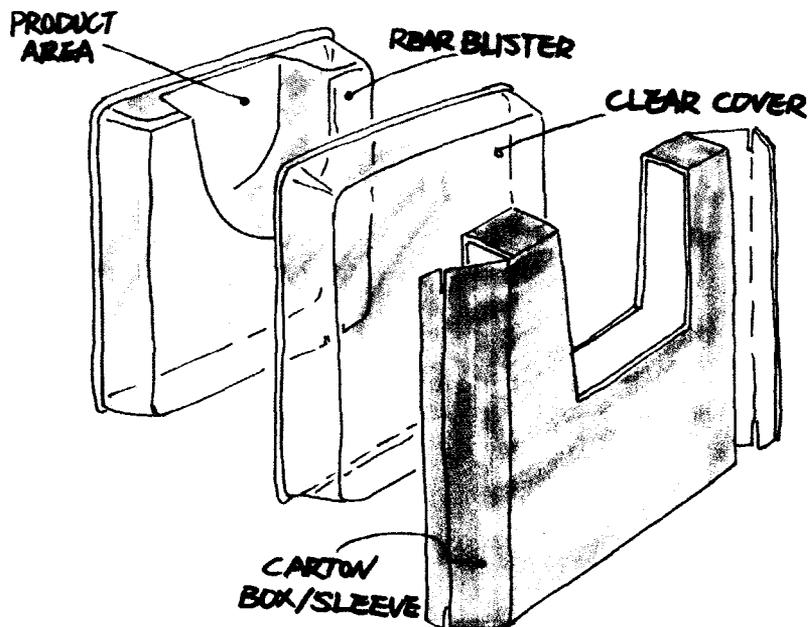


material of the product holder and cover.

Combination: At the assembling line, the contents are easily to put in the intermedia holder and then insert into the cavity box. The cavity box may be decorated without any other stuff like insert carton paper or plastic card, because they have the printing on their surface.

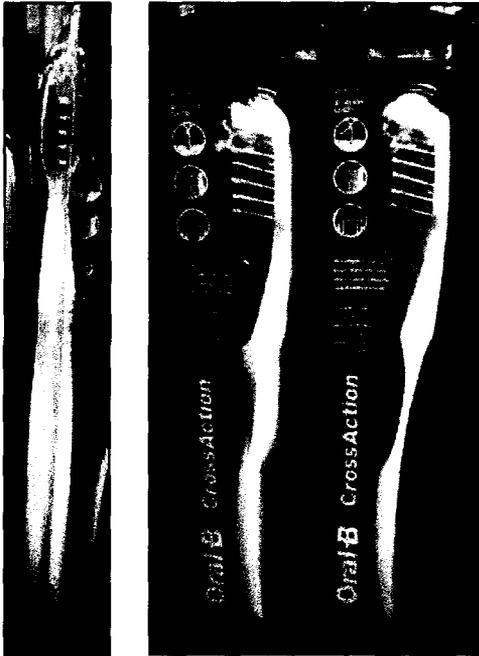
Face value: Customers can both see the product clearly through the transparent cover and get a good feeling for their money because of the large attractive printed carton box. The large printed box can also offer a good protection for the expensive contents.

Rompa: producing – plastic parts



Cavity Box

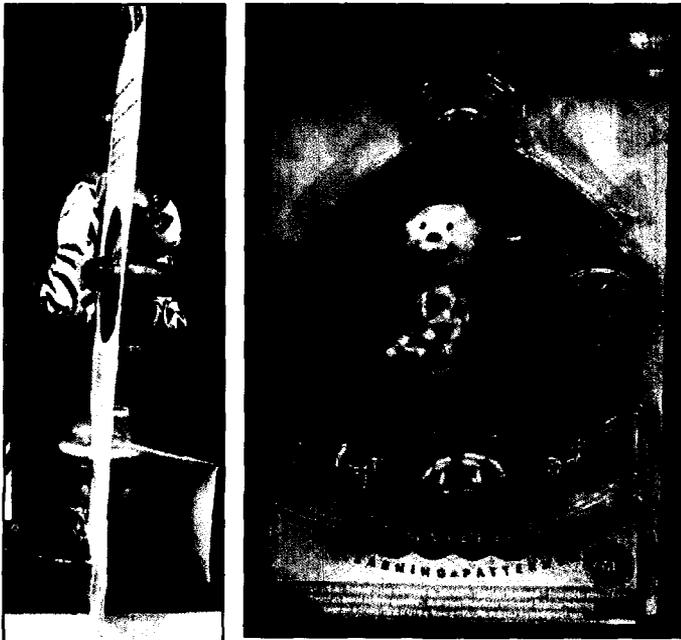
Double view blister



Concept: The double view blister is very popularly applying in the domestic products, electronic industry, toy stuff, and stationery etc.

Technique: The double view blister is fixed by the blister covers which are thermoformed according the outline of product, and the printed carton is sandwiched between the two transparent blisters by hot sealing. Using common thermoforming technique, the double view blister packaging will gain a low

cost, lightweight and well protection effect.



Side view

Front view

necessary introduction of the

contents and company's logo.

Face value: Customers have views from both front and rear side of the products what are they want to buy. Through this way, the customers can not only see the product without open the packaging but also get the information about the product from the carton insert directly. This special style can be supplied a high attention by the

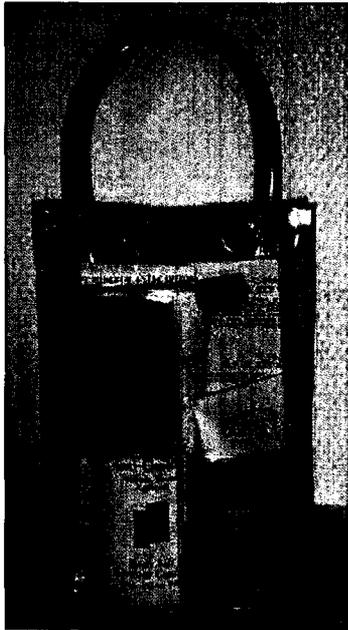
Material: The blisters themselves can be chosen the material from the normal transparent plastic films.

Combination: The double view blister is consisted of transparent blister container and printed carton paper which include the

customers, especially by the younger or children.

Rompa: producing

Transparent plastics handbag



Concept: This design makes a useful stuff for both the contents and the daily use after purchase. It is popular in the cosmetic industry, child products, food stuff and retailing.

Technique: For the handbag body, they can be manufactured by die-cutting from the plastic sheets. And then the die-cut films are welded together. Last step is welding or stick the handles.

Material: The handbag can choose PVC or PE sheet as their material. The plastic sheets can be printed before they are cut or weld.

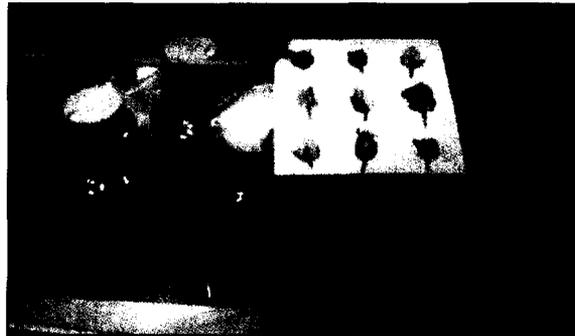
Combination: As a handbag and a packaging, transparent plastic handbag is quite simple and combines with almost nothing. The clients can require printing or weld some decorative stuff on and use zip or snap to seal.

Face value: high face value and practicability

Rompa: not available

2.1.3 Glass & Plastic transparent packaging

Concept: This is a mutual benefit two kinds of materials: glass box together.



packaging concept combination by transparent and plastic film

Technique: For the plastic boxes, the simplest manufacture process like folding technique is enough for them. And for the glass bottles, the blow technique or other casting technique is suitable for them.

Material: These two different materials endue with more advantages of this kind of pack, one is the outside plastic packaging which can protect the glass bottles avoid unexpected broken; the other is collected more products in one pack. The glass bottles and the plastic box are all making packs from the common materials and manufacturing techniques.

Combination: There may be without any other decorative stuff for the glass & plastic connection, because the customers can watch the contents from the outside and without any extra attachments. But it still can add some descriptive carton paper or plastic sheet if it is necessary.

Face value: Consumers can see the different goods which are contained in the glass bottles according to different color or materials. So users can get several tastes from the different products by one time shopping, meanwhile, retailers, supermarkets, and producers can sale more their goods.

Rompa: not available

2.2 Common manufacture processes and plastic materials

2.2.1 Main manufacture processes for transparent packaging

There are kinds of manufacturing processes and plastic materials for the transparent packaging manufacturing. Hereby, I will explain the main manufacture techniques and common plastic sheets mentioned above and applying at Rompa. Generally, the manufacturing processes like Vacuum Forming, Injection Molding, Extrusion, Folding, Die-cutting and Foam are applied in the plastic packaging industry. The following compare table shows these common manufacture processes with their different features on the production.

	Vacuum Forming	Injection Molding	Extrusion	Folding	Die-cutting	Foam
Part cost	moderate to high	low	low	low	low	low
Tooling cost	low	high	low	low	moderate to low	moderate to low
Production rate	moderate	high	high	high	high	high
products feature	large parts	intricate	uniform	simple	simple	simple
Suitable for polymers	limited	large variety	multiple	limited	large range	limited
Products shrinkage	stable	limited	limited	no	no	limited

As the widest processes applied in the transparent packaging production, the Vacuum Forming Process and Injection Molding Process will be presented which are major manufacturing technologies apply to the most of the plastic packaging manufacturers, include Rompa.

The Vacuum Forming Process

The typical process steps can be identified as clamping, heating with sheet level activated, pre-stretch, forming with plug assist, cooling with air and spray mist, release and trimming. They are examined more closely under the following sub headings;

1. Clamping

The clamp frame needs to be sufficiently powerful enough to ensure the plastic sheet is firmly held during the forming process. It should be able to handle the thickest material likely to be formed on the machine – up to 6mm with a single heater model and up to 10mm with the twin heater machines. If an automated process is used the operation of the moving parts must be guarded and interlocked to avoid accidental damage.

2. Heating

Heaters are generally infra-red elements mounted within an aluminium reflector plate. In order to obtain the best vacuum forming results, using any material, it is essential that the sheet is heated uniformly over its entire surface area and throughout its thickness. In order to achieve this it is necessary to have a series of zones which are controlled by energy regulators. Ceramics do have some disadvantage in that their high thermal mass makes them slow to warm up (approx 15 minutes) and slow in their response time when adjustments are made.

More sophisticated quartz heaters are available which have less thermal mass enabling more rapid response time. Pyrometers enable accurate heat temperature control by sensing the melting temperature of the sheet and interacting with the operating process control. Precise temperature readout is also available with a computer controlled system working in unison with the pyrometer(s). Twin heaters are also recommended when forming thicker materials as they assist in providing more uniform heat penetration and faster cycle times.

Twin quartz heaters are advisable when forming high temperature materials with critical forming temperatures. By close control of areas of heat intensity, heat losses around the edges caused by convection air currents and absorption from clamp areas can be fully compensated for and consistent results achieved on a continuous basis. Cost savings can also be considerable if Quartz heaters are specified as there is an adjustable percentage power drop when the heaters are in the rear position during the forming process.

3. Sheet Level

A photo-electric beam is incorporated in the machine to scan between the bottom heater and the sheet of plastic. If the sheet of plastic sags down and breaks the beam then a small amount of air is injected into the bottom chamber, thus lifting the sheet to stop it from sagging.

4. Pre-stretch (Bubble)

Once the plastic has reached it's forming temperature or "plastic" state it can be pre-stretched to ensure even wall thickness when the vacuum is applied. Pre-stretch is an invaluable feature when forming deep draw parts with minimum draft angles and high mould surface detail. The method of controlling the bubble height should be such that consistent results are obtainable.

5. Vacuum

Once the material is suitably pre-stretched a vacuum can be applied to assist in forming the sheet. With larger machines a vacuum reservoir is used in conjunction with a high volume capacity vacuum pump. This enables a two stage vacuum to be applied ensuring rapid molding of the heated sheet.

6. Plug Assist

Plug-assist forming is the term used to describe the use of a male plug tool, mounted on a pneumatic or hydraulic cylinder situated over the forming area of the machine, to force the material into a female cavity within the molding area. It enables complicated

and deep-draw moulds to be produced without webbing and with even thickness distribution. The idea behind the process is to feed as much material into the cavity prior to the vacuum being applied in order to avoid thinning in that area. Plug moulds are generally made from wood or metal and a smooth surface allows the sheet to slide whilst stretching into the mould. A felt or leather lining ensures that the risk of premature chilling on contact is greatly reduced. Resin plugs provide a good alternative as being good insulators they do not affect the temperature of the sheet.

Plug assist is also an essential feature when forming multiple impression male moulds as they can be placed very close together without the fear of the material webbing between the formed parts.

7. Cooling and Release

Once formed the plastic must be allowed to cool before being released. If released too soon then deformation of the molding will result in a reject part. To speed up the cooling cycle high speed fans are fitted and activated once the part is formed. A spray mist option is also available whereby nozzles are attached to the fans and a fine mist of chilled water is directed onto the sheet. This, in conjunction with the fans can speed up the cooling cycle by up to 30%.

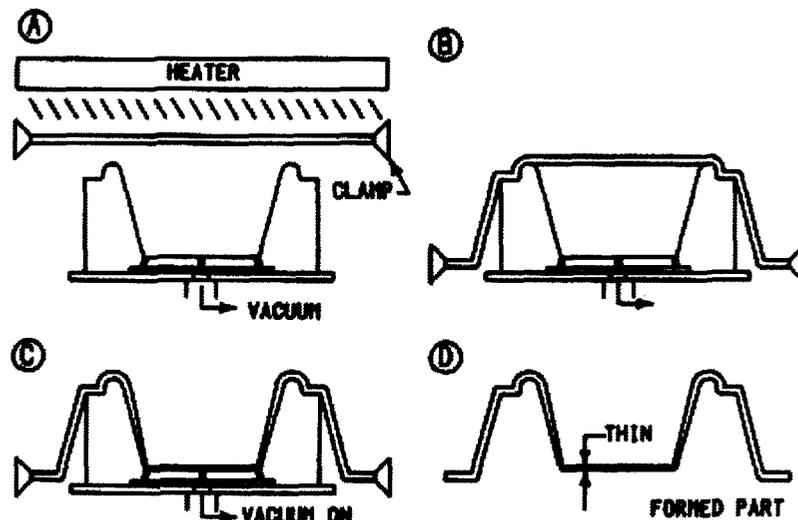
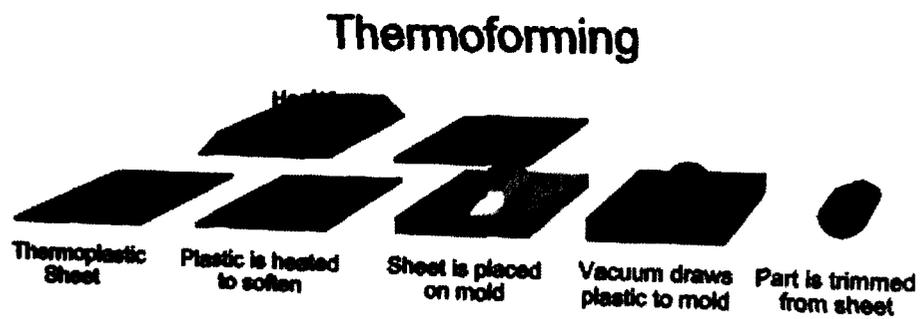
Mould temperature control units are also available which regulate the temperature within the mould ensuring accurate and consistent cooling times when cooling crystalline and crystallizing polymers such as PP, HDPE and PET.

8. Trimming and Finishing

Once the formed part has cooled and been removed from the machine the excess material is removed. Holes, slots and cut-outs are then drilled into the part. Other post-forming processes include decoration, printing, strengthening, reinforcing and assembly.

A variety of different trimming methods are used to trim the product from the sheet. The type of equipment best suited depends largely on the type of cut, size of the part,

draw ratio, thickness of material and the production quantity required. They are also factors to consider when determining the investment cost of such equipment. Thin gauge parts are normally trimmed on a mechanical trim press – otherwise known as a Rollerpress. Heavy gauge parts can be removed, placed into trim “jigs” or fixtures and trimmed with any of the following; Horizontal / Vertical Bandsaw, Hand Held Air Powered Router, CNC Routers - 3, 4 and 5 axis.



the most general vacuum thermoforming process

The Injection Molding Process

Injection molding is the process of forcing molten plastic into a mold cavity. Once the plastic has cooled, the part can be ejected. Injection molding is often used in mass production and prototyping. Injection molding is a relatively new way to manufacture parts. The first injection molding machines were built in the 1930's.

There are six major steps in the injection molding process:

1. Clamping

An injection molding machine consists of three basic parts; the mold plus the clamping and the injection units. The clamping unit is what holds the mold under pressure during the injection and cooling. Basically, it holds the two halves of the injection mold together.

2. Injection

During the injection phase, plastic material, usually in the form of the pellets, are located into a hopper on the top of the injection unit. The pellets feed into the cylinder where they are heated until they reach the molten form (think of how a hot glue gun works here). Within the heating cylinder there is a motorized screw that mixes the molten pellets and forces them to the end of the cylinder. Once enough material has accumulated in front of the screw, the injection process begins. The molten plastic is inserted into the mold through a sprue, while the pressure and speed are controlled by the screw. *Note: some injection molding machines use a ram instead of a screw.*

3. Dwelling

The dwelling phase consists of a pause in the injection process. The molten plastic has been injected into the mold and the pressure is applied to make sure all of the mold cavities are filled.

4. Cooling

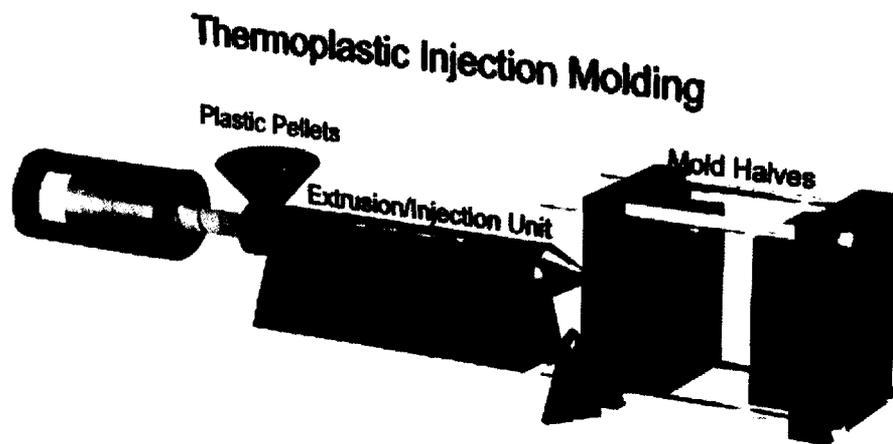
The plastic is allowed to cool to its solid form within the mold.

5. Mold opening

The clamping unit is opened, which separates the two halves of the mold.

6. Ejection

An ejecting rod and plate eject the finished piece from the mold. The un-used sprues and runners can be recycled for use again in future molds.



the illustration of Injection Molding

2.2.2 General plastic materials for transparent packaging

I will simply to introduce several thermoforming characteristics of common plastic materials which are using at Rompa or available on the markets. It is intended as a rough guide to thermoforming materials and not as a comprehensive listing of thermoplastic on the markets.

PET

(PolyethyleneTerephthalate)

General PET is tougher than other plastic polymers. This toughness is one the positive reasons for the growth of PET sheet applications. In particular PET sheet exhibits outstanding durable hinge properties making longer life packaging like PET clamshells for domestic appliances packaging. The PET properties that make it desirable include: clarity and sparkle, light weight, good cost/performance ratio, recyclable and regrindable. The most important point of PET sheet need almost the lowest thermoforming temperature (130 - 140°C), comparing with other thermoplastic sheets.

Applications Domestic appliance packaging, vacuum formed products, drinks bottles, smart cards

Vacuum Forming Good quality, high definition. Pre drying is never needed. The low thermoforming window of 130-140□ means that it vacuum form quickly.

PVC

(PolyVinylChloride)

General Extruded or laminated, PVC has good resistance to chemical and solvent attack, second only to polypropylene. Its vinyl content gives it good tensile strength and some grades are flexible (hence its suitability for the textile industry). Colored or clear material is available (the clear material has a blue tint, clearly visible at the edges of sheets).

Applications food packaging, medical goods and packaging, domestic appliance Packaging, smart cards, waterproof clothing, chemical tanks, ducting, footwear components, leathercloth, toys, adhesive tapes

Vacuum Forming Reasonable quality, fair definition – the heating properties of PVC are mainly elastic but, the elastic window is weak and more characteristic of the plastic state which makes vacuum forming possible, particularly on thinner sheets. Vacuum forming grades are available which have even weaker elastic windows than standard PVC.

PP

(PolyPropylene)

General Extremely chemically resistant and almost completely impervious to water, it has been extensively used for chemical containers and other tough, industrial applications. More recently it has been finding favor in the home as dishwasher proof utensils, dishes and

children's outdoor toys, and the office as brightly colored and tough stationary. Thermoforming range is mostly plastic and gets progressively weak with heat. White sheets will go clear as soon as they reach the plastic state.

Applications Domestic appliance packaging, dishwasher safe food containers, stationary, storage bins, battery boxes, toys, pipes, chemical tanks, disposable cups, cable insulation

Vacuum Forming Very good quality, exceptionally high definition. When using unpigmented, white sheet, vacuum form the sheet as soon as it goes clear. For pigmented sheets, observe the sag of the material as it heats up. Remember that avoid excessive sagging which can cause webbing on the final forming. Commercial vacuum formers have a magic eye that injects a slug of compressed air into the chamber underneath the sheet, to support it when the sagging becomes too pronounced.

PS **(PolyStyrene)**

General Probably the second most common thermoplastic in everyday use. High impact Polystyrene is a polystyrene and polybutadiene mixture that has much better impact resistance than normal polystyrene (and is more expensive). Poor resistance to UV light.

Applications Domestic appliance packaging, toys, computer and office equipment housings, packaging trays, low cost injection molding, food packaging, radio buttons, display bases

**Vacuum
Forming**

Good quality, high definition – one of the easiest, fastest (due to low thermoforming temperature) and most for giving vacuum forming materials. The protective film can be felt on during forming and trimming, protecting the surface quality.

2.3 New material introduction

2.3.1 Several new materials introduce to Rompa for through sight plastic packaging

To offer better services for the customer, packaging manufacturers are focusing on researching lighter and lighter materials, which must be resistant and handling-proof [Praxair]. It is a trend to use the new material which can not only reduce the packaging materials consumption but also decrease the impact of the environment. It is the first and most important step to select a proper material for the transparent packaging during the product design and manufacturing process. Based on those using materials, the material suppliers are making variety of innovations and tests for the new requirements of the plastic films from the market. Lighter weight, attractive appearance, cheaper in price, less environmental pollution and use less produce more are all considered by the packaging makers and the packaging clients. In Rompa, in order to satisfy with clients' necessities of the next generation transparent packaging, I try to find some new materials which can suitable for the ceaseless requirements. Here picked several the latest samples from the materials' suppliers:

SpectraFX films

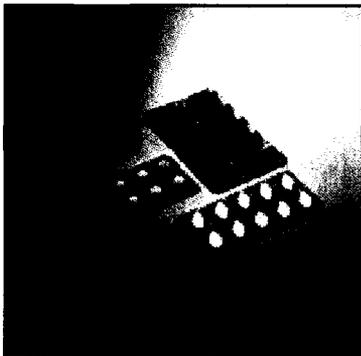
SpectraFX films are fully thermoformable. The uniqueness about them is the fact they are coated with a chameleon additive that literally changes colors as you move it or view it from different angles. These films are constructed with the same high quality pigments found in today's automotive



coatings.

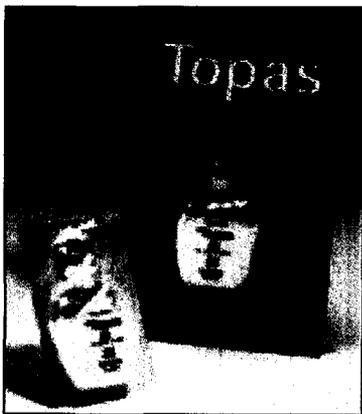
The most versatile of these films is constructed with a Clear Lexan / SpectraFX / Clear Lexan. The beauty of this particular version is the ability to achieve unlimited color effects simply by changing the color of the backing whether it's I.M.D. (resin color) or simply backcoating. [Alsa Corp]

Cyclic Olefin Copolymers (COC)



High strength and stiffness, excellent transparency and very high moisture barrier make cyclic olefin polymers and copolymers distinctive among olefin plastics.

Unlike polyethylene and polypropylene, these polymers are completely amorphous, resulting in parts with low shrinkage and warpage.



Cyclic olefin copolymers (COC) are copolymers of ethylene and a ring-structured olefin, typically derived from dicyclopentadiene. The incorporated ring structure gives COCs their stiffness, while its size prevents the molecules from becoming ordered enough to crystallize.

The total absence of crystallinity ensures very high transparency. Because the copolymers are olefinic, they have low densities, close to 1.0, resulting in a very high

stiffness-to-weight ratio. By adjusting the ratio of the comonomers, COCs can be produced with a wide range of heat deflection temperatures.

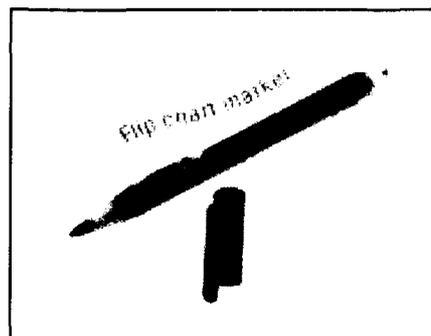
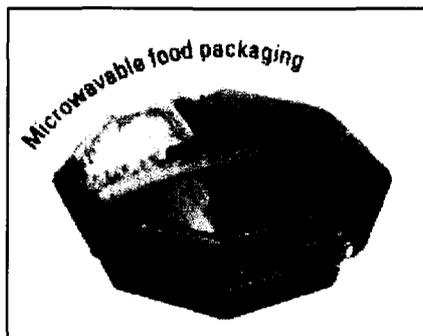
The combination of clarity, stiffness and moisture barrier has led to the use of COCs in packaging films, while the combination of clarity, moisture barrier and olefinic bio-

inertness makes them excellent candidates for medical packaging of such degradable drugs as heparin and insulin.

Dimensional stability is another valuable attribute of these resins. A small change in dimensions can adversely affect performance on precision optical parts. The negligible post-molding shrinkage of COCs combined with their very low moisture absorption enable production of highly stable plastic optics capable of temperature exposures that would deform other precision optic plastics. [Ticona]

NORYL® MODIFIED PPO® RESIN

NORYL® resin is a modified PPE/PS blend that offers eco-friendly, market-tailored performance, optimized processing and enhanced productivity in applications ranging from computers and business equipment to electrical/electronic appliances to telecommunications. There's a broad choice of injection-moldable, extrudable and foamable grades, plus automotive-specific grades and special high modulus grades able to replace stamped steel and die-cast metal in tight tolerance, functional assemblies. Its halogen-free flame retardancy characteristics make it particularly suitable for use in public building applications. [GE plastic]



As a part of the Design Core of the Market, and an important element of transparent plastic packaging production, choosing a suitable material for a particular product is invariably left to the design team [Pugh, 1990, pp52]. These new materials mentioned above are all invented for those people who want their products with an attractive appearance for the customers. Not only thinking about the properties of the materials, government policies and environmental implication, but need considering with the cost of material and the manufacturing possibility at the company. According to the production capacity at Rompa nowadays, the necessary from the clients, the high price of the new material and the limit equipment for the material experiment, these new materials may be apply to the new packaging in the future at Rompa. For example of the SpectraFX films, it has a beautiful coating. But it wills impact the transparency of the through sight packaging, so it is just suit with these products which want a beautiful appearance and not a transparent packaging. Even these new materials cannot apply to the packaging manufacturing nowadays at Rompa, but a brief relationship of these transparent plastic packaging mentioned above, production processes and plastic materials will be showed in the following part.

2.4 Relationship of the transparent plastic packaging, manufacture processes and plastic materials

According to these transparent plastic packaging which presented above, I will make a brief relationship among the common transparent plastic packaging, plastic materials and manufacturing techniques.

	Vacuum Forming	Injection Molding	Extrusion	Folding	Die-cutting	Foam
PET (Polyethylene terephthalate)	Clamshell # Double View Clamshell # Tri-fold # Contoured Blister # In-put Clamshell # Double View Blister # Cavity Box # Drum			Carton & Plastic Packaging * Glass & Plastic Packaging * Window Box Box Hanging Packs		
LD-PE HD-PE (Polyethylene)			Transparent Plastics Bag Flat bag		Transparent Plastics Handbag	
PVC (Polyvinyl chloride)	Clamshell # Double View Clamshell # Tri-fold # Contoured Blister # In-put Clamshell #		Transparent Plastics Bag Flat bag	Hanging Packs	Transparent Plastics Handbag	

	Double View Blister # Cavity Box # Drum					
PP (Polypropylene)	Clamshell # Double View Clamshell # Tri-fold # Contoured Blister # In-put Clamshell # Double View Blister # Cavity Box # Drum	Rigid Box #		Carton & Plastic Packaging * Glass & Plastic Packaging * Window Box Box Hanging Packs		
PS (Polystyrene)	Clamshell # Double View Clamshell # Tri-fold # Contoured Blister # In-put Clamshell # Double View Blister # Cavity Box # Drum	Rigid Box #		Carton & Plastic Packaging * Glass & Plastic Packaging * Window Box Box Hanging Packs		Wrap & Foam Packaging
SpectraFX		Rigid Box ##				
COC	Clamshell, Blister ##					
NORYL	Clamshell, Blister ##					

* --- only the plastic parts

--- only the plastic parts manufactured at Rompa

--- may to use these new materials to manufacture new products at Rompa

From this table, various of transparent plastic packaging such as Clamshell, Double View Clamshell, Tri-fold, Contoured Blister, In-put Clamshell, Double View Blister and Cavity Box are manufactured at Rompa which are combined with appropriate manufacturing process and thermoplastic material. Because the time of my internship and the company's reasons, the new materials could not test or apply to the products manufacture. But these new materials like SpectraFX, COC and NORYL will be consider applying to the new plastic packaging production at Rompa. Depend on the different requires from the clients and the products, packaging company can choose suitable production method and material for those specializations.

3. Conclusions

According to the Product Design Specification (PDS) [Pugh, 1990, pp44-66] which is a document created during the problem definition activity very early in the product realization process. The PDS lays the ground work for all engineering design activities and insures that all relevant factors are accounted for and all stakeholders are heard from. It includes market issues, product design & performance issues, organization capability issues and social & political issues etc. My thesis started from researching the existing through sight packaging which can produced by Rompa or other competitors in the market. Through the research I got the first hand specifications from those different kinds of transparent plastic packaging. From these products mentioned above, plastic packaging is identified with more acceptances with their beautiful appearance, lower price, less environmental pollution, more flexibility to cooperate with other materials, more varieties of choices and more flexibility to shape. These particular properties make the plastic packaging become the most variety and the fastest growing packaging among the packaging family. Along with rapid development of plastic packaging, is the demand changing with each passing day from both the customers and product manufacturers. From gradually reducing the weight of the transparent packaging to special material for the packaging, from integrating with other intermedia to colorful printing on it and from single protective function packaging to multifunctional pack such as to add the anti-theft insert, transparent packaging are entering a rigorous competition period while the packaging suppliers are facing new both opportunities and challenges. Wherefore, to gain the trends of the new products in the market and to make some research on the new techniques such as new materials are essential tasks for the transparent packaging suppliers like Rompa. At the Design Core of Market in this thesis, some more economy and attractive products are presented such as the Window Box with the printing. Even the folding boxes are not producing in Rompa nowadays, but it may apply the integrative printing technique to the thermoforming packaging. If this application wills success, it can reduce not only the production time but also the cost. From the new material research part, I was regret that these new plastic materials can

not be applied to the real production at Rompa. But I hope they will be had some chances to use in the near future.

During this final thesis period, I have not only consolidated and improved my knowledge learned from classes, but also built up and corrected my personality more positive. I did not just complete my thesis, but it was a challenge during my lifetime. It should be a worthwhile time for me and my future.

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