UK Market Review of Moulded Paper Pulp

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Executive summary

As part of its objectives to encourage the increased use of recovered paper within the UK market, WRAP has commissioned PendlePace Ltd to carry out “A UK Market Review of Moulded Pulp Products”.

The objectives of the three phase market study have been to carry out a comprehensive analysis, identifying the current and potential markets for moulded pulp products, the opportunities to increase utilisation of recovered fibre and to identify the best available technology for the manufacture of moulded pulp products.

Market analysis and interviews indicate UK consumption of moulded pulp products to be between 45,000 and 55,000 tonnes (£53.3 million) with imports of 15,000 tonnes and exports of 7,000 tonnes. UK production has been estimated at between 35,000 tonnes and 45,000. Imports into the UK, predominantly come from Denmark, France and Germany, and mainly comprise packaging for eggs, fruit, vegetables and a variety of protective packaging applications. The main export markets from the UK are Sweden, Ireland, Norway and Germany.

A review of competing materials indicates a total market potential of approximately 130,000 tonnes (£124.5 million) of MPP equivalent volume based on todays technological capabilities. The greatest majority of this volume of competing materials is currently utilised in the white goods and industrial/protective packaging sectors.

The UK has one of the highest per capita moulded pulp consumption levels within Europe at 0.91Kg/capita. Compared with the US at 1.38Kg/capita, the UK lags behind. In context if the UK had the same per capita consumption as the US then the annual consumption would be 83,000Tpa.

The UK MPP industry has seen significant changes during the last three years. SCA and Omni-Pac have closed their UK plants, and new companies have entered the market, including Moulded Paper International. Cullen Packaging has also ceased production for a twelve-month period, following a fire and will start their new plant during mid-2005. The leading UK players are Huhtamaki Lurgan (egg packaging) and Vernacare (medical applications), both of whom have EBITDA margins of about 15%. The major exporters to the UK are Hartmann, Huhtamaki, CDL and Omni-Pac.

UK sector segmentation and analysis have been given for all key areas; the four biggest being egg packaging (28,000Tpa), medical applications (8,000Tpa), industrial uses (8,600Tpa) and food/fruit packaging (4,200Tpa). The main channel to market, for both UK MPP manufacturers and imported moulded pulp products, is direct to end-users and packers, with small volumes going via specialist or geographical distributors/agents.

The highest growth rate (6-10%pa) is forecast in the white goods and industrial sectors, however, an overall market sector growth of 2%pa is projected, increasing total UK MPP consumption, over the next 5 year period, to 60,000 tonnes. Growth in new markets and products will be highly dependent on MPP manufacturers activities within these markets, their ability to displace alternative materials, and the development of new technologically advanced, cost efficient and flexible manufacturing equipment.

Pre-consumer recovered (unprinted and printed news) and post-consumer (mixed recovered paper) are the major fibrous raw materials utilised in MPP production. Other grades used are pre-consumer new KLS and virgin fibre, albeit at lower volumes. Waste preparation plants at UK MPP manufacturers are basic, and there appears to be limited knowledge of sophisticated post-consumer fibre cleaning/strength development techniques, potentially offering a significant opportunity to reduce costs. The main competitive alternative materials to moulded pulp are expanded polystyrene (EPS), plastic and corrugated die-cut inners. In terms of price, time-to-market, aesthetics and physical strength characteristics, EPS has a slight edge over other materials, although its poor environmental credentials make it vulnerable to attack. This provides major replacement/alternative opportunities to moulded pulp products.

MPP manufacturing in the UK is dominated by the higher speed rotary forming process (egg packaging and medical products), with the smaller producers opting for the slower reciprocating process and tunnel drying, due to its greater flexibility in servicing their markets. This strategy will direct future marketing activities towards the niche and industrial markets and away from sectors requiring very smooth and aesthetically superior characteristics, although increased utilisation of after-pressing techniques will mitigate this situation to some extent. The thermoforming process, which, produces products with a very smooth surface and without shrinkage, such as mobile telephone inserts, is absent from the future UK MPP manufacturing landscape, reflecting its slow production output rate, and higher mould costs.

Energy used, primarily in drying, represents the single largest cost of production at 30 to 40% followed by labour at 25% to 35%. Raw material cost is a relatively modest proportion of production cost at approximately 5-6%, but does represent a potential cost reduction opportunity by sourcing cheaper paper grades.

Average selling prices range from approximately £800/t for egg packaging, £1000/t for Horticulture and industrial packaging type products through to £1350/t for thin wall products such as paper plates. In all areas, other than egg packaging, moulded pulp is a minor competitor with the pricing level dictated by other materials.

Conclusions from the interviews indicate a number of key issues; of which four are regarded as the most important for the short to medium term development and evolution of the UK MPP industry.
These four key issues are:

- The formation of a UK (or European) moulded pulp trade association to promote market/product development and provide technical resource for the MPP industry
- The implementation of successful case studies to demonstrate the benefits of MPP, and to raise product awareness across the packaging market
- The transition to a post-consumer recovered-fibre based industry
- The achievement of significant energy efficiency improvements and improved wet-pressing techniques

The MPP industry is expected to come under further cost pressure, due to the competition from other materials and imports, including from the Far East. MPP is currently regarded as a low-tech material with limited technical specifications, and with purchase price being the ultimate driver.

The pressure driving increased awareness of sustainability and resource efficiency will only increase in the future, and therefore the inherent environmental strength of moulded pulp should provide a significant advantage, particularly over plastic packaging. The challenge for the industry is tackle the technological weakness of product design, the energy inefficient de-watering, and market perception of moulded pulp. These issues must be addressed, if higher growth rates than those indicated are to be achieved. Should solutions be found, then the opportunities to increase market share within existing sectors together with the potential to break into new sectors, are considerable.

Finally, sincere thanks are extended to the many people interviewed during the compilation of the report. The contributions range from companies involved in moulded pulp manufacture around the world to equipment manufacturers, end users and other organizations. Company names are listed in section 12.1 and section 12.2.
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## Abbreviations

### A
- **a** annum; year
- **AG** Aktiengesellschaft (similar to Plc)
- **A/S** Aktie Selskab (Shareholding Company, similar to Ltd and Plc)
- **ASTM** American Society for Testing and Materials

### B
- **BCT** box crush test
- **BHKP** bleached hardwood kraft pulp
- **BSKP** bleached softwood kraft pulp

### C
- **°C** degrees Celsius
- **CAD** computer aided design
- **CAM** computer aided manufacture
- **CCM** corrugated case manufacturer
- **CDL** Celluloses de la Loire
- **cm** centimetre
- **CNC** computer numerically controlled
- **CO₂** carbon dioxide
- **COMTRADE** United Nations’ trade database
- **CPO** computer print-out
- **CTMP** chemi thermo mechanical pulp

### D
- **d** day, 24 h
- **DIN** Deutsches Institut für Normung
- **DIY** Do-It-Yourself
- **DVD** digital versatile disk

### E
- **EBIT** earnings before interest and taxes
- **EBITDA** earnings before interest, taxes, depreciation and amortisation
- **e.g.** exempli gratia (for example)
- **EPE** expanded polyethylene
- **EPP** expanded polypropylene
- **EPPSI** Evergreen Pulp and Packaging Systems Inc.
- **EPS** expanded polystyrene
- **EU** European Union
- **EUR** Euro, currency unit within the European Union

### F
- **°F** degrees Fahrenheit
- **FAO** Food and Agriculture Organization of the United Nations

### G
- **g** gram
- **g/m²** grams per square metre
- **G** gravitational force
- **GDP** gross domestic product
**H**
- hour
- Hz: hertz; cycles per second

**I**
- i.e.: id est (in other words)
- IMPEPA: International Molded Pulp Environmental Packaging Association
- Inc.: incorporated
- ISO: International Organization for Standardization
- ISTA: The International Safe Transit Association

**K**
- KFC: Kentucky Fried Chicken
- kg: kilogram
- KLS: kraft lined strawboard
- kPa: kilo Pascal
- kW: kilowatt; unit for (electric) power
- kWh: kilowatt-hour; unit for (electric) energy; 1 kWh = 3600 kJ = 3.6 MJ

**L**
- LLC: limited liability company
- Ltd: Limited

**M**
- m: metre
- mm: millimetre
- min: minute
- m²: square metre
- m³: cubic metre
- M&S: Marks & Spencer
- MP3: MPEG (Moving Picture Experts Group) 1 audio layer 3
- MPP: moulded pulp products
- MPPMAC: Moulded Pulp Packaging and Machinery Association of China

**N**
- n.a.: not available or not applicable
- n.m.: not meaningful
- no: number
- N.B.: Nota Bene (note well)
- NHS: National Health Service

**O**
- OCC: old corrugated containers
- OEM: original equipment manufacturers (also should be changed on 15.7.1 section)
- OMG: old magazines
- ONP: old newspapers
- OPP: oriented polypropylene
- OWP: office waste paper

**P**
- £: Pound sterling
- p.a.: per annum; per year
- PASA: National Health Service Purchasing and Supply Agency
- PE: polyethylene
- PET: poly(ethylene terephthalate)
- PLA: poly lactic acid
- plc: public limited company
1 Introduction

As part of the WRAP programme objective to encourage the use of increased amounts of recovered paper in alternative applications, it has been highlighted that the United Kingdom may lag behind other countries in the use of moulded pulp packaging based on recycled fibre.

In order to assess this situation, a study has been undertaken of the Moulded Pulp Products sector within the UK, European and international markets. The study has involved the compilation of statistics, information, interviews and benchmarking details of manufacturers of moulded pulp products, machinery manufacturers, suppliers and end-users.

2 Objectives

The objective of the study was to carry out a comprehensive analysis of the UK market for moulded pulp products, and to deliver a practical and useable report, which will give a clear understanding of:

- The current market for moulded pulp products
- The potential market for moulded pulp products
- The opportunities for influencing increased utilisation of recovered fibre within the moulded pulp sector
- The best available technology

3 Definition of moulded pulp products

Moulded pulp products have traditionally (and predominantly) been manufactured from recycled fibre, normally containing high percentages of pre-consumer newsprint. The recycled fibre is pulped in conventional papermaking equipment, cleaned and then diluted prior to passing to the wet end of the mould-forming machine.

Selected concentrations of fibre, with additives, are formed on a mould or die that uses a screened surface, which extracts (by vacuum) the water from the fibre to form the desired geometric shape. After the shape has been formed, and whilst still containing a very high percentage of water, it passes to the drying stage where the water is removed. This occurs in an oven, hot press or in the mould, and results in the dried shape and surface finish of the moulded pulp product.

Moulded pulp products can be used in numerous applications, historically served by cardboard, wood, polystyrene foam and other plastic products. Among these are egg boxes and trays, fruit trays, carry out trays for fast food, flower pots, packaging products for electronic equipment and other electronic and industrial applications.

3.1 Definitions of moulded pulp products according to IMPEPA

IMPEPA (International Molded Pulp Environmental Packaging Association) has segmented the different types of moulded pulp products into four categories, in order to assist manufacturers, end-users and others identify which type of moulded pulp product is suitable for their requirements and specifications.

The four types of moulded pulp products defined by IMPEPA are as follows:

- Type 1: Thick-wall
- Type 2: Transfer molded
- Type 3: Thermoformed products
- Type 4: Processed products

3.1.1 Type 1: Thick-wall products

Thick wall products are used primarily for support packaging applications where the wall thickness varies from 3/16 inch (4.7 mm) to ½ inch (12.7 mm). Typical applications are edge and corner protectors, heavy item packaging, engineering spare parts, pallets, etc.

Normally one surface of thick-wall products is very rough, and the opposite side is moderately smooth. The moulded pulp product performance characteristics are classed as moderate due to the employment of relatively inexpensive single-pass moulds and the use of a fibre furnish mix comprising mixed recovered paper and kraft containing papers.
Typical wet-end mould forming methods producing thick wall products include reciprocating, dip/duck and swing-movement types.

### 3.1.2 Type 2: Transfer molded

Transfer moulded products are the most commonly produced moulded pulp products and are usually thin-walled, with a wall thickness varying from 1/16 inch (1.6 mm) to 3/16 inch (4.7 mm).

The forming process utilises forming and take-off/transfer moulds and produces a moulded pulp product, which typically has a relatively smooth surface on one side, and a fairly smooth surface on the opposite side with good accuracy and definition.

Fibre furnish normally comprises a mix containing a very high percentage of recovered newsprint, or in many cases 100% recovered newsprint. Typical uses are for protective and cushion packaging for electronic equipment, mobile phones, and other household and hardware items.

High capacity rotary forming machines are used to produce egg packaging (trays and cartons), fast-food take-away drink holders, fruit trays, etc.

### 3.1.3 Type 3 Thermoformed Products

Thermoformed products are the highest quality of moulded pulp items available, and are of a thin-walled nature. The process involves forming and drying the fibrous item in a single or small series (2-3) of drying moulds, and produces a product which is smooth, has good strength characteristics and which is well formed with accurate dimensions.

Typical applications for thermoformed products are point of sale protective packaging, where excellent aesthetics and accurate shapes are specified.

### 3.1.4 Type 4 Processed Products

Processed moulded pulp products comprise a category of products which have been treated in an additional/secondary process, after manufacture by any of the traditional forming methods.

Such additional processes include after-pressing, coating, printing, laminating, die-cutting, etc.

Typical applications for such products are where barrier treatments are required or in products designed to comply with a customer’s individual specification.

## 4 PendlePace Ltd

The study has been researched and compiled by Andrew Rothwell of PendlePace Ltd (tel: +44 1200 445 928 and PendlePace@aol.com), Caroline Nilsson of Foritec AB and Yong Gang Kang of Brunel University.
5 Outline of the three phases

The key deliverables of the three distinct phases of the market study were as follows:

5.1 Phase 1

Identification of the current market in the UK for moulded pulp products and sector applications, which include:

- Tonnage manufactured in the UK:
  - Ambient dried products
  - Mould dried products

- Utilisation of fibrous raw materials:
  - recycled (OCC/mixed/news, etc.)
  - virgin (hardwood/softwood)
  - tonnes
  - grades

- Sector applications:
  - electrical
  - industrial
  - perishables
  - gardening applications
  - medical
  - healthcare products
  - food packaging
  - catering applications
  - others

- Exports and imports:
  - country
  - tonnages
  - product type
  - sector application

- Current UK production by value and tonnes of moulded pulp products
- Current UK consumption by value and tonnes of moulded pulp products

5.2 Phase 2

Identification of new markets and sectors for growth, which will be forecast over years 1 to 3, with indicative statistics for years 5 and 10.

- Potential for future growth:
  - existing markets
  - new markets
  - new products
  - projected growth volumes/percentages
  - projected value growth

- Action plans:
  - new markets
  - existing markets
  - new products

- Benchmarking:
  - North America
  - Europe
  - China
  - Asia
- Fibre suitability analysis:
  - segmentation by product
  - segmentation by sector
  - technical performance vs. different fibre structures
- Substitution options:
  - product
  - sector
  - environmental replacement
  - cost drivers

### 5.3 Phase 3

A detailed analysis of the best available technology for the manufacture of moulded pulp products:

- Equipment availability:
  - UK
  - outside UK (Europe/USA/Canada/Asia/China)
  - ambient dried products
  - mould dried products

- Equipment specifications:
  - price
  - performance
  - manning levels
  - technical capability
  - optimum run lengths
  - die changing times
  - future developments/trends
6 Scope development

The scope of the study has been broadened, in order to deliver an enhanced and clearer understanding of the UK market for moulded pulp, by inclusion of the following information:

### 6-1 Scope of work

<table>
<thead>
<tr>
<th>Market</th>
<th>Industry structure</th>
<th>Other key issues</th>
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</table>
| • Consumption:  
  - UK market  
  - benchmark non-UK countries | • MPP manufacturers:  
  - profitability  
  - competitiveness  
  - competitive advantages  
  - 5-year capacity changes  
  - technology benchmarks  
  - entry barriers | • Product evolution:  
  - mould drying techniques  
  - high consistency forming  
  - porous structures, etc. |
| • Drivers:  
  - market  
  - Product | • Sensitivity analysis of current manufacturers | • Substitution products:  
  - SWOT analysis  
  - other fibrous grades  
  - EPS  
  - plastics  
  - others  
  - price analysis/comparisons |
| • Prices and volumes | • Industry capacity:  
  - current maximum capacity  
  - production trends  
  - capacity utilisation | • Techniques:  
  - quality definitions  
  - functionality  
  - specific characteristics  
  - techniques/equipment  
  - aesthetics |
| • Channels to market  
  - direct  
  - converters  
  - agents/retailers | • Raw material suppliers  
  - fibre  
  - chemical, etc. | • Environmental impact assessment |
| • End-uses:  
  - demand  
  - growth trends  
  - industry structure/segmentation | • Impact of new entrant  
  - response from current producers  
  - prices  
  - volumes | • Biodegradability |
| • Buyers  
  - categories  
  - key markets | | • Threats and limitations |
| • Purchasing criteria:  
  - price  
  - service  
  - functionality/appearance  
  - environmental | | |
7 Production, consumption & trade

The starting point for estimating the production, consumption and trade of MPP in the UK has been to extract and distill data from a number of statistical databases within Europe and from the United Nations. The quality and availability of the data varies considerably from country to country, and was found to be incomplete, and has therefore progressively been refined during the study; as more information was received from the interviews and research.

7.1 Sources and quality of statistics

The production statistics were taken from SCB (Statistics Sweden). A large part of the statistics is missing from the production and consumption data. We have checked several other sources (e.g. UK National Statistics, Statistics Denmark, etc.) to obtain the missing information. However, most of the missing information cannot be obtained as it is considered confidential. The number of MPP producers in most Western European countries is very small (sometimes as low as one per country) and publishing production statistics would therefore be the same as divulging information on individual companies. For example, this is the case for Denmark, where Hartmann is the sole manufacturer of moulded pulp products.

Statistics are available for the UK, for all years in the selected time period. From 2001 onwards, the UK statistics for MPP were changed from showing both volume and value of the production, to only showing the value of the production. We have therefore estimated the volume produced, by using the same value per tonne documented for 2000. Our assumption is based on a continuous increase in the value per tonne up until 2000, where the imports and exports indicate a falling value per tonne but a steady or increasing volume. We believe the value decrease to mainly be a result of the fluctuating exchange rate.

Production statistics for individual Western European countries are estimated, and based on the trade statistics available for each country and estimated consumption volumes for the countries based on consumption per capita in other European countries and consumption in similar countries (size, production structure, MPP vs. plastics trend, etc.).

The consumption statistics are derived from the production and trade statistics, and are therefore apparent consumption numbers.

The trade statistics have been taken from the United Nations database COMTRADE.

The statistics for MPP are divided into two groups (codes):

- 48237010: moulded pulp for egg packaging
- 48237090: moulded pulp for other products

There are no statistics available for the first group, only for the higher code (482370) or for the second group. The code used at Statistics Sweden for European statistics is 21251457.

7.2 Production, consumption and trade of MPP in the UK

The MPP industry is a very small sector within the paper industry. Figure 7-1 illustrates the estimated consumption of MPP in the UK as a percentage of the total paper and board consumption in the UK in 2002. That year the share of MPP was just 0.3%.

The implication of the small size of the MPP industry is the high impact any change in production, consumption and trade will have on the industry. The closure or start-up of a plant may completely alter the production in a country, and, as a consequence, the trade pattern for this and other countries. It is very important to understand this situation as small sectors, such as the moulded pulp sector, can change characteristics and development very quickly compared to larger paper industry sectors.
7-1 MPP consumption as share of total paper and board consumption in the UK in 2002

The consumption (from statistical data) of MPP in the UK is estimated to be approximately 40,000 tonnes, which is smaller than the volume of 54,800, which has been estimated from the interviews. The statistical consumption shows a declining pattern - from about 44,500 tonnes in 1996 to a low of 37,600 in 1999. The 2001-2003 production and consumption numbers are estimated only, as there are no volume statistics for these years. However, the consumption has stabilised at an estimated level of 42,000 to 43,000 tonnes.

7-2 Production, trade and estimated consumption of MPP in the UK (tonnes) 1996-2003

The production of MPP in the UK has decreased during recent years, which is due to the closures of Omni-Pac’s and SCA’s plants in England and Wales, although we believe the production volumes in the UK will positively increase in the next few years; especially if the exchange rate continues to develop favourably.

The production estimate for 2003 has been based on information from producers, which indicates that the production capacity was about 36,100 tonnes. We have used a capacity utilisation rate of 90%, which equals a production estimate of 32,500 tonnes in 2003. Figure 7-3 shows the production, consumption and trade of MPP in the UK in million EUR. Statistical data is available for the whole period 1996-2002 in value. The production data for 2003 is not available at the time of this report.
7-3 Production, trade and consumption of MPP in the UK (million EUR) 1996-2003

Source: Statistics Sweden

N.B. Production statistics for 2003 not available

The decreasing trend for the UK MPP industry can also be seen in figure 7-4, where the production’s share of consumption fell from a level of 90% in 1996 to between 70% and 80% in 2001-2003.

7-4 Production as share of consumption in the UK 1996-2003

Source: Statistics Sweden

The UK is a net importer of MPP, with imports about twice as high as exports in 2003 (figure 7-5). Imports have increased by almost 50% over the past five years, and we estimate the imported share of the consumption to be 42% in 2003.

7-5 UK imports and exports of MPP 1996-2003

Source: COMTRADE
The imports have an increasing importance for the UK consumption of MPP, as can be seen in figure 7-6. The share of imports has increased from about a quarter of the consumption in 1996 to more than 40% in 2003.

**7-6 Imports as share of consumption in the UK 1996-2003**

Additionally, exports are becoming increasingly important for the UK manufacturers of MPP, and the share of exports of the production in the UK is estimated at about 26% in 2003 (figure 7-7). The reasons behind this development remain unclear, but normally such a pattern indicates a more niche-type production and trade development.

**7-7 Exports as share of production in the UK 1996-2003**

Most of the imports of MPP into the UK come from Denmark, as is also the pattern for most other Western European countries. Germany and France are also big exporters to the UK, and these three countries have dominated the imports throughout the whole time period.

*Source: COMTRADE, Statistics Sweden*
The export pattern has been more or less consistent over the whole period, with more than half the exports going to Sweden and Ireland. The volumes are small, however, and what can be seen as a large change in the statistics may be the result of a temporary (even single) change only. For example, Norway's share of the UK exports increased considerably between 2002 and 2003, but the change in volume was only 260 kilos. Less than 1% of the exports go to non-EU countries, and the majority of this trade goes to Eastern Europe (42 tonnes). A mere 18 tonnes is exported to North America.

The value per tonne gives an indication of the product composition of the produced, imported and exported products. Figure 7-10 shows the value per tonne in 1996-2003, where the value per tonne for the production (and hence partly for consumption) in 2001-2003 are estimates based on the estimated production volume for those years.

The value of the imported products has been considerably higher than for the domestic production and exported products, but the import and export values would appear to have become balanced in later years. Naturally, the exchange rate of the British pound plays an important part in this development.
7.3 Production, consumption and trade of MPP in Western Europe

The statistics available from official sources are far from complete, and this can be seen in figure 7-11 where the consumption statistics have been compared to the exports statistics for Western Europe in 1996-2003. As can be seen, the consumption in Western Europe is lower than the exports, which is not realistic considering the relatively local nature of MPP production.

7-11 Consumption and exports of MPP in Western Europe 1996-2003

The trade statistics are the best available statistics for this sector, and give the most accurate indication of production and consumption by country in Western Europe.

Total exports in Western Europe in 2003 were about 131,000 tonnes. Most of this trade is within Western Europe, as exports out of Europe (excluding Eastern Europe) are very small. Not surprisingly, Denmark is the largest exporter of MPP in Europe, with exports of 45,950 tonnes of MPP in 2003. Hartmann is Denmark’s only producer of MPP, and it is one of the largest MPP producers in the world. The exports typically mirror Western European industry structure very well, where France and Germany have a number of large production plants and Denmark and the Netherlands have only one plant each although they are of a relatively large size.

Imports were slightly higher than exports, at about 141,000 tonnes in 2003. The imports show a more traditional pattern for the paper industry, where the largest importers also are among the largest nations. It is clear that Italy and the Netherlands have a relatively high share, while France has a noticeably small share of the imports. The actual volumes are, however, small and it is therefore difficult to draw any clear conclusions from these statistics. The trade in Western Europe will be highly dependent on where the production units are located, as there are so few producers in total in the region. Additionally, the trade situation shows that some countries are large exporters as well as importers (e.g. Germany), and this can influence the amount of cross-border trade, where the production units are located close to a border or on the product categories made in each country.
The UK is a small exporter of MPP considering the country’s importance in Western Europe, although it has a significantly high share of imports. The exports from the UK (tonnes) are consistently stable, and the cyclical that can be seen is due to the changes in the exchange rate.

European trade with other regions, excluding Eastern Europe, is small. In 2003, Western Europe imported only 1,333 tonnes of MPP from the USA. The UK took 62% of those imports, i.e. 827 tonnes, which is a very small share of the UK consumption. The trade from Western Europe to the USA amounted to 2,090 tonnes in 2003, and 65% of the exports came from Denmark. Only 6.5% of the USA’s imports in 2003 came from Western Europe, and 6.2% of the exports from the USA went to Western Europe.

### Estimated consumption of MPP in Western Europe and the UK

The previous two chapters demonstrate the production, consumption and trade in the UK and Western Europe based on the statistics. However, as mentioned in chapter 7.1, the quality of the statistics vary significantly as some countries only have one or two MPP producers and do not give out detailed statistics. We have therefore made an estimate of the consumption of MPP in the UK and Western Europe based on information from the interviews and from other public sources.

We estimate the consumption of MPP in the UK to be 54,800 tonnes for 2004.

Our estimate for Western Europe is based on the assumption of an MPP per capita consumption of 0.7 kg and the population in Western Europe in 2004. That gives a consumption level of about 270,000 tonnes. We have verified this level by calculating the production of MPP in Western Europe, which we estimate to about 310,000 tonnes. This estimate is based on the production numbers (available and estimated) for European plants (see table 17-11), divided by the estimated number of plants in Western Europe. The average production per plant is then 10,296 tonnes, which gives a total Western European production of 308,870 tonnes on the assumption that the number of MPP plants in Western Europe is 30.

**Est. MPP consumption in Western Europe and the UK in 2004**

<table>
<thead>
<tr>
<th>Country</th>
<th>Consumption (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UK</td>
<td>54,800</td>
</tr>
<tr>
<td>Western Europe</td>
<td>270,470</td>
</tr>
</tbody>
</table>

N.B. WE consumption estimate based on 0.70 kg per capita of MPP and population. (Source: CIA).
The consumption of MPP is not expected to increase significantly over the next 5-10 years. There is potential growth in some segments, such as industrial protective packaging and mobile phone packaging inserts, although production is still dominated by egg packaging which is expected to grow in line with the population growth. The total growth rate for MPP will hence be relatively low, and we estimate the growth to 1-2% per annum. (See also chapter 10).

Figures 7-14 and 7-15 illustrate the consumption and consumption development by country in Western Europe. The consumption growth has been calculated against the population growth for each country. We have not made a growth development based on the GDP growth, as the GDP growth rates in Western Europe have varied widely during the last few years from very high rates to negative rates. The basis for the consumption is the population in each country and a per capita consumption of 0.7 kg.

The large countries are, as expected, also the largest consumers of MPP. Five countries (Germany, France, UK, Italy and Spain) account for more than 75% of the consumption. The population growth rates are very low in Western Europe, ranging from 0.02% per year for Germany to 1.28% for Luxembourg, and the change in share per country is so small over the time period that it is not significant for most countries.

Finally, we have tried to merge all this information into estimates for the consumption and production of MPP by country in Western Europe, which is shown in table 7-16.

### 7-16 Estimated consumption and production of MPP in Western Europe in 2002/03

<table>
<thead>
<tr>
<th>Country</th>
<th>Consumption</th>
<th>Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>3,695</td>
<td>0</td>
</tr>
<tr>
<td>Belgium</td>
<td>2,628</td>
<td>0</td>
</tr>
<tr>
<td>Denmark</td>
<td>4,163</td>
<td>42,000</td>
</tr>
<tr>
<td>Finland</td>
<td>4,315</td>
<td>3,443</td>
</tr>
<tr>
<td>France</td>
<td>54,229</td>
<td>54,000</td>
</tr>
<tr>
<td>Germany</td>
<td>52,061</td>
<td>39,000</td>
</tr>
<tr>
<td>Greece</td>
<td>7,775</td>
<td>9,000</td>
</tr>
<tr>
<td>Iceland</td>
<td>200</td>
<td>0</td>
</tr>
<tr>
<td>Ireland</td>
<td>2,179</td>
<td>800</td>
</tr>
<tr>
<td>Italy</td>
<td>41,683</td>
<td>28,599</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>97</td>
<td>0</td>
</tr>
<tr>
<td>Netherlands</td>
<td>13,493</td>
<td>40,000</td>
</tr>
<tr>
<td>Norway</td>
<td>3,000</td>
<td>8,000</td>
</tr>
<tr>
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<td>7,061</td>
<td>9,000</td>
</tr>
<tr>
<td>Spain</td>
<td>35,259</td>
<td>30,775</td>
</tr>
<tr>
<td>Sweden</td>
<td>4,920</td>
<td>1,000</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>54,800</td>
<td>34,500</td>
</tr>
<tr>
<td><strong>Total Western Europe</strong></td>
<td><strong>291,556</strong></td>
<td><strong>300,117</strong></td>
</tr>
</tbody>
</table>

Source: PendlePace estimates, Statistics Sweden, COMTRADE

Consumption = Production + Imports - Exports

---

The consumption of MPP is not expected to increase significantly over the next 5-10 years. There is potential growth in some segments, such as industrial protective packaging and mobile phone packaging inserts, although production is still dominated by egg packaging which is expected to grow in line with the population growth. The total growth rate for MPP will hence be relatively low, and we estimate the growth to 1-2% per annum. (See also chapter 10).

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<tr>
<td><strong>Total Western Europe</strong></td>
<td><strong>291,556</strong></td>
<td><strong>300,117</strong></td>
</tr>
</tbody>
</table>

Source: PendlePace estimates, Statistics Sweden, COMTRADE

Consumption = Production + Imports - Exports
7.5 Benchmarking summary of Western Europe and North America

We have calculated the MPP consumption per capita in the UK, selected Western European countries and North America based on the apparent consumption for each country and the population in 2004. As the consumption statistics in Western Europe vary considerably in reliability, the MPP consumption per capita levels should be seen as indicative only. They may vary for several reasons, e.g. due to different consumption patterns of materials (the share for MPP egg packaging is higher in Northern Europe than in Southern Europe where EPS and plastic egg packaging has a higher share) or due to the level of production in the country (the production of consumer goods is decreasing in Northern Europe, but increasing in Southern Europe).

As can be seen in table 7-17, the UK has one of the higher MPP per capita consumption levels in Western Europe with an estimate of 0.91 kg. The Western European levels vary between 0.38 kg and 0.91 kg, and the average is about 0.7 kg.

### 7-17 Estimated consumption per capita in selected Western European countries and North America

<table>
<thead>
<tr>
<th>Region/country</th>
<th>Estimated MPP consumption(^1) (tonnes)</th>
<th>Population (millions)(^2)</th>
<th>MPP (kg per capita)</th>
</tr>
</thead>
<tbody>
<tr>
<td>United Kingdom</td>
<td>54,800</td>
<td>60.3</td>
<td>0.91</td>
</tr>
<tr>
<td>France</td>
<td>54,561</td>
<td>60.4</td>
<td>0.90</td>
</tr>
<tr>
<td>Finland (2003)</td>
<td>3,772</td>
<td>5.2</td>
<td>0.72</td>
</tr>
<tr>
<td>Sweden (2002)</td>
<td>4,920</td>
<td>9.0</td>
<td>0.55</td>
</tr>
<tr>
<td>Belgium (2003)</td>
<td>3,933</td>
<td>10.3</td>
<td>0.38</td>
</tr>
<tr>
<td>Austria (2003)</td>
<td>4,190</td>
<td>8.2</td>
<td>0.51</td>
</tr>
<tr>
<td>Italy (2002)</td>
<td>41,683</td>
<td>58.1</td>
<td>0.72</td>
</tr>
<tr>
<td>Spain (2002)</td>
<td>35,259</td>
<td>40.3</td>
<td>0.88</td>
</tr>
<tr>
<td>North America</td>
<td>450,000</td>
<td>325.5</td>
<td>1.38</td>
</tr>
</tbody>
</table>

\(^1\) Source: Statistics Sweden and estimates by PendlePace  
\(^2\) Source: CIA

The UK has one of the highest apparent consumption per capita levels in Europe, but it is only 66% of that in North America. If the UK had the same per capita MPP consumption as North America, this would equate to an annual consumption of 83,174 tonnes, or an increase of 28,374 tonnes. Such an increase will be difficult for the UK production/consumption to achieve.

To increase consumption of recovered fibre by a similar quantum will require a new/very large MPP plant, with export capability in the egg tray/carton market. The world’s largest rotary machine (Emery) has a capacity of 24,000 tonnes.

We have not made benchmarking comparisons against China regarding production and consumption, because the MPP statistics in China are not reliable and because the consumption pattern for MPP in China is completely different to Western Europe and the UK.
8 Cost Structures of MPP Manufacturers

Examples of cost structures, obtained from both interviews and publicly available financial accounts are shown in the two tables below. Table 8-17 indicates the cost-base similarities between the UK, Europe and North America in terms of energy, labour and transport.

The key differences relate to China, which is importing much of its raw materials and energy: this being reflected in the higher ratios for these costs in relation to the other geographical sectors. Of major significance is the very low labour cost for China, which is less than 20% of those in Europe and North America, and also for transport costs, which reflect the close proximity of the MPP manufacturers in China, to their main local customers.

8-1 Cost structure ranges by region (% of total manufacturing cost)

<table>
<thead>
<tr>
<th></th>
<th>UK</th>
<th>Western Europe</th>
<th>USA</th>
<th>China</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable costs excl. energy</td>
<td>3-10%</td>
<td>5-10%</td>
<td>5-12%</td>
<td>15-20%</td>
</tr>
<tr>
<td>Energy</td>
<td>30-40%</td>
<td>30-40%</td>
<td>25-40%</td>
<td>40-55%</td>
</tr>
<tr>
<td>Labour</td>
<td>25-35%</td>
<td>25-35%</td>
<td>22-25%</td>
<td>5-7%</td>
</tr>
<tr>
<td>Transport</td>
<td>10%</td>
<td>8-13%</td>
<td>10%</td>
<td>5%</td>
</tr>
<tr>
<td>Margin (% of net sales)</td>
<td>12-30%</td>
<td>10-15%</td>
<td>10-15%</td>
<td>15-30%</td>
</tr>
</tbody>
</table>

N.B. Estimates by PendlePace
Manufacturing costs excludes sales, administration and general costs

The information, from both these sources, are similar and are indicative of the major costs, attributable to the manufacture of moulded pulp products. The percentages shown in figure 8-2 are taken from company annual reports, and should be seen as indicative only as they may vary depending annual changes, MPP qualities, raw material sourcing, country specific factors, etc.

8-2 Cost structures for selected European MPP producers 2002 and 2003

Analysing the cost structure of MPP products, there are a number of notable characteristics:

- Transport costs make up a large share of the total product cost, and this limits the geographical market area for each MPP plant/company. The large companies handle this by having production plants evenly spread around Europe, e.g. Hartmann (5) and Huhtamaki (6). Smaller companies have a competitive disadvantage because of their reliance on one plant only.

- The production process also has similar problems to the papermaking process (e.g. pressing and drying, etc.)

- MPP production is highly energy-consuming, because of drying the products (which contain very high amounts of water) in relatively inefficient drying tunnels. This area requires the industry to focus on major efficiency improvement. Some development has been undertaken, and new ideas are slowly evolving, e.g. drying in microwave ovens and high velocity/circulation tunnels.
The moulded pulp processes do not lend themselves to the efficient manufacture of coloured products, and this eliminates a potential niche market for the industry.

Labour costs are high in both Europe and the USA. Labour for packing moulded pulp products at the dry-end is excessive, and is a serious opportunity for automation.

The rotary and thermoforming processes are not compatible with the ability to make small production runs.

Although the majority of moulded pulp products are made from low-cost recovered fibre, the selling price for the product has historically not been competitive with other materials, apart from in the commodity egg packaging market.

The selling prices of competing materials are usually lower than that for equivalent alternative materials, and this is especially the case for clear plastics and EPS. A similar situation exists for die-cut corrugated structures, as corrugated board production is highly efficient and produced in very large volumes.

However, material cost situation has changed, to a large degree, during the last 12 month period, with major increases in the price of oil driving significant increases in the cost of downstream derivatives, e.g. styrene monomer. The volatility of the price of Brent crude oil, and in particular the recent increases can be seen in figure 14-5.

8-3 Price of oil 1988-2005

According to a number of interviewees, the selling price of MPP and competing materials, such as clear plastics and EPS, have moved to approximately the same level. This situation has occurred mainly in the North American market, and whilst similar prices in Europe (where there is greater EPS competition) are becoming nearer to reality, selling price parity has not yet been totally achieved.

Other interviewees consider EPS and clear plastics to be cheaper but more volatile due to the dependence on the oil price, which at times make them more expensive than MPP.
9 UK supply chain

The supply chain can be segmented into four main elements, which include the following:

- Raw material suppliers
- UK MPP producers
- Agents, distributors and merchants
- End-users

9.1 Supply chain of moulded pulp products

There are four UK manufacturers of moulded pulp in the UK, as follows:

- Huhtamaki (Lurgan) Ltd
- Vernacare Ltd
- Moulded Paper International Ltd
- Cullen Packaging Ltd

Import supplies of MPP to the UK are from a small number of European based manufacturers, although there are also small quantities entering the UK market from China.

The key companies exporting moulded pulp into the UK market are:

- Huhtamaki, Netherlands
- Huhtamaki, Germany
- Hartmann, Denmark
- Omni-Pac, Germany
- Celluloses de la Loire, France
- Societe Emballages de Moulee, France
- Cemosa, Spain
- Ciat, Spain

The main raw material for the four UK manufacturers, which is predominantly recovered fibre, is sourced through a number of channels, although waste paper merchants are the major suppliers. Smaller amounts of recovered fibre are purchased from local councils and waste management companies, with a number of the MPP manufacturers having pre-consumer waste purchasing arrangements with corrugated case manufacturers.

Other raw materials, which are in the main chemicals and a small amount of dyestuffs, are purchased from a variety of chemical companies, including a number of multinational players.

MPP manufacturers endeavour to sell and deliver their products direct to end-users (e.g. electronic manufacturers, fast-food companies, etc.), although in many cases they sell to intermediate companies, such as corrugated manufacturers, packaging merchants and packers.

There is very little overlap in the customers of the four UK MPP manufacturers, with most competition coming from non-UK manufacturers.

The large non-UK MPP manufacturers (e.g. Hartmann, Huhtamaki and Omni-Pac) sell their products through their own local sales offices, to both direct and in-direct customers. As with the UK MPP manufacturers they sell to end-users, such as fast-food companies, electronic manufacturers and egg packers. They also channel their sales via national packaging merchants for onward distribution to smaller end-users and packers.

There is limited evidence to suggest that non-UK MPP manufacturers sell their products to UK corrugated case manufacturers.
10  UK MPP Markets

10.1 Overview of Market Segmentation

Figure 10-1 exhibits the key segmented elements of the UK consumption of moulded pulp products.

At 28,000 tonnes the supply of MPP to the egg packing industry (trays and cartons) equates to 51% of the total UK consumption, and is predominantly serviced by four major companies (Huhtamaki, Omni-Pac, Hartmann and Celluloses de la Loire). Of the total tonnage consumed in this sector, approximately 40% is imported from other European countries.

Medical applications (urinals, kidney dishes, etc.) form a significant part of the consumption of moulded pulp in the UK market, equating to 8,000 tonnes or 14.5%. Consumption of moulded pulp within the food, fruit, vegetable and wine packing industry is estimated at 4,200 tonnes. This volume of product appears to be totally imported from outside the UK, with there being no UK MPP manufacturer supplying this sector.

Supply of moulded pulp packaging to the industrial sector is 5,500 tonnes, and is potentially the major area for future growth. The major portion (over 60%) of the consumption of MPP consumed in the industrial sector is imported into the UK from other European countries.

10-1 Segmentation of moulded pulp products production in the UK (2004)

![Diagram showing the segmentation of moulded pulp products production in the UK (2004)](image)

N.B. The total consumption figure is an estimate based on all the interviews. It is therefore different from the consumption figure found in the statistics.

10.2 Egg packaging

Egg packaging is the traditional market for MPP, and even today MPP is the most important material in this sector despite several attempts by producers of EPS, clear plastics and corrugated board to take market shares.

10.2.1 European market for egg packaging

The market for egg packaging in Europe is dominated by the three large MPP producers, whose operations continue to be dominated by egg packaging, despite efforts to differentiate:

- Hartmann, Denmark
- Omni-Pac, Germany (70% egg packaging)
- Huhtamaki, Netherlands (75% egg packaging)

Smaller producers have difficulties competing in the egg packaging sector because of the demands for commodity-scale production, and there are also indications that the big companies protect their markets to a high degree.
The European market for eggs is stable, and the trend is for a static or slow growth development in the usage of egg packaging. Imports of eggs from Eastern Europe are increasing, which will ultimately have an impact on egg packaging consumption due to the closure of egg packing plants in Western Europe.

The egg packaging market has suffered from high price pressure during the last few years, and there are indications that the price of MPP has decreased. This has forced MPP manufacturers to cut costs, which makes it even more difficult for smaller producers of MPP egg packaging. Normally, smaller MPP producers stay away from the egg packaging market for this reason.

10.2.2 Competing Materials in the European Market

Relatively little clear plastic, foam or corrugated board is used, and some MPP producers view the usage of other materials solely as a price lever by buyers. Both consumers and packers prefer MPP for egg packaging. Consumers like the environmentally friendly look/feel of the packaging, and MPP is also the material they are used to, for this kind of packaging. Egg packers consider plastic egg cartons as too light for egg packing machines (denesting problems), and EPS egg packaging as noisy in egg packing machines (employee health concerns).

The split between MPP and plastics/EPS is estimated at 60/40 for Europe and 50/50 for the USA. However, the split between MPP and plastics/EPS in Europe varies considerably, as Northern Europe use almost 100% MPP egg packaging, while more plastic and EPS packaging can be seen in Southern Europe because of their higher demands for bright colours. This has led MPP producers to include more virgin pulp and pre-consumer waste in the fibre furnish, in order to offer a whiter product and brighter colours in coloured egg packaging.

Competing materials and examples of manufacturers in each niche are:

- Foam cartons (polystyrene):
  - Linpac, UK
- Clear plastic cartons (polyethylene):
  - Ovotherm, Germany
  - Deltaform Ltd., UK
- EPS:
  - Linpac, UK (trays and cages)
- Corrugated board:
  - SCA, Germany

The Austrian company Ovotherm produces more than 300 million egg packs per year, and has a market share of more than 30% of clear egg packs. The market for clear egg packs is estimated at approximately 1 billion packs.

The MPP producers see an advantage for MPP over plastics/EPS in egg packaging because of good moisture absorbency and repellent properties at the same time. End-customers also prefer the tactility/organic feel of moulded pulp packaging, in comparison to plastic forms of packaging.

Additionally, the cost of moulded pulp egg packaging is competitive against both polystyrene and plastic packaging, due to the high efficiency and output volumes of production on rotary machines.
10.2.3 UK market for egg packaging

The consumption estimate for the UK egg MPP packaging market is estimated at 28,000 tonnes per annum, with about 25,000 tonnes of egg boxes and 3,000 tonnes of egg trays.

The UK egg consumption has been more volatile than the European consumption, as illustrated in figure 10-3. Egg consumption in the UK decreased in 1999/2000, but in 2003 was at a higher level than over the past ten years. Eggs have become more popular in general after the fall in consumption in the late 1980s. The future UK market for MPP egg packaging is expected to be stable, with possibly a slight increase.

Huhtamaki Lurgan remains the only UK producer of egg cartons after Omni-Pac closed its operations in 2003. Huhtamaki Lurgan now supplies a large share of the UK market for egg cartons, as the transport costs for importing egg cartons are very high. However, Hartmann exports egg cartons to the UK market from its Tønder plant in Denmark. The Hartmann volume in the UK market is approximately 4,000-5,000 tonnes per annum, based on information from the trade statistics. Additionally, French producer Celluloses de La Loire (CDL) has increased its sales of egg trays into the UK significantly since Omni-Pac’s closure of the Great Yarmouth plant. Omni-Pac is reported to supply the UK market from its German plant, but its market share is relatively small.

An interesting UK feature (mentioned by two interviewees) is the high turnover of purchasing managers at retail chains, which has made the UK a somewhat more demanding market for egg packaging than other countries. This is because new purchasing managers strive to make an impact by changing the purchasing and characteristics of the egg packaging.

10.2.4 Competing Materials in UK Market

The UK egg packaging market normally favours moulded pulp packaging, but volumes of EPS and clear plastics have grown after the Omni-Pac plant closure. The following material split estimates have been given by two different interviewees:

- 90% MPP, the remaining trays being made of 7% EPS (Linpac for ASDA) and 3% clear plastics (Ovotherm)
- 60-70% MPP, rest plastics (local production only)

On the assumption that MPP has a market share of 85%, the annual market volume for EPS/clear plastic can be estimated at 4200 tonnes, representing a clear opportunity for the existing manufacturers of moulded pulp egg packaging.

According to one interviewee, the share of EPS is very small, and is supplied by Linpac only. Clear plastics have become more popular, even though customers prefer MPP. The clear plastic egg cartons are used for cheaper eggs, and the retail chains can therefore differentiate between different eggs in this way exactly as they can by using different colours for MPP egg cartons. The share of cheaper eggs in the UK is about 40%.

There is also a strong move to replace MPP egg trays by plastic tray manufacturers, as these can be reused several times. However this changeover is making very slow progress, and it is forecast that the transition will not be significant over the next 5 years.

Shown in the table below are comparisons of the main competing materials used for egg packaging.
10-4 Competitive material comparisons

<table>
<thead>
<tr>
<th></th>
<th>MPP</th>
<th>EPS</th>
<th>Clear Plastic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewable resource/biodegradable</td>
<td>5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Aesthetics/Organic feel</td>
<td>5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Shock/vibration absorption</td>
<td>4</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Bending strength</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Nesting properties</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Volume on a pallet</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Lowest cost</td>
<td>5</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Liquid absorption</td>
<td>5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>TOTAL RATING</strong></td>
<td>32</td>
<td>13</td>
<td>18</td>
</tr>
</tbody>
</table>

Rating assessment (1 = worst and 5 = best)

It is clear from the results, that MPP is the superior material for the packaging of eggs, as is confirmed by its high market share.

10.2.5 North American market for egg packaging

According to both Hartmann and Omni-Pac, 50% of the egg packaging in the North American market is moulded pulp and 50% is clear plastics.

10-5 Market for egg packaging in North America in 2002 and future

Some egg packaging producers operate in both Europe and North America, e.g. Omni-Pac (Pactiv) and Hartmann, but the markets are completely separate, and very little or no trade takes place between the two continents.

10.2.6 UK Market Status and Opportunities

The estimate for the current volume of packaging for the UK egg market is approximately 28,000 tonnes. Future growth estimates for this market indicate very limited volume growth, and of no more than 0.3% per annum up to 2014. It is forecast that egg packaging will grow in line with the growth in population in the UK. Even though this growth rate is significantly below the growth rates of the other MPP applications, egg packaging will only decrease its share of the total MPP demand from 51% to 45% between 2005 and 2014. This is because egg packaging forms such a large part of this sector. The actual volume increase is only 739 tonnes.

10.3 Medical sector

The UK moulded pulp consumption estimated volume for the medical sector is 8,000 tonnes per annum, with an equivalent MPP volume of 1,200 tonnes per annum of alternative materials being used.
10.3.1 Sector Overview

In 2004, the total UK expenditure on healthcare provision (excluding nursing and residential care) was in excess of £50 billion, of which 97% was accounted for by the National Health Service (NHS) and the remainder by the private sector.

Expenditure on healthcare has increased consistently ahead of inflation over the last ten years, with good growth in both the public and private sectors. It now accounts for around 9% of GDP, and although this percentage has grown, it remains below the levels of expenditure seen in the majority of other developed countries.

The NHS has undergone a progressive and radical change in its structure due to a number of major reforms introduced by successive governments. The changes, designed to result in a market-type mechanism for public health service delivery, have divided the NHS into two distinct groups, the providers of health services (NHS Trusts) and the purchasers (GP Fundholders and Integrated District Health Authorities/Family Health Service Authorities).

The private healthcare market is substantial with a value in excess of £1.4 billion. The sector has shown good growth over the last fifteen years reflecting a number of factors including growing dissatisfaction with the NHS due to a perception of declining standards, increasing consumer expectations and consultants preference. Overall, the demand for private healthcare is expected to show high growth in future.

Many of the products used within the healthcare sector are specialist in nature and reflect the specific needs of patients, with safety, hygiene and functionality all key issues. Product features such as style, appearance and quality have always been considered important in the private sector. However, the recent changes in the NHS have resulted in greater emphasis on quality, durability and aesthetics.

Within NHS Trusts, the Estates Department play a key role in the buying and specification process for all products. The department have wide ranging responsibilities, dealing with major capital projects as well as purchasing disposable medical supplies.

Other key influencers on the specification process include the User Department, who will generally be involved in the specification of medical equipment and other products.

The NHS Supplies Authority (PASA), which was established in 1991 to enable the NHS to achieve the ‘best value for money’ on all medical and non-medical products, represents a significant source of supply. The authority influences around 70% of purchases, supplying a limited range of brands based on annual or biannual contracts.

In the private healthcare sector the buying and specification process differs considerably depending upon whether the hospital is part of a group or independent.

Many of the hospital groups have a specification manual, developed by the property department within head office. This clearly defines the type and brand of product to be used.

In private hospitals, the hospital manager is generally a key influencer on the specification process, with other influencers including external consultants and the hospital board. (Source: Keynote)

Within groups and independents, purchasing is usually the responsibility of either the hospital manager or a supplies department. Products are commonly sourced locally, although specialist products may be purchased direct from the manufacturer. (Source: Keynote)

10.3.2 Suppliers of Moulded Pulp Products to NHS

The leading current and historical supplier of MPP disposable medical products to the NHS is the Vernacare Group, based in Bolton. Small %’s of MPP disposable medical products are supplied by a limited number of other specialist medical supply companies.

10.3.3 Competing Materials

Competing materials are glass, polypropylene and stainless steel, but these are rapidly being phased out, due to their multiple-use capability and hence potential ability to pass on infection. The majority of the MPP products currently supplied to the NHS are manufactured from recovered fibre, although where a perception of medical cleanliness is required, then virgin pulp or bleached fibre is used. Several hospitals in Sweden have banned the use of recovered fibre in disposable MPP, and potentially the rest of Europe could follow in the medium/long term, reflecting the high hygienic demands on these products in hospitals. Interestingly it has been suggested that MPP disposable medical supplies from China may not comply with the Royal Institute of Public Health and Hygiene standards, and this non-compliance with UK/European legislation, may ultimately affect the on-going purchase of these products.

The MPP potential replacement volume for glass, polypropylene and stainless steel is estimated at 15%, as older hospital (where these competitive materials are used) are phased out and replace by new style facilities. This potential volume equates to 1200 tonnes.

Shown in the table below are comparisons of the main competing materials used for medical applications.
10-6 Competitive material comparisons

<table>
<thead>
<tr>
<th></th>
<th>MPP</th>
<th>Glass Re-usable</th>
<th>Plastic Re-usable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waterproof</td>
<td>4</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Mascarability</td>
<td>5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Reduction in nursing time</td>
<td>5</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Environmental standards compliance</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Infection control characteristics</td>
<td>5</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Single-use characteristics</td>
<td>5</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>TOTAL RATING</strong></td>
<td><strong>29</strong></td>
<td><strong>17</strong></td>
<td><strong>17</strong></td>
</tr>
</tbody>
</table>

It is evident from the above that the modern requirements of the NHS, identify MPP as the most suitable material for medical applications, and that the threat from alternative materials is likely to diminish in the coming years.

10.3.4 Barriers to Entry for Competitive Materials

A major purchasing requirement is availability at short notice, although functionality is also a key purchasing driver and all products must be absolutely fit for purpose. Disposability for single-use medical products is also growing in importance in the NHS and the difficulties associated with mascerating expanded polystyrene items may preclude it from many applications within the medical sector.

The medical segment is a relatively large and profitable segment for European MPP producers. This development is expected to continue, but there may be implications on the fibre furnish as some hospitals in Western Europe now require virgin fibre based products.

The estimate for the current volume of moulded pulp disposable products to the UK medical sector is 8000 tonnes. Future growth is estimated at 4% per annum up to 2008, declining slightly thereafter to 3% up to 2014.

10.4 Electrical (including mobile phones)

The UK consumption of MPP in the electrical sector is estimated at 2,000 tonnes, with the MPP volume equivalent of competing materials also being at an equal volume (2,000 tonnes).

10.4.1 Market Overview (Mobile Phones)

The market for mobile phones has developed very quickly as can be seen in 10-7. The market penetration in Western Europe is, today, at a high level, and the sales growth has slowed down. The actual size of the packaging for mobile phones has probably reached a minimum, as the size of the packaging follows the size of the mobile phones, which are now very small. The accessories may, however, still decrease in size, which will also affect the mobile phone packaging.

The volume (in tonnes) used in this sector will primarily depend on the weight and thickness of the packaging, which is likely to be the next target for the mobile phone companies to reduce the packaging costs. The MPP producers active in this sector will hence continue to face great challenges and competition from other materials, as well as high demands from customers.

10-7 Global trends in sales of mobile phones

[Diagram showing global trends in sales of mobile phones]

Source: Hartmann annual report 2002

MPP is often used as inner packaging in mobile phone boxes. The material used changes on a frequent basis between MPP, corrugated board, solid board, foam and plastics. This is a result of the mobile phone companies’ continuous search for new, better and cheaper materials.
10.4.2 Competing Materials

Some mobile phone companies have adopted a no-plastics policy, which is expected to be advantageous for MPP producers, e.g. Sony and Motorola (see section 10.4.4).

Traditionally, mobile phone inner packaging has been made of plastics. Today, an increasing share is made of moulded pulp, but also from corrugated board and other, new, materials. e.g. Dutch company PaperFoam supplies starch-based packaging machinery to cartonboard producers, who use the machinery for making inner packaging. Motorola is one customer, to whom they backsell (see section 10.4.3). However, the plastics industry is highly active in developing new plastic materials, which have more environmentally friendly/recyclable/biodegradable properties.

The uptake of moulded pulp products has developed in a number of new applications over the last 5-10 years (end caps for ink cartridges, mobile phone packaging etc). The use of moulded pulp products in these new uses has been as an alternative for other substrates such as expanded polystyrene and cardboard. Replacement has not been total in any sector, and end-users move from product to product depending on their current marketing strategies, price, aesthetics and new product development offerings from suppliers.

10-8 Competitive material comparisons for electrical (+mobile phones)

<table>
<thead>
<tr>
<th></th>
<th>MPP</th>
<th>EPS</th>
<th>Corrugated die-cut origami</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowest price</td>
<td>3</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Aesthetics</td>
<td>4</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Nesting properties</td>
<td>4</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Weight comparison</td>
<td>4</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Shock/vibration absorption</td>
<td>4</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Static/dust free</td>
<td>4</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>No of days for trial samples</td>
<td>1</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Product availability</td>
<td>2</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Mould/die cost</td>
<td>1</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Environmental</td>
<td>5</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

TOTAL RATING 32 35 36

Rating assessment (1 = worst and 5 = best)

The table indicates the current preference for EPS in the electrical and mobile phone sectors. However as the difference in results is close this will inevitably influence a variability in purchase-decision outcomes.

10.4.3 PaperFoam as an alternative to MPP for Mobile Phone packaging

PaperFoam is a Dutch company, which has developed a packaging based on starch. The material was originally developed by the starch supplier Avebe, but they did not want to invest in developing the product, and the development was taken over by another company. PaperFoam started up in 1998, and started selling its products in 2000.

The material is a mix of potato starch, natural fibres, water and a premix (which is confidential). The furnish is injected into a mould, which is heated at 220 degrees, and ejected in its finished state after approximately 90 seconds. The products are biodegradable, and can be composted or burned. When burned, water and CO2 is released. The time for decomposing in a biodegradable environment is 15-20 days. According to PaperFoam, the advantage in the product lies in its anti-static and dustfree properties which are especially suitable for mobile phone packaging, and the many design possibilities of the material.

Until now, they have focused solely on mobile phone packaging, where they supply large companies. They have started to look at other application areas for their product, but they want to continue to focus on the higher value-added segments. Their customers are often corrugated case manufacturers, who use the PaperFoam material as inner packaging. Today they supply to companies in Europe, North America and Asia (including China). The raw materials can be sourced locally at the customer’s, except for the premix which is sold by PaperFoam only.
They do not have their own production, but supply the technology and machinery to packaging producers. The machines are small and can easily be shipped to the customer, and the investment is relatively small. It is also easy for the customer to increase capacity by adding another machine. The PaperFoam machines do not have oven-drying and the size of the machine is therefore very small.

Another advantage in the production is the construction of the “wet end”, which can be seen as a batch process. The mix is made in containers separate from the machine, which enables the use of a large number of colours without any problems with cleaning of the machine. This also gives the possibility of making small batches, and the minimum production volume is 1,000-2,000 units. The furnish is only 50% diluted with water, and the drying process is hence not as energy-consuming as the MPP process.

The disadvantage on the other hand is the long time required for each cycle, and which forces this kind of production to focus on niche applications, with smaller volumes and higher margins.

Starch-based packaging materials are currently not a major threat to MPP. The appearance and strength of the end-product is not as good as MPP or plastics, but this is a material that is in its early stages of development and MPP producers should watch the development closely.

10.4.4 Environmental issues (Mobile Phones)

MPP has a competitive advantage in its use of recovered paper, which is seen as environmentally friendly by the market. There are, however, no price premiums to be gained based on environmental advantage. The advantage lies mainly in the MPP manufacturers’ ability to sell an environmentally friendly image to their customers and end-users.

As an example it has been highlighted that several major companies, such as e.g. Sony, Motorola, Nokia and Casio, have declared their intention to decrease the usage of plastics and EPS in favour of moulded pulp, paper, paperboard and other more environmentally friendly materials. However, these companies are still highly cost-conscious, and not willing to pay a premium price for purchasing paper, moulded pulp or board.

Some companies continuously look at new materials and fibres to replace plastics and EPS, and they often change the material used in the packaging.

The MPP producers do not foresee any major changes in the environmental regulations that will have an impact on the demand or production of MPP.

Most multinational companies put major effort into communicating their concerns and measures taken for the environment. This includes informing the customers about materials used, impact on the environment from production and transports, as well as recycling possibilities. Sony has extensive information about the company and the environment on its web page. Its efforts to communicate its environmental concerns and efforts to the customers can also be seen from its development of “eco info”, Sony’s own mark to indicate the environmental aspects of its products.

10.4.5 Market Opportunities

Consumption of MPP for electrical items (mobile phones, hair dryers, toasters, etc.) totals 2,000 tonnes, and is forecast to exhibit one of the highest growth rates of the developing products. The requirement for the majority of electrical items is currently met by EPS, which has a dominant position. Moulded pulp has slowly made in-roads into this sector, but the end-user technical demands are for smooth, well-formed shapes with good aesthetics, which can only be met by thermoformed moulded pulp. With the move towards tunnel drying in the UK moulded pulp sector, this virtually excludes UK supply for this market, with the exception for products which are treated in an after-press.

The current volume equivalent of competing materials is estimated at an equal volume to moulded pulp (i.e. 2000 tonnes). Future growth from industry sources and interviews indicates good growth of 4% per annum up to 2007, declining slightly thereafter to 3% in 2008, and down to 2% up to 2010.

10.5 Food, fruit and wine

The current UK consumption of moulded pulp in the food, fruit and wine sector is estimated at 4,200 tonnes per annum with an MPP equivalent in alternative materials of 1,150 tonnes per annum.

10.5.1 Market Overview (fruit and vegetables)

In 2003, the UK fresh fruit and vegetables market was valued at £ 7.6 billion, having increased by just 3.9% since 1999. Marginal growth in the green vegetables and potatoes sectors is largely responsible for the limited growth of the market.
The fresh fruit sector accounts for 38.1% of the overall market and is gaining share. This is probably explained by the continuing trend towards convenience eating, as fruit generally requires little or no preparation, while vegetables usually require preparation and cooking. Meanwhile, both the fruit and vegetables sectors have benefited from widespread publicity about the positive impact on health of consuming fruit and vegetables regularly. Indeed, the scientific evidence that fruit and vegetable consumption can protect against cancer and other illnesses now appears overwhelming, with studies from around the world highlighting the benefits of eating even small amounts. In the UK, a government drive to encourage people to eat more fruit and vegetables may be having a positive effect on the market. (Source:Keynote)

10-9 Fruit consumption in Western Europe and the UK 1996-2002

Most consumers now buy their fresh vegetables and fruit from the grocery multiples, (e.g. Tesco, Sainsburys, M&S) rather than specialist fruit and vegetable stores. The multiples tend to display fruit and vegetables at the entrance to their store in the belief that a display of bright colours presents an attractive and healthy image of their store to consumers. The supermarkets have also helped to increase the variety of fruit and vegetables available to the consumer and have exploited growing demand for convenience products by introducing an ever-growing range of prepared fruit and vegetables. These include pre-packed fruit and vegetable mixes, with the fruit and vegetables peeled and ready to cook. A wide variety of fresh salad mixes is available. Brands have never had the same impact in the fresh fruit and vegetables sector as in other areas of the food market. However, the main suppliers say that this is now changing and the major retailers are increasingly willing to carry brands alongside their own products.

It is forecast for fruit consumption to continue to increase over the next few years, as the trends of growing demand for convenience foods, and concerns over health, continue to influence consumers. In addition, the growing presence of brands in the fruit sector should also drive demand. However, consumption of potatoes and other vegetables is likely to continue its downward trend. Potatoes are losing out as British people switch from their once staple food item to more convenient alternatives, such as pasta and rice. Meanwhile, frozen vegetables are likely to continue to win market share at the expense of fresh produce, such as beans and peas. Some sectors, such as prepared vegetables and salads should continue to grow rapidly. Intensifying competition among retailers is likely to undermine value growth with the market expanding by just 3% in value terms between 2004 and 2008. (Source:Keynote)

The major importers/distributors of fruit and vegetables into the UK market are:

- Capespan International Holdings
- Del Monte Fresh Produce (UK) Ltd
- Fyffes Group Ltd
- Geest plc
- Greenvale AP Ltd
- G’s Marketing Ltd
- Mac Multiples Ltd
- MBM Produce Ltd
- Saybest Ltd
- Worldwide Fruits Ltd

Source: Keynote
10.5.2 UK Distributors of MPP for Fruit and Vegetables
Packing of fruit and vegetables for the UK can either occur outside the UK, and prior to shipping; or in less cases it is packed in the UK from bulk containers. Approximately 80% of all fruit and vegetables are pre-packed before they reach the UK. This leaves 20% of imported fruit and vegetables to be transfer-packed in the UK. The UK packers buy their packing materials, through specialist packaging merchants who stock a range of packaging materials.

The main specialist (fruit and vegetable) packaging merchants in the UK are:

- Produce Packaging Ltd
- Premier packaging Ltd
- F. Edmed and Sons Ltd
- PG Packaging
- ESP Ltd

Generally these packaging merchants are relatively small, although one of the largest is Produce Packaging based in Kent. All packaging merchants stock a range of materials for their customers, including MPP, plastic, polystyrene, PLA (poly lactic acid), etc. End-users and packers are very particular in their choice of packing material, and often change from one type to another depending on price and prevailing marketing initiatives.

The main supply markets (fruit/vegetables) to the UK are Italy, France and Spain. The Italians tend to favour polystyrene packing for their fruit and vegetables, although the French and Spanish tend to use whatever is the cheapest at any point in time. Approximately 80% of all imported fruit and vegetables are packed at source, with the remainder being packed in the UK (Total UK MPP packing usage estimate = 1,850 tonnes per annum)

10.5.3 Manufacturers of MPP for Fruit and Vegetables
All the moulded pulp packaging purchased by the leading packaging distributors, and indeed all other packaging merchants is purchased from outside the UK. The main suppliers of MPP to the UK fruit/vegetable packaging merchants are:

- Huhtamaki, Netherlands
- Huhtamaki, France
- SEM, France
- Cemosa, Spain
- Ciat, Spain

10.5.4 PLA (Poly lactide) as an alternative packaging medium for fruit and vegetables
A new/evolving material called poly lactid acid (PLA) has been developed to replace oil-based plastic materials in for example the tableware market. It is a glass-clear material made of corn starch, that looks and functions like clear polystyrene. Plant starches are broken down into natural sugars, and the carbon and other elements are used to make PLA in a fermentation and separation process.

PLA degrades fully in composting facilities, where it turns into water, carbon dioxide and organic material. The drawbacks of this material are that the material can only be used for cold food applications, as it cannot take temperatures above 40 degrees, and that it is stiff and brittle and needs modifications for most applications.

A large number of applications are and have been tried with this material, including (for example) trials by Sony to use it as front panels for its DVD players among other products.

PLA was developed in 2000, and a PLA polymer is today sold under the name of NatureWorks PLA by Cargill Dow LLC, a joint venture of Cargill and Dow Chemical Co. 30-50% .

PLA is a potential threat to the use of MPP mainly in fruit and vegetable packaging, and in some food and catering applications (containers), but will mainly replace clear polystyrene products.

Shown in the table below are comparisons of the main competing materials used for fruit and vegetables.
10-10 Competitive packing material comparisons for fruit and vegetables

<table>
<thead>
<tr>
<th></th>
<th>MPP</th>
<th>EPS</th>
<th>Plastic/Non-Expanded Polystyrene</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowest price</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Aesthetics/organic feel</td>
<td>5</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>De-nesting properties</td>
<td>4</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Shock/vibration absorption</td>
<td>5</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Delivery time for prototypes</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Space saving capability</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Coloured material</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Liquid absorption</td>
<td>5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>TOTAL RATING</strong></td>
<td>31</td>
<td>20</td>
<td>27</td>
</tr>
</tbody>
</table>

Rating assessment (1 = worst and 5 = best)

The assessment indicates the ranking of the different competing materials. It is interesting to note the high value obtained by non-expanded polystyrene packaging, although this certainly does not show through in its low market share.

10.5.5 Market Issues and Forecasts

An increasing trend in the sales of fruit and vegetables in supermarkets (with Marks and Spencer’s leading the way) is the trend away from bulk packing into sales in small trays, containing 4/6/8 pieces of the particular item. Undoubtedly, this will affect the amount of moulded pulp used for bulk applications, but will open up good opportunities for smaller moulded pulp trays, although expanded polystyrene is also favoured by end-users and customers.

The issue of bulk/space saving is a big plus point in favour of moulded pulp packaging for fruit and vegetables, in that 3.4 times more MPP, of the equivalent shape to an EPS product can be fitted on a pallet. This is due to the superior nesting properties of moulded pulp vs. EPS. However, MPP is heavier and more expensive for an equivalent size shape than EPS or non-expanded EPS.

Market feedback indicates that moulded pulp may increase the shelf life of fruit and vegetables (e.g. mushrooms) due to its simultaneous moisture absorbing and breathable properties. Whilst these comments are un-substantiated, this advantage could favourably impact the cost equation in favour of moulded pulp vs. competing substrates (e.g. EPS/plastic).

10.5.6 Meat trays

Meat trays are considered an impossible niche for MPP producers, as meat packers favour EPS or plastic packaging. Moulded pulp is not viewed by customers as an acceptable form of packaging due to its lower feel of cleanliness, and the potential for contamination from the recovered fibre content of the product.

Additionally, the ability to create a good hermetic seal is difficult to accomplish with MPP trays, which is critical in many applications today where gas is used in the meat packs.
10.5.7 Wine

10.5.7.1 Market Overview

The wine segment is a small but stable niche for MPP. Wines are usually transported in board cases, which are wrapped around the bottles (normally six at a time) in packing machines. The use of MPP is relatively limited, but is used by some producers in the mid-price segment. For expensive wines producers prefer wooden boxes. Plastics or foams are not found in wine packaging.

10-11 Wine production in Western Europe 1996-2002

MPP used for wine packaging is unsophisticated, and there are no demands on improving the appearance of the product. The appearance of the MPP wine packaging is rough and greyish, and coloured MPP is not often used. The MPP structure is relatively soft compared to other mediums, such as cushioning in industrial packaging.

The MPP is used as cushioning between the layers of wine bottles in the corrugated boxes, and normally 3-6 bottles per layer are stored in a two-layer box. There are also demands for single and double MPP wine bottle protectors.

10.5.7.2 Market Opportunities in the Wine Sector

The demand for moulded packaging for wine bottles is extremely small, and is satisfied predominantly by 2 of the UK MPP manufacturers. The main alternative packaging media is expanded polystyrene, which is estimated to have a market share in excess of 70%. The opportunities in this market are limited, and are not forecast to grow due to the small wine production in the UK.

10.5.7.3 Market Opportunities in the Fruit and Vegetable Sectors

Current volume in the fruit and vegetable sector is 4200 tonnes, and which is all supplied by non-UK MPP manufacturers. This market is viewed as being of no potential to UK manufacturers of moulded pulp products due to its commodity type nature, and the requirement for high speed rotary production.

There is limited supply of both polystyrene (both expanded and non-expanded) to this market and the volume estimates for these materials are 250 tonnes per annum (equivalent to an MPP volume of 1,150 tonnes).

10.5.8 Fast food and Catering

The current total of moulded pulp consumed in the fast food and catering sectors is estimated to be 2,800 tonnes per annum. The MPP equivalent volume of alternative materials used in these sectors is approximately 6,900 tonnes, the majority of which is polystyrene and boxboard.

The UK fast food and takeaway market generated estimated sales of £ 8.1 billion in 2003 at retail selling prices, increasing sales by 3% over the previous year. Its share of the total UK catering market has been increasing year-on-year over the past five years.

Consumer demand for convenience, and the widespread development of fast food and takeaway outlets on various sites, has encouraged sales. Although dominated by a few large global brands (e.g. McDonald’s, Burger King, KFC, Sub-Way), the market is still highly fragmented with most operators classed as small businesses.

The largest market sector is sandwiches, contributing over 36% of all sales in this market in 2003. As well as traditional sandwich bars and cafés, sandwiches are now also available from other outlets such as petrol station forecourts, supermarkets, other retail outlets, and numerous office delivery services.
The second-largest category is burgers, representing 22.4% of all sales in this market. After a poor performance in 2002, the market for burgers improved its sales performance in 2003 through menu diversification and more emphasis on brand building. Burgers are taking a smaller share of sales at traditional burger outlets, year-on-year. Both the pizza sector and chicken restaurant market have benefited from consumers moving away from burgers. Chicken outlets (e.g. KFC) continue to expand and emphasize their family dining options, while home delivery pizza sales (Pizza Express, Domino Pizza, etc.) have driven growth in the pizza sector. Sales growth in the fish and chips sector remains limited.

The other fast food and takeaway sector includes a variety of outlets such as coffee shops, Indian and Chinese outlets, sushi and noodle bars, soup bars, salad bars, organic food outlets, doughnut, muffin and other pastry shops. Traditional takeaway foods such as Chinese and Indian are saturated and are experiencing little growth. (Source Keynote)

Sales growth from 2004 to 2008 is forecast to be less than the previous five years, due to a lower level of new openings, increased competition and mature markets in some market areas. Between 2004 and 2008, the total market is forecast to increase by 11.2% at current prices, compared to a growth of 15.5% at current prices between 1999 and 2003.

The main area where moulded pulp products are used in the fast food/takeaway sector is for drink cup-holders at take-away restaurants. These are given to customers when they purchase food and drinks (and drive away in their car) and are designed to either hold two or four drinks. The two major purchasers for this application are McDonald’s and Burger King. KFC is the third largest company purchasing MPP cup-holders.

The estimated breakdown of the three leading UK take-away company restaurants is as follows:

<table>
<thead>
<tr>
<th>Total restaurants</th>
<th>Take-away facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>McDonald’s</td>
<td>1,339</td>
</tr>
<tr>
<td>Burger King</td>
<td>750</td>
</tr>
<tr>
<td>KFC</td>
<td>685</td>
</tr>
</tbody>
</table>

Sources: PendlePace Ltd

Clearly, McDonald’s is the market leader, and as such purchases the highest number of cup-holders. The total consumption of moulded pulp fast food drink holders is estimated at 2,800 tonnes per annum.

Shown in the table below are comparisons of the main competing materials used for the fast food sector.

### 10.12 Competitive material comparisons for fast food sector (excluding cup holders)

<table>
<thead>
<tr>
<th></th>
<th>MPP</th>
<th>EPS</th>
<th>Cardboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowest price</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Aesthetics</td>
<td>2</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>De-nesting properties</td>
<td>4</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Suitable for direct-food contact</td>
<td>1</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Resistance to grease/oils</td>
<td>1</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Printability with good graphics</td>
<td>1</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Biodegradable/recyclable</td>
<td>5</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><strong>TOTAL RATING</strong></td>
<td><strong>18</strong></td>
<td><strong>22</strong></td>
<td><strong>32</strong></td>
</tr>
</tbody>
</table>

Rating assessment (1 = worst and 5 = best)

The sole area of use of moulded pulp in the fast food sector is for drink cup-holders at take-away restaurants. Other types of competitive material are not used in this application although there is wide use of both EPS and other competitive materials, where there are requirements for direct food contact and/or resistance to grease and oils are required. These other areas include burger clam shells (predominantly made from boxboard) and breakfast clam shells (manufactured from EPS).

The above table makes an assessment for general applications within the fast food sector, and covers protection and packaging for a wide range of products.

### 10.5.8.1 Market Opportunities

The major supplier to this market is UK based. There are also limited supplies from European moulded pulp manufacturers to the UK market.

Fast food outlets, which are dominated by McDonald’s, Burger King and Kentucky Fried Chicken, represent a market share of approximately 5%. Interviews indicate that there are limited long-term opportunities for MPP within this sector.
due to the direct-food contact issues, unacceptable aesthetics and the limited ability to promote a clean image, although good growth is forecast up to 2007, slowing thereafter to 2% per annum. Use of MPP in this sector is solely for takeaway-cup-holders, and there is little interest for new MPP products in this sector according to the interviewed companies.

10.5.8.2 Catering sector

The UK catering sector includes food and drink that is purchased outside the home, at catering sites and establishments and is usually eaten on the premises. Total annual sales for this market were £38.4 billion in 2001, and the market experienced no growth for the first time in many years. However, a static market overall, hides differing trends in various sectors. Sales in the pubs and hotels sectors declined in 2001, while sales in all other sectors increased annually, with particularly healthy increases in contract catering (7.6%) and restaurants (4%).

In 2001, the UK hotel market decreased by 5.5% on the 2000 market size figure. After a relatively good year in 2000, sales declined in 2001. Between 1997 and 2001, the UK hotels market increased in value by just 10%.

63.7% of hotel users are corporate clients and the other 36.3% are leisure, or consumer, visitors. The consumer sector fared slightly better than the corporate market in 2001 (although sales still fell by 2%). Sales in the restaurant market increased by 4%, to £8.06 billion in 2001, performing better than the catering market as a whole.

Contract catering continues to be the best performing catering market overall. In 2001, the market increased by 7.6% at current prices and was valued at £3.51 billion. Between 1997 and 2001, sales increased by 55.6% and, while the growth rate in 2001 was the lowest annual increase for some time, it was still well above the overall catering market growth. By 2001, private contractors took 59.6% of the total workplace and institutional catering market. In some sectors, such as business and industry, private contractors have the overwhelming share of sales although, in other sectors, including healthcare, there is still scope for further growth.

The largest contract catering market is business and industry. Other core sectors are education, catering for the public, healthcare and others. Sales growth was achieved in all sectors but the strongest growth (11.6% at current prices in 2001) was in education, where more schools outsourced non-core activities in 2001.

The other major catering markets are licensed clubs and holiday camps, caravan and camping sites. Catering sales at licensed clubs increased by 2.2% in 2001 with the catering market at holiday camps, caravan and camping sites increasing by 3% in 2001.

The next few years are forecast to be difficult times for the catering industry as economic and political uncertainties impact on travel, tourism and consumer discretionary spending. Total market sales are forecast to increase by just 2% up to 2006. Little or no MPP is used in the catering sector, with the exception of the Chinet-type disposable plates, produced by Huhtamaki. There is very little consumption of these products in the European market, although the apparent high consumption in North America indicates a potential opportunity to develop sales in Europe.

(Source: Keynote)

10-13 Growth in ready meals in Europe

The main moulded pulp product supplied to the catering sector is disposable paper plates and trays. These are predominantly supplied by Huhtamaki and are sold under the Chinet brand name. These products are manufactured according to a patented process from post-consumer recovered bleached fibre.

The main competitor to moulded pulp is paper plates/trays stamped out of polythene coated cardboard (both virgin and recycled). Catering products manufactured by this method are 50% lower than the price of moulded pulp alternatives.

Shown in the table below are comparisons of the main competing materials used in the catering sector.
### 10.14 Competitive material comparisons for catering

<table>
<thead>
<tr>
<th></th>
<th>MPP</th>
<th>EPS</th>
<th>Cardboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowest price</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Aesthetics</td>
<td>2</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>De-nesting properties</td>
<td>4</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Suitable for direct-food contact</td>
<td>1</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Resistance to grease/oils</td>
<td>1</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Printability with good graphics</td>
<td>1</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Biodegradable/recyclable</td>
<td>5</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><strong>TOTAL RATING</strong></td>
<td><strong>18</strong></td>
<td><strong>22</strong></td>
<td><strong>32</strong></td>
</tr>
</tbody>
</table>

Rating assessment (1 = worst and 5 = best)

The rankings for the catering sector are identical to the fast food sector. This is particularly relevant in terms of aesthetics for customer acceptability and direct-food contact issues.

The uptake of moulded pulp in the food industry and catering sectors has been negligible for reasons of direct food contact issues and inferior aesthetics. The main advantage for moulded pulp lies with its environmental credentials, although this does not translate into a price advantage, and nor does it over-ride other end-user requirements, such as performance and looks.

The current price of disposable plates manufactured from folding boxboard is approximately 50% of the price of plates made from moulded pulp. The current price of moulded pulp disposable plates is estimated at £20 per 1,000 plates.

The UK consumption of paper plates is estimated at 500 million/annum, equating to approximately 6500 tonnes; in addition to which there is approximately 400 tonnes equivalent of EPS used for paper plates. The potential for moulded pulp against competing materials can therefore be estimated at 6900 tonnes.

The supply of moulded pulp to the catering sector is relatively modest and consumes low volumes of moulded pulp items. Growth in this sector is forecast to be reasonable over the period to 2008, predominantly for the Chinet type disposable catering range. Growth will be continually be limited by competition from lower-priced alternatives.

### 10.6 Horticulture

Current consumption of moulded pulp in the horticulture market is estimated at 600 tonnes per annum, with the MPP equivalent volume of competing materials (i.e. EPS and plastic) estimated at 2,000 tonnes per annum.

#### 10.6.1 Market Overview

The total UK Garden Products market was valued at an estimated £4.8 billion in 2003. Since 1991, the market has more than doubled illustrating the strong growth experienced by the sector. The market has performed favourably in recent years, although 2004 has seen some slowdown in activity.

The major channels for garden products are the Garden Centres, with annual sales of around £1.2 billion, and the DIY multiples sector with estimated garden product sales of £1.7 billion in 2003. The DIY multiples have seen significant growth in recent years and have taken increasing share from the garden centres to become the dominant channel in the distribution sector.

Garden product sales have seen substantial growth through the latter part of the 1990’s and this has continued up to 2004, which has stimulated growth in both the DIY multiples and the garden centres as well as other channels including catalogue stores and supermarkets in certain product sectors. Overall, DIY multiples have continued to take share from the garden centres. In 1991, garden centres accounted for around 33% share of the total domestic garden products market, but in 2003 they were estimated to have a share of less than 25%. In contrast to this, the share taken by the DIY multiples has risen from 27% by value in 1991 to approximately 40% in 2004.

Within the garden centre market, there has been a shift away from high volume/low margin products to higher value products.

Other channels such as supermarkets have also increased their product ranges in the last few years, with Tesco committing to increasing their range of non-food items whilst some Safeway/Morrison stores have garden centre areas within some of their retail outlets.
Within the more traditional sectors of the market, and particularly horticultural products, Garden Centres are still strong, accounting for almost 50% by value. Garden centres in general are able to offer greater product knowledge for horticultural products and are perceived to provide better services, care and maintenance of stock than other outlets.

DIY multiples have a relatively limited share of the horticultural sector although they have increased their product range in recent years. DIY multiples are also increasing their offering of higher value products such as furniture and barbecues and have moved up-market in recent years.

Some supermarkets now offer dedicated garden centre areas whilst others now erect marquees in the store car parks to sell horticultural products throughout the summer months.

Within the garden centre market, Wyevale is the clear market leaders with a share of 16%. The market is still fairly fragmented with over 20 companies accounting for a further 25% of the market and the rest of the sector being made up from other “smaller” garden centres.

The DIY multiples market has fairly recently experienced significant change and a number of major acquisitions has left B&Q, Focus/Wickes and Homebase accounting for 96% of the market making it one of the most concentrated markets in Europe.

Future prospects for the garden products market are relatively optimistic with underlying growth of over 5% predicted in many product sectors. (Source : Keynote)

10.6.2 MPP Distribution of Horticulture Products

Wholesale supplies to the sector are dominated by a number of large specialist horticultural distributors, and a plethora of small/local companies. The main wholesalers to this sector are:

- Gardman Ltd
- Tenax Ltd

10.6.3 Competing Materials

The main competing materials are expanded polystyrene and plastic, although both these substrates are coming under increased environmental pressure due to their lack of biodegradability.

The main moulded pulp products used in the horticulture sector are:

- Hanging basket liners
- Plant pots
- Floral trays
- Plant rings (for oasis)
- Special shapes (e.g. hearts and crosses)

The market for moulded pulp products is divided into two types of products as follows:

- Low margin/high volume: hanging basket liners/small plant pots
- High margin/low volume: large/complex shapes

There are a wide number of applications within the horticulture sector where polystyrene/plastic are used (e.g. small plant pots/containers etc); the primary reason being the inability for MPP manufacturers to supply moulded pulp alternatives at competitive prices.

The functionality of plastic combined with a very low price makes plastic (followed by polystyrene) the favoured materials for the majority of horticultural applications. However where organic aesthetics are required in specialist/non-commodity applications, MPP is favoured and has developed a good niche.

Competitive materials are estimated to comprise approximately 2,000 tonnes equivalent of MPP

Shown in the table below are comparisons of the main competing materials used for the horticultural sector.
### 10-15 Competitive material comparisons for the horticulture sector

<table>
<thead>
<tr>
<th></th>
<th>MPP</th>
<th>EPS</th>
<th>Plastic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowest price</td>
<td>1</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Resistance to water</td>
<td>2</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Shape accuracy</td>
<td>4</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Product weight</td>
<td>2</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Biodegradable/recyclable</td>
<td>5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Organic type aesthetics</td>
<td>5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>TOTAL RATING</strong></td>
<td>19</td>
<td>20</td>
<td>22</td>
</tr>
</tbody>
</table>

*Rating assessment (1 = worst and 5 = best)*

### 10.6.4 Market Trends and Opportunities

In the commodity areas, MPP from China has appeared over the last 2-3 years, and both Gardman and Tenax are reported to be importing these products at up to 15% less than current prices. It is clear that price is the absolute driver in commodity products, and this lever is being used to pressure down the price for the added-value items. Additionally, both polystyrene and plastic equivalents are lower in price than MPP, although they are not viewed as environmentally friendly. The main colours demanded by the market are green for liners and brown/natural for all other products.

Erin Horticulture, based in Birr Ireland, is a supplier of MPP to this sector. The current estimate for the size of the horticulture market is 600 tonnes per annum. Future growth forecasts are for a static market over the next 2 years and declining thereafter as imports start to impact growth.

### 10.7 White goods & Industrial Packaging

Current volume of moulded pulp used in this sector is estimated at 8,600 tonnes per annum. The MPP volume equivalent of alternative materials used in these sectors has been calculated at 110,500 tonnes; predominantly composed of polystyrene and to a lower degree corrugated die-cut shapes.

Industrial packaging is an attractive segment for all kinds of packaging, as it has shown a good growth during the 1990’s, and especially the market for electrical appliances.

The requirements in this market are much higher than in most other MPP sectors, and this, together with the demands for smaller production runs and higher profit margins, has opened up a market for smaller MPP producers. However, the large companies have made big efforts to penetrate this market, and have invested in new machines that better suit the production of MPP industrial packaging.

While rotary machines are used for egg packaging, because of scale economies, the reciprocating (+after-pressing) MPP process is often the preferred production technology for industrial packaging as this produces a packaging product with a higher quality specification.

Industrial packaging covers a large number of products and industries, and the opportunities for MPP packaging vary considerably from sector to sector. The following illustrates the development in two niches for industrial packaging:

- **White goods**: These products are generally too heavy for MPP, and polystyrene foam is difficult to replace. However, the producers have made efforts to find alternative materials, at the least, to partially replace polystyrene foam in the packaging, e.g. the use of laminated liner as edge cushioning.

- **Printers & TVs**: MPP has successfully penetrated this market, and the volume of MPP packaging in this sector has increased significantly.

Replacement of polystyrene foam is the main target in industrial packaging, and major steps have been taken. MPP has managed to replace some polystyrene foam, although corrugated board and laminated liners, in addition to recycled polystyrene foam have increased in these applications.
MPP producers work hard and continuously to develop improved MPP packaging that can take more weight, as this is a major obstacle to increasing the volumes in this segment.

The market for industrial packaging in the UK has been severely affected by the decrease in industrial production in the country, e.g. SCA's decision to close down its UK MPP plant was based on its loss of industrial clients. A good example is the car industry, and the production development in the EU and the UK is illustrated in figure 10-16. While the production of cars in the EU has increased most years between 1997 and 2002, and with a total of 10.8% over the period, the UK car industry has decreased its output. The total decrease of car production in the UK over the period was 4.1%.

10-16 Car production in the EU and the UK 1997-2002

![Car production chart]

Source: Automotive Unit of the Department of Trade and Industry

Supply of moulded pulp for white goods (fridges, freezers, washing machines, etc.) totals 3,100 tonnes, and is certainly a good potential area of potential for UK manufacturers. However, much of this industry has moved to overseas locations with lower manufacturing costs than the UK, and therefore the future scope will be limited, unless greater marketing and awareness initiatives are undertaken by the MPP industry.

Forecasts, supported by the interviews and market analysis, indicate that the potential for growth in the industrial protective is significant and that the short-term (2006/2007/2008) opportunities offered by the rise in the price of oil indicate volume increases of up to 10%, falling by 2009 to 7% and thereafter to 6% (up to 2014).

10.7.1 Protective packaging for industrial/white goods applications

Protective packaging encompasses a wide variety of plastic, paperboard, foams and other materials used to safeguard, support and cushion products during transport, handling and delivery to customers.

Published statistics indicate that the total protective packaging market will grow by approximately by 5% over the period to 2008, and that generally foamed and plastic packaging will continue to expand at the expense of cellulose based materials (including MPP and corrugated), primarily due to their ability to be produced in ultra lightweights and excellent cushioning properties.

Plastics can also be moulded at very low prices (in comparison to MPP) into specific/complex shapes to conform with fragile items, thereby enhancing protective capabilities. Demand for moulded plastic foams in protective packaging will be stimulated by the light-weight, low cost, and excellent protective capabilities of expanded polystyrene (EPS) and expanded polyurethane (PUR). It is expected that sales of expanded polystyrene will grow at the expense of expanded polyurethane, based on cost and production advantages.

The two main protective packaging mediums competing with moulded pulp products are expanded polystyrene and die-cut corrugated interior cushioning. An overview of these two materials is given in the following sections.

10.8 Expanded polystyrene (EPS)

Expanded polystyrene was originally patented by BASF in 1950. Since the early 1960’s it’s use expanded into the packaging sector, where it is now used to provide packaging for a variety of packaging products ranging from fish boxes to electronics.

Polystyrene is produced by a 2-stage steam moulding process, in which pentane is used as the blowing agent, resulting in a bead type structure. In the second stage the beads are introduced into the desired shape mould and are softened with steam and pressure, resulting in the beads expanding and filling the mould. Contraction during the cooling of the mould allows the desired moulded shape to be released.
The development of new process control systems in the EPS industry has enabled greater control levels/accuracy in the shape moulding process. These developments facilitate the formation of high precision moulds, and also deliver reduced waste and labour costs.

The introduction of the new vacuum transfer moulding process has also introduced faster cycle times into the process, and in addition there has been a significant reduction in energy costs.

It is apparent that the EPS moulding industry is powering ahead with technological process development at a significant rate, in order to develop superior products at reduced cost and maintain it’s competitive position within the packaging sector.

10.8.1 European consumption of EPS for packaging

The European consumption of expanded polystyrene increased up to 2000, but has been gradually reducing since then.

10-17 European consumption of EPS 1998-2003

The downward trend in the European consumption of expanded polystyrene has been driven by the movement of manufacturing companies to new European accession states to take advantage of lower production costs.

In Eastern Europe, the sector has been growing rapidly as EPS manufacturers follow OEM’s (Original equipment manufacturers) to lower cost manufacturing facilities. Within Western Europe there are also large regional differences. The Nordic countries have displayed strong growth in this sector along with many of the Southern European countries. However in Germany, France, Belgium and the UK, the last 3-4 years represent a period of stagnation and even collapse in expanded polystyrene consumption.

The expanded polystyrene industry is well organised and agreed at its 7th International Conference to raise the profile of the industry as a low-cost and effective packaging material, but also as a sound environmental option. The EPS industry is targeting the requirement of “land-linked” industries, which are unable/unwilling to relocate.

The net effect of the above trends is that production of expanded polystyrene far out strips consumption by around 20%, thereby effectively driving down prices, and making EPS extremely competitive against other forms of packaging (e.g. Moulded Pulp Products). This trend particularly affects the UK, where the % of polystyrene used in packaging applications is high.

10.8.2 UK Expanded Polystyrene Market Overview

In the UK, EPS for packaging applications equates to some 54% of total EPS demand, whereas in Europe, as a whole, EPS for packaging applications is significantly lower at 29.5%.

EPS processed in the UK for the building sector is disproportionately small, and accounts for approximately 4% of the total European market. The latest figures published in 1999, by The British Plastics Federation, clearly exhibit the different consumption patterns between the UK and Europe.
10-18 Share of EPS in selected sectors in 1999

<table>
<thead>
<tr>
<th></th>
<th>UK</th>
<th>Western Europe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packaging</td>
<td>54.0%</td>
<td>29.5%</td>
</tr>
<tr>
<td>Construction</td>
<td>39.2%</td>
<td>68.0%</td>
</tr>
<tr>
<td>Other</td>
<td>6.8%</td>
<td>2.5%</td>
</tr>
</tbody>
</table>

Source: eumps

The latest statistics by the British Plastics Federation (1999) give the following breakdown for the UK EPS market:

- Capacity 70,000 tonnes
- Consumption 55,300 tonnes
- Overcapacity 14,700 tonnes (21.0%)

10-19 EPS consumption in the UK by segment

<table>
<thead>
<tr>
<th></th>
<th>%</th>
<th>Tonnes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packaging</td>
<td>53.2</td>
<td>29,000</td>
</tr>
<tr>
<td>Building products</td>
<td>39.8</td>
<td>21,700</td>
</tr>
<tr>
<td>Other applications</td>
<td>7.0</td>
<td>3,800</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>100</td>
<td>54,500</td>
</tr>
</tbody>
</table>

Source: eumps

10.8.3 UK EPS Market Segmentation Overview vs. MPP Opportunities

The total volume of EPS supplied to the packaging market was 29,000 tonnes. The majority of EPS packaging is used by the consumer electronics sector, notably in the packaging of brown goods (television sets) and white goods (oven/fridges etc).

The use of EPS in the packaging of food (direct contact) is also significant, although this sector usage is forecast to decline as a result of the introduction of more environmentally acceptable packaging.

Additionally, the use of EPS for the packaging of fresh fish is major and this sector is expected to remain strong with continued growth.

The continued growth in the use of home computers has also had a positive effect on the UK EPS market, and EPS has managed to maintain its market share against moulded pulp penetration.

10-20 Estimated breakdown of the use of EPS

<table>
<thead>
<tr>
<th></th>
<th>%</th>
<th>Tonnes EPS</th>
<th>MPP Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>White goods/industrial</td>
<td>60</td>
<td>17,400</td>
<td>78,300</td>
</tr>
<tr>
<td>Direct/Indirect Food</td>
<td>30</td>
<td>8,700</td>
<td>39,150</td>
</tr>
<tr>
<td>Other applications</td>
<td>10</td>
<td>2,900</td>
<td>13,050</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>100</td>
<td>29,000</td>
<td>130,500</td>
</tr>
</tbody>
</table>

Source: PendlePace estimates

If the EPS packaging volume of 29,000 tonnes was converted to the moulded pulp equivalent tonnes then the volume requirement for MPP would be 130,500 tonnes (assuming a weight ratio of 4.5:1)

The estimated breakdown for the EPS market shows that the moulded pulp equivalent for the EPS share of the white goods/industrial sector totals 78,300 tonnes. This is the volume available to the MPP industry should EPS be completely replace by moulded pulp.

10.8.4 UK EPS Packaging Manufacturers

The major UK producer of expanded polystyrene for packaging applications are as listed below:

- Kay-Metzler Ltd
- Linpac Moulded Foams Ltd
- Polybox (Stornoway) Ltd
- Rosslite Ltd
- SCA Tuscarora
- Simplipac Ltd
- Springvale
- Styropack (UK) Ltd
- Sundolitt Ltd
- Thulecraft Ltd

Linpac Moulded Foams and Styropack (UK) Ltd are the two largest UK manufacturers of EPS packaging.

### 10.8.5 Linpac Moulded Foams

LINPAC has a network of Moulded Foam factories which specialise in the design, manufacture and supply of effective and attractive protective systems and packaging for a wide variety of industries and applications - the list includes automotive, boxed fish, communications, horticulture, drinks and beverages, electronics, marine products, manufacturing, medicine, pharmaceuticals and retailing.

Their product range is equally wide and they can supply EPS (expanded polystyrene), EPP (expanded polypropylene) and EPE (expanded polyethylene). Linpac has 3 UK operations based in Chichester, Scunthorpe and Tonypandy. The Tonypandy operation produces moulded foams in EPS (expanded polystyrene) and EPP (expanded polypropylene) with over 15 modern machines capable of making the largest component to the smallest. It has ISO 9002 accreditation. The Scunthorpe unit is a specialist in EPS moulding. As well as its traditional customers in the fishing industry, it supplies the teleelectronics, DIY and household goods industries. The unit has the capacity and experience to supply high volumes of moulded foams competitively, but it can turn its hand equally readily to smaller accounts and unusual product designs. It even makes an innovative moulding for use in garden ponds as a safe place where frogs can hibernate.

Linpac has a very wide range of products and is focussing on six key sectors.

- Automotive products
- Electronic products
- Building and general industrial products
- Food and retail packaging
- Pharmaceutical and healthcare packaging
- Safety related products

### 10.8.6 Styropack (UK) Ltd

Styropack (UK) Ltd is part of the Synbra Group which has headquarters in the Netherlands. The companies stated aims are to be a leading European company in Styrenics and is active in the following sectors:

- Insulation for construction
- Packaging for food, industry and horticulture
- Recycling raw materials.

The company has 40 production sites and 150 production machines in the Netherlands, Germany, France, United Kingdom and Denmark. Turnover is Euro 300 million and the company employs 2000 people. Within the UK, the company has a number of plants, including a new national design centre, which focuses on product design and reduced costs.

The main products produced by Styropack are EPS (expanded polystyrene), EPP (expanded polypropylene) and EPE (expanded polyethylene).

The company's facilities utilise 3D CAD modelling techniques, accredited drop tests, impact simulators, and offers customers an analytical software product design programme.

Styropack's main customers are in the automotive, electronic and electrical sectors and include Sony, Jaguar, Philips, Stoves, Compaq, Samsung and Panasonic.
10.8.7 Observations on EPS Packaging v Moulded Pulp Products

The EPS packaging sector is well organised and approaches the marketing of its products in a professional, technical and scientific manner. The industry has recognised its environmental shortcomings, and is making major efforts to address these, by projecting an environmentally friendly industry, and is working hard at recycling its products.

Key EPS packaging competition to the Moulded Pulp producers occurs in Automotive products, Electronic products, Food and retail packaging and Building products (which primarily encompasses insulation applications). All these sectors are dominated by expanded polystyrene, but offer major opportunities for MPP manufacturers.

The clear disadvantages of moulded pulp packaging, in comparison to competing materials and particularly polystyrene, are the generally poor aesthetics, rough surface and lower performance properties, which are not acceptable for a number of applications. These negative features preclude the use of moulded pulp protective packaging in the majority of consumer areas, with a number of exceptions, which are already serviced.

The polystyrene industry is highly pro-active, in terms of reducing product costs and environmental issues, and has been rapidly developing its production processes, and more technically advanced products. Recent developments have lead to the introduction of biodegradable polystyrene, and this has certainly started to help mitigate the negativities surrounding the disposal of the product. Additionally, due to the over-capacity of polystyrene production, price pressure is a feature of the industry, although with the rapidly escalating price of oil, this pressure has started to affect their cost structure and ability to compete, as cost effectively has historically been the situation, in the packaging market.

It is evident from the study that the MPP industry must achieve a move to a higher technology platform, enabling the production of improved aesthetic products at prices comparative to expanded polystyrene. Until this evolution occurs, the industry must focus its sales efforts on those markets, where appearance, performance and cost are less demanding. However, there still remains good potential for products, which are not aesthetic-sensitive.

10.9 UK and European corrugated market overview

10.9.1 UK corrugated industry overview

Total consumption of corrugated cases in the UK is approximately 2.5 million tonnes, of which just over 2 million tonnes is based on recovered fibre. There are five major producers of corrugated board/cases in the UK, and between then they operate 238 operations. These producers are:

- Mondi Packaging (UK) Ltd
- SCA Packaging Ltd
- Smurfit UK Ltd
- Kappa Packaging UK Ltd
- DS Smith plc.

In addition, there are a significant number of independent manufacturers, in addition to several hundred sheet converters.

The main UK end-use industries for corrugated cases are as follows:

- Foodstuffs 33%
- Manufacturing goods 18%
- Produce/fresh food 10%
- Beverages 11%
- Household/electrical 7%

The trend in demand for the total consumption of corrugated cases and folding cartons across Europe are as in the table below.


10.21 Corrugated case consumption in Europe

<table>
<thead>
<tr>
<th></th>
<th>1995</th>
<th>2001</th>
<th>Estimated 2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrugated (1,000 tonnes)</td>
<td>12,002</td>
<td>14,009</td>
<td>15,143</td>
</tr>
<tr>
<td>Corrugated (million m²)</td>
<td>21,147</td>
<td>24,931</td>
<td>27,248</td>
</tr>
<tr>
<td>Microflute (1,000 tonnes)</td>
<td>817</td>
<td>1,112</td>
<td>1,316</td>
</tr>
<tr>
<td>Folding cartons (1,000 tonnes)</td>
<td>2,477</td>
<td>2,637</td>
<td>2,721</td>
</tr>
</tbody>
</table>

Source: Landell Mills

Growth in the corrugated sector over the period 1999-2000 averaged about 3.0% per annum. During the same period the share of microflute (within the corrugated sector) increased from 8.5% to 10.3%.

The growth in the microflute market can be attributed to the following:
- The need to reduce packaging costs
- Environmentally induced reductions in grammage
- Displacements of carton board
- New market developments

The vast majority of microflute demand is for complex die-cut containers, accounting for 80% of total microflute demand. A further 15% is accounted for by regular slotted cases and 4% by fitments. It is estimated that fitments will maintain their share at about 5% of the European market.

Corrugated containers hold a 63% share of all transit packs, although this share is as high as 86% for ambient food, and as low as 14% for short-shelf-life food.

Five countries account for 70-75% of Europe's corrugated consumption, as follows:
- Germany 20%
- France 15%
- Italy 16%
- UK 13%
- Spain 11%

The level of demand throughout Europe is highly influenced by the prevailing levels of economic activity within individual countries. However, there has been a slowing of demand for corrugated cases as manufacturing industry has been progressively relocating outside Western Europe/UK to lower cost economies. Volume was historically related to GDP, but as manufacturing has declined a more reliable measure is manufacturing output.

10.9.2 Corrugated Die-Cut Inners (Origami vs. Moulded Pulp)

It is forecast that the major area where moulded pulp could gain market share at the expense of corrugated is within the microflute sector. The reason for this is the smaller size of items, which are generally packaged in microflute. (eg consumer/electrical/diy/etc)

In order to estimate the size of the UK market for corrugated die-cut inners (origami), the following assumptions have been made
- 2004: Estimated European microflute consumption 1,400,000 tonnes
- 2004: Estimated UK microflute consumption 182,000 tonnes (assume 13% share)
- 2004: Estimated microflute corrugated inners (4%) 7,280 tonnes

From these estimates, it is evident that the volume of corrugated die-cut inners is relatively low, and therefore does not offer a major opportunity for the moulded pulp industry.

In terms of the remainder of the UK corrugated sector, where the total 2004 consumption is estimated at 2.5 million tonnes, then the volume of corrugated inners is estimated to be approximately 100,000 tonnes. Quite clearly the majority of these inners will not be replaceable by moulded pulp, although there will be opportunities within the following two sectors
- Manufacturing 18% market share
- Household/electrical 7% market share
Potential opportunity  25,000 tonnes

The total potential opportunity for corrugated inner replacement by MPP is therefore estimated at 32,280 tonnes

10.9.3 European corrugated trends

Key trends in the European and UK corrugated industry over the last 5-10 years have been as follows:

- corrugated has been forced to address the fit-for-purpose approach taken by plastics and other materials
- design of finished cases has become more important (e.g. micro-flute)
- purchasing habits of consumers have been analysed to focus industry strategy
- moves to eliminate over-packaging, with the reduction of secondary packaging
- end-use attributes will continue to grow in importance
- cycle times from order to delivery have reduced dramatically, and this will continue
- increasingly successful moves in developing lighter weight grades of corrugated board
- good growth in decorative corrugated, heavy duty corrugated and industrial market applications
- the influence of European environmental legislation to reduce volumes of packaging for both cost and environmental reasons

There is, thus, a large change-process taking place within the European corrugated sector and this, plus the evolutionary pressures on plastic packaging is influencing both the EPS and Moulded Fibre packaging sector.

Packaging weights are reducing and packaging performance/specifications are improving, i.e. two diametrically opposed trends.

10.9.4 Corrugated packaging issues

A recent study of the European corrugated market by PIRA identified the following issues the industry should heed.

- Efforts to capture value-added product development are limited. The main reason is the inherent limitations imposed by the nature of the product
- The corrugated industry must allocate R & D funding to re-examine some of the basic premises related to corrugated materials with a view to creating new applications technology
- Corrugated board survives because it is the most cost effective product for its designed purpose. Other materials can impact this situation if they are able to perform an additional/different function in a non-directly comparable way
- It now takes companies less time to develop and test a new product ready for market, than it takes for its packaging to be produced
- Cycle time compression presents one of the most compelling value-creation opportunities to the corrugated sector

It is interesting to note that the majority of the above comments could equally apply to the MPP industry.

10.9.5 Die-cut corrugated inners/ origami

Die-cut corrugated inners or corrugated origami (as they are sometimes referred to), are the formed shapes inside corrugated boxes/cases which are used to hold the contents in place and to provide protection against impact. The corrugated die-cut shape is made from various combinations of recovered paper, which have been converted into corrugated sheet, and which are then cut out to a pre-determined shape in a die-cutting machine.

The product will be held in suspension in the erected die-cut shape, and is kept away from the sides of the outer case for protection. Corrugated board can be shaped to form partitions, liners and other packaging accessories, that work to cushion semi-fragile products and increase the integrity of the outer container.

10.10 Corrupad

Corrupad packaging has been highlighted, at a small number of interviews, as an alternative to moulded pulp protective packaging. Corrupad was developed in the UK, and is currently manufactured by Dependable Packaging Ltd in Birmingham. The product is covered by a patent and has also been licensed to manufacturers in the USA and Canada.

Corrupad is produced from single-faced C flute corrugated paper and is made from 100% recycled chipboard (the lowest quality of recycled board). The product is produced by layering single face corrugated material on top of itself to produce a thick compressible sheet type structure, which can be pressed and formed into different shapes of cushion packaging.
The ability to produce highly complex shapes is limited, but it can be produced for packaging such as corner protectors, channels, angles etc. It is quite a flexible product, and it is has extremely good cushioning properties. It is reported to comply with a 1 metre drop test for a heavy set of weighing scales.

It is estimated that the annual consumption of Corrupad in the UK market is 800 tonnes.

### 10.11 Honeycomb protection

Honeycomb has been reported as an alternative material to moulded pulp protective packaging. Honeycomb is produced in a complex series of distinct stages, with the honeycomb cells being ultimately sandwiched between 2 outer smooth layers of board material. The specific geometry of the cells give honeycomb, weight for weight, the highest compression strength of any packaging material, and it can be produced in any shape.

Honeycomb is used in a variety of applications, and is particularly effective for the protection of heavy items, whether this is for protective packaging or in other uses. Honeycomb is used for pallets, and is developing a niche in the USA in this sector. It is also being increasingly used in the automotive, aerospace and industrial sectors, and in the heavy furniture industry.

Market leader in the UK is Dufaylite, with Cascades holding a strong position in the North American market.

As a development towards a lower price/improved honeycomb material, work has been ongoing at K.U Leuven in Belgium to produce such a product. This product is similar to Corrupad, in that it is produced from single flute corrugated, by length wise splitting the substrate, turning it, and then gluing to produce the final product.

Honeycomb is a limited competitor to moulded pulp due to its very high cost, but it is a robust packaging and protection medium, and for heavy items is superior in performance to eps, corrugated die-cut origami and moulded pulp.

Shown in the table below are comparisons of the main competing materials used in the industrial and white goods sectors.

This section of the report has been written to show examples of comparisons, and to rank the benefits of each material.

The comparisons highlight the environmental credential of MPP, and although these are comparable to corrugated, they are both far superior to EPS. Moulded shape comparisons indicate that EPS is 4-5 times lighter than MPP, and approximately 2-3 times lighter than corrugated. MPP has excellent nesting/de-nesting characteristics in comparison to EPS. Corrugated shapes are shipped in flat format from the board converter and are erected by hand prior to packing with the item to be packed.

### 10.11.1 Competitive material comparisons for industrial and white goods protective packaging

Given below are marketing, technical and manufacturing comparisons between moulded pulp, EPS and Die-cut corrugated shapes.

#### 10-22 Competitive materials comparisons for industrial and white goods (marketing)

<table>
<thead>
<tr>
<th></th>
<th>MPP</th>
<th>EPS</th>
<th>Die cut corrugated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewable resource</td>
<td>5</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Biodegradable</td>
<td>5</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Weight comparison (gsm)</td>
<td>4</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Lowest cost</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Aesthetics</td>
<td>1</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Ageing properties</td>
<td>2</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Nesting properties</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Packing/erection costs</td>
<td>5</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Volume on a pallet</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><strong>TOTAL RATING</strong></td>
<td>30</td>
<td>20</td>
<td>31</td>
</tr>
</tbody>
</table>

*Rating 1 = worst and 5 = best*

Overall the ranking for both MPP and corrugated die-cut shapes are almost identical.
10-23 Competitive materials comparisons for industrial and white goods (manufacturing)

<table>
<thead>
<tr>
<th></th>
<th>MPP</th>
<th>EPS</th>
<th>Die cut corrugated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of days samples</td>
<td>1</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Product availability</td>
<td>1</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Mould/die cost (1-5)</td>
<td>1</td>
<td>5</td>
<td>3.5</td>
</tr>
<tr>
<td>Wet-end moulding speed</td>
<td>1</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Drying costs</td>
<td>1</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Raw material cost</td>
<td>5</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td><strong>TOTAL RATING</strong></td>
<td>10</td>
<td>23</td>
<td>19.5</td>
</tr>
</tbody>
</table>

Rating assessment (1 = worst and 5 = best)

The manufacturing rating/ranking exhibits, for MPP, the high costs for samples and moulds. Additionally, the low efficiency of the MPP manufacturing process, in comparison to EPS and corrugated is also highlighted. The overall manufacturing ranking identifies the vulnerability of the MPP.

10-24 Competitive material comparisons for industrial and white goods (technical)

<table>
<thead>
<tr>
<th></th>
<th>MPP</th>
<th>EPS</th>
<th>Die cut corrugated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water absorption</td>
<td>3</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Thermal conductivity</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Shock/vibration absorption</td>
<td>3</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Bending strength</td>
<td>2</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Dimensional stability</td>
<td>2</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Fire retardant</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Cushioning properties</td>
<td>4</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Static/dust free</td>
<td>4</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>TOTAL RATING</strong></td>
<td>25</td>
<td>28</td>
<td>24</td>
</tr>
</tbody>
</table>

Rating assessment (1 = worst and 5 = best)

The total technical rating for MPP is comparable to both EPS and corrugated, and highlights the excellent technical performance of MPP. However there are major end-user question marks about the impact/cushioning performance of MPP compared to EPS (e.g. from international electrical goods manufacturers), and these indicate the necessity for fundamental R & D to evaluate this criteria.

10.11.2 Market Opportunities in the Industrial and White Goods Sectors

Current market volumes for Industrial and white goods are 5500 tonnes and 3100 tonnes respectively. Market growth in the industrial protective packaging sector is forecast at 10% up to 2006, slowly decreasing to 6.0% in the period 2010 up to 2014. Growth in the white goods sector is forecast to be at 2.0% up to 2008, and then 1.0% thereafter.

10.12 Summary of Replacement Opportunities for MPP vs EPS and Corrugated Die-Cut Inners

The lack of awareness of moulded pulp products by potential customers, packaging companies, end-users, etc, is a major issue, which must be addressed by the industry if it is to expand its presence in the total protective packaging market. Currently, external knowledge of the MPP industry, its products and participants is low, and this coupled with a lack of industry-wide representation is enabling competitors to gain market share, and effectively leave the moulded pulp industry in a static position.

The two main materials competing against MPP are expanded polystyrene and corrugated die-cut shapes, although the major opportunity for the sales of moulded pulp pulp packaging lie in substituting expanded polystyrene protective packaging applications. Key to secondary manufacturers, end-users, packers and consumers are how these materials compare to each other, over a variety of specifications and issues.
Estimates made earlier in this section indicate the potential moulded pulp protective packaging replacement potential as follows:

- EPS 78,300 tonnes
- Microflute inners 7,280 tonnes
- Standard corrugated inners 25,000 tonnes
- Total replacement opportunity 110,500 tonnes

We estimate that a focused effort on increasing the awareness of moulded pulp products and its benefits, could develop the consumption of moulded pulp products by up to 11,000 tonnes per annum. This figure is based on interview-feedback, increased marketing activity to raise the general low awareness of moulded pulp products and technically improved cushioning.

The lack of awareness is critical in industrial/white goods manufacturing segments where many packaging managers do not even consider moulded pulp as a packaging alternative.

Both the white goods and industrial sectors, therefore offer MPP manufacturers, who increase their activity and presence in these sectors, major opportunities to develop significant new and increased volumes.

### 10.13 Industrial/White Goods Protective Packaging Opportunities

Packaging for industrial/white goods applications is viewed as the segment with the greatest potential for the development of moulded pulp products. This is evidenced across the UK, Europe and North America.

Additionally, there remain further opportunities for after-pressed products to develop increased sales for electronic and electrical applications.

Analysis of the UK potential, derived from interviews, estimates the realistic UK opportunity to be 6,000 to 8,000 tonnes, supported by the existing MPP manufacturing infrastructure, increased marketing activity/capability, and the development of technically acceptable protective packaging structures.

The figures are tonnage estimates based on interviews, sector statistics, competing substrate analysis, etc. It must be stated that these are the potential figures for conversion to moulded pulp packaging, and that the sectors are predominantly/currently serviced by both the expanded polystyrene and corrugated industries.

### 10.25 Realistic opportunities for future development of moulded pulp protective packaging

<table>
<thead>
<tr>
<th>Sector</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial packaging</td>
<td>5,000</td>
</tr>
<tr>
<td>Electronics</td>
<td>1,000</td>
</tr>
<tr>
<td>White goods</td>
<td>500</td>
</tr>
<tr>
<td>Consumer (houseware, tools, etc.)</td>
<td>800</td>
</tr>
<tr>
<td>Plumbing, radiators</td>
<td>400</td>
</tr>
<tr>
<td>Others</td>
<td>600</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>8,300</strong></td>
</tr>
</tbody>
</table>

Source: PendlePace estimates

The total of 600 tonnes for others covers one-off innovative and niche applications for moulded pulp products. A current example of this is the use by Aveda (owned by Estée Lauder) of moulded pulp packaging for an up-market range of cosmetics, which utilises 100% recycled packaging materials (including metal, paper and moulded pulp).
11 UK MPP Market Projected Volumes and Growth Summary

We have projected the consumption development by application in the UK in 2005-2014, based on the information received and assimilated through the interviews. The basis is the consumption by application estimated for 2005, and we have thereafter applied the growth rates in table 11-1. In general, we believe the consumption of MPP in the UK will grow by 1-2% per annum, but with a high variation depending on the application.

11-1 Projected volume and growth by application in the UK

<table>
<thead>
<tr>
<th>Sector</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egg</td>
<td>0.3%</td>
<td>0.3%</td>
<td>0.3%</td>
<td>0.3%</td>
<td>0.3%</td>
<td>0.3%</td>
<td>0.3%</td>
<td>0.3%</td>
<td>0.3%</td>
</tr>
<tr>
<td>Medical</td>
<td>4.0%</td>
<td>4.0%</td>
<td>4.0%</td>
<td>3.0%</td>
<td>3.0%</td>
<td>3.0%</td>
<td>3.0%</td>
<td>3.0%</td>
<td>3.0%</td>
</tr>
<tr>
<td>Industrial</td>
<td>10.0%</td>
<td>9.0%</td>
<td>8.0%</td>
<td>7.0%</td>
<td>6.0%</td>
<td>6.0%</td>
<td>6.0%</td>
<td>6.0%</td>
<td>6.0%</td>
</tr>
<tr>
<td>Food/fruit/vegetables/wine</td>
<td>-1.0%</td>
<td>-1.0%</td>
<td>-1.0%</td>
<td>-2.0%</td>
<td>-2.0%</td>
<td>-2.0%</td>
<td>-2.0%</td>
<td>-2.0%</td>
<td>-2.0%</td>
</tr>
<tr>
<td>White goods</td>
<td>2.0%</td>
<td>2.0%</td>
<td>2.0%</td>
<td>1.0%</td>
<td>1.0%</td>
<td>1.0%</td>
<td>1.0%</td>
<td>1.0%</td>
<td>1.0%</td>
</tr>
<tr>
<td>Fast food/take-away/catering</td>
<td>4.0%</td>
<td>3.0%</td>
<td>3.0%</td>
<td>2.0%</td>
<td>2.0%</td>
<td>2.0%</td>
<td>2.0%</td>
<td>2.0%</td>
<td>2.0%</td>
</tr>
<tr>
<td>Electrical</td>
<td>4.0%</td>
<td>4.0%</td>
<td>3.0%</td>
<td>3.0%</td>
<td>2.0%</td>
<td>2.0%</td>
<td>2.0%</td>
<td>2.0%</td>
<td>2.0%</td>
</tr>
<tr>
<td>Gardening</td>
<td>0.0%</td>
<td>0.0%</td>
<td>-1.0%</td>
<td>-2.0%</td>
<td>-2.0%</td>
<td>-2.0%</td>
<td>-2.0%</td>
<td>-2.0%</td>
<td>-2.0%</td>
</tr>
<tr>
<td>Toys</td>
<td>2.0%</td>
<td>2.0%</td>
<td>1.0%</td>
<td>1.0%</td>
<td>1.0%</td>
<td>1.0%</td>
<td>1.0%</td>
<td>1.0%</td>
<td>1.0%</td>
</tr>
<tr>
<td>Other</td>
<td>2.0%</td>
<td>2.0%</td>
<td>1.0%</td>
<td>1.0%</td>
<td>1.0%</td>
<td>1.0%</td>
<td>1.0%</td>
<td>1.0%</td>
<td>1.0%</td>
</tr>
</tbody>
</table>

Total MPP sector 2.1% 2.1% 2.0% 1.6% 1.5% 1.5% 1.6% 1.6% 1.7%

Source: Based on interviews with MPP producers, end-users and estimates by PendlePace.

The above projections assume that the modus operandi of the MPP industry continues as at present.

The greatest growth, in volume and percentage terms, will take place in the industrial/protective packaging sector, where there is currently a higher substitution opportunity, as and when companies require to substitute EPS in their packaging.

11-2 Projected volume and growth by application in the UK

Source: Based on interviews with MPP producers, end-users and estimates by PendlePace.

11.1.1 Share of Sectors held by Competitive Materials

Estimates have been made of the MPP volume equivalent held by competing materials in each of the key sectors analysed. (Only in products where MPP can replace competing materials)
11.3 Estimates of MPP volumes held by competing materials per sector

<table>
<thead>
<tr>
<th>Sector</th>
<th>MPP Consumption (Current)</th>
<th>Competing materials consumption (current)</th>
<th>MPP volume equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eggs</td>
<td>28,000</td>
<td>4,200</td>
<td></td>
</tr>
<tr>
<td>Medical Disposables</td>
<td>8,000</td>
<td>1,200</td>
<td></td>
</tr>
<tr>
<td>Industrial/White goods</td>
<td>8,600</td>
<td>110,500</td>
<td></td>
</tr>
<tr>
<td>Fruit and Vegetable (trays)</td>
<td>4,200</td>
<td>1,150</td>
<td></td>
</tr>
<tr>
<td>Fast food/Catering (Plates/Cup Holders)</td>
<td>2,800</td>
<td>6,900</td>
<td></td>
</tr>
<tr>
<td>Electrical</td>
<td>2,000</td>
<td>2,000</td>
<td></td>
</tr>
<tr>
<td>Horticulture</td>
<td>600</td>
<td>2,000</td>
<td></td>
</tr>
<tr>
<td>Toys</td>
<td>100</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>500</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>54,800</strong></td>
<td><strong>127,950</strong></td>
<td></td>
</tr>
</tbody>
</table>

Source: PendlePace estimates

The above table summarises the share of each of the sectors held by competing materials. The volume of equivalent moulded pulp tonnes of alternative materials is 230% the volume of moulded pulp, clearly exhibiting the potential opportunities available. However the MPP industry must implement a number of key actions (as detailed at the end of this report), if it is to increase its share against the major competing materials.

11.2 Forecast development of MPP in Western Europe

The consumption of MPP is not expected to increase significantly over the next 5-10 years. There is potential growth in some segments, such as industrial protective packaging and mobile phone packaging inserts, although production is still dominated by egg packaging which is expected to grow in line with the population growth. The total growth rate for MPP will hence be relatively low, and we estimate the growth to 1-2% per annum. (See also chapter 10).

11.4 Estimated development of MPP consumption in Western Europe and the UK

N.B. The Western European MPP consumption estimate is based on 0.70 kg per capita of MPP and population. GDP growth rates used: Western Europe 2.0% throughout the period; UK 2.2% in 2005, 2.1% in 2006 and 2.0% thereafter. Population growth rates: Western Europe 0.22% and the UK 0.29% (Source: CIA).

The consumption of many paper grades increases in line with GDP growth. We have, therefore, illustrated in figure 7-13 what the development of MPP would be in the UK and Western Europe if the consumption grows in line with GDP. As more than half of the production in the UK, and probably the same share in Western Europe, is egg packaging, we also show what the consumption development would be if the consumption follows the population growth in the UK and Western Europe respectively.

The two methods of calculation give consumption levels of 274,060 tonnes (population growth) and 304,593 tonnes (GDP growth) in Western Europe in 2010. For the UK, the consumption levels in 2010 will be 55,760 tonnes (population growth) and 61,895 tonnes (GDP growth) in this way of calculating. The conclusion for the UK is that even though the consumption will develop in line with the GDP growth rate, the actual potential increase in use of recycled fibre in this...
sector is marginal. For this to change, the UK will need one or two more MPP plants of a medium size (>10,000 tonnes) to be established in the country, or for MPP to make a major breakthrough in new applications or technology. The latter scenario will be difficult to achieve, as the competition with other materials is highly intense and as the sectors where this can be accomplished are not large in actual consumption volumes.

11-5 MPP consumption (volume) by country in Western Europe 2004-2014

11-6 MPP consumption (share of total) by country in Western Europe 2004-2014

N.B. Consumption growth based on population growth by country
Source: CIA

Figures 7-14 and 7-15 illustrate the consumption and consumption development by country in Western Europe. The consumption growth has been calculated against the population growth for each country. We have not made a growth development based on the GDP growth, as the GDP growth rates in Western Europe have varied widely during the last few years from very high rates to negative rates. The basis for the consumption is the population in each country and a per capita consumption of 0.7 kg.
12 Global MPP Industry Qualitive Review

Due to the limited/publicly-available information on the MPP industry, interviews have been highly important in providing missing information and verifying other available information. This section summarises the main findings from the interviews.

12-1 Interviewed MPP manufacturers

<table>
<thead>
<tr>
<th>Company</th>
<th>Country</th>
<th>Company</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cullen Packaging</td>
<td>United Kingdom</td>
<td>Beijing Xili Pangpu</td>
<td>China</td>
</tr>
<tr>
<td>Huhtamaki Lurgan</td>
<td>United Kingdom</td>
<td>Haiji Moulded Pulp Pack.</td>
<td>China</td>
</tr>
<tr>
<td>Moulded Paper</td>
<td>United Kingdom</td>
<td>Tianjin Jianlong MPP</td>
<td>China</td>
</tr>
<tr>
<td>Omni-Pac UK</td>
<td>United Kingdom</td>
<td>Tianjinshi Huadi</td>
<td>China</td>
</tr>
<tr>
<td>Pulp-Tec</td>
<td>United Kingdom</td>
<td>Fibrecel</td>
<td>USA</td>
</tr>
<tr>
<td>Vernacare</td>
<td>United Kingdom</td>
<td>Henry Molded Products</td>
<td>USA</td>
</tr>
<tr>
<td>Erin Horticulture</td>
<td>Ireland</td>
<td>JEG Corporation</td>
<td>USA</td>
</tr>
<tr>
<td>Huhtamaki Franeker</td>
<td>Netherlands</td>
<td>Keiding</td>
<td>USA</td>
</tr>
<tr>
<td>Celluloses de la Loire</td>
<td>France</td>
<td>Orcon Industries</td>
<td>USA</td>
</tr>
<tr>
<td>Ecofeutre</td>
<td>France</td>
<td>Pactiv</td>
<td>USA</td>
</tr>
<tr>
<td>SOFREC-SEM</td>
<td>France</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Omni-Pac</td>
<td>Sweden</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The main focus has been on interviewing UK companies, although companies in Western Europe have also been interviewed as there is a high level of trade between the UK and other European countries. Additionally, interviews have been carried out in North America and in China, in order to benchmark the development of the industry in other regions, and the possible impact and similarities to the MPP development in Western Europe.

MPP producers have been the most important interview group, but we have also interviewed end-users to identify the volume and growth for different applications. MPP equipment suppliers are another interview group, as we sought to identify the current and expected future status of MPP technology.

Several attempts to interview a number of the large UK retail supermarket groups proved to be fruitless, with no positive responses to requests for interviews.

12-2 Interviewed end-users, machinery manufacturers and other companies

<table>
<thead>
<tr>
<th>End-users</th>
<th>Country</th>
<th>Machinery manufacturers</th>
<th>Other companies &amp; organisations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excel Industries</td>
<td>United Kingdom</td>
<td>Inmaco</td>
<td>Abbey Board United Kingdom</td>
</tr>
<tr>
<td>NHS (PASA)</td>
<td>United Kingdom</td>
<td>Emery</td>
<td>British Plastics Fed. United Kingdom</td>
</tr>
<tr>
<td>Stonegate Egg Packer</td>
<td>United Kingdom</td>
<td>Pulp Moulding Dies</td>
<td>Conf. of Paper Ind. United Kingdom</td>
</tr>
<tr>
<td>Panasonic</td>
<td>United Kingdom</td>
<td>Tek-Pak</td>
<td>Food &amp; Drink Federation United Kingdom</td>
</tr>
<tr>
<td>Perseco (McDonald’s)</td>
<td>United Kingdom</td>
<td>Beichen Smithery China</td>
<td>Produce Packaging United Kingdom</td>
</tr>
<tr>
<td>Volvo Logistics</td>
<td>United Kingdom</td>
<td>Huanyuan</td>
<td>Remade Scotland United Kingdom</td>
</tr>
<tr>
<td>V&amp;S Group</td>
<td>Sweden</td>
<td>Naya Moulded Pulp Equipment</td>
<td>Robins Pack Consult United Kingdom</td>
</tr>
<tr>
<td>Östgöttaägg</td>
<td>Sweden</td>
<td></td>
<td>PaperFoam Netherlands</td>
</tr>
<tr>
<td>Nohenode Pharmacy</td>
<td>China</td>
<td></td>
<td>IMPEPA USA</td>
</tr>
<tr>
<td>Qingdao Huiyu MPP</td>
<td>China</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yi Ren Company</td>
<td>China</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
12.1 Key issues identified from Global interviews

Detailed below are the key issues identified from the interviews made within the UK, Europe, China and North America.

12.1.1 General issues

- Small number of UK MPP manufacturers (4/5)
- MPP manufacturers were interested in market study.
- A number of MPP manufacturers were not prepared to show production machinery
- No identifiable technical/market-awareness cooperation between current manufacturers
- No UK or European moulded pulp association
- Manufacturers believe there is a lack of market awareness of moulded pulp within the corrugated industry and end-users
- MPP industry requires significant R&D input to machinery to increase output rates and reduce drying/energy costs
- Major price competition from competing materials (e.g. EPS)
- The majority of moulded pulp products are predominantly manufactured from either pre-consumer or post-consumer fibre
- Only small volumes of virgin fibre are used by the MPP industry
- Price is the absolute key driver despite the good environmental credentials of moulded pulp products.
- EPS and plastic equivalent products are generally slightly lower in price.
- Education (suggested in one interview) of children in schools should be used to promote MPP
- The EPS industry is facing big environmental pressures
- Huhtamaki and Hartmann licence their technology to other MPP manufacturers
- Corrugated case manufacturing companies report a lack of awareness of MPP
- Future growth estimates by UK and European MPP manufacturers are that the 5-10 year forecast for the market volumes will be flat/limited growth
- Industrial MPP unit margins are reported as the highest (compared to egg packaging which has lowest margins)

12.1.2 Market issues

- Market growth for existing moulded pulp products (e.g. eggs/industrial) is forecast at between zero to GDP growth
- Expanded polystyrene is viewed as the major competitor
- A narrow number of market sectors is supplied
- There should be room for more producers of egg cartons/trays in the UK after Omni-Pac closed its UK egg packaging plant.
- Little or no price premium is paid by customers for environmental credentials
- Industrial packaging applications are viewed as main future/potential market
- Non-direct food contact acceptability is limiting sales development
- Aesthetics and smoothness of tunnel/conventional dried products restricts acceptance for added-value applications
- Moulded pulp products are under-rated in the market place
- Moulded pulp products in the food sector have been pigeonholed for organic products in the food sector
- Marketing (or a lack of it) is a major issue for the MPP industry
- There is export potential for niche/special/complex moulded pulp products
- Vegetable and fruit sales in supermarkets are moving away from bulk packing and into small unit trays (e.g. 4/6/8 items etc.)
End-users in the fruit sector would like greater availability of coloured MPP

MPP products from China are up to 20% cheaper than equivalent UK products

Starch-based packaging and PLA (Poly Lactic Acid) are becoming market competitors to moulded pulp, but the threat is limited at the moment as the producers (e.g. PaperFoam) have not yet been able to develop a product with as good appearance and strength as MPP or other packaging currently used. The production of PaperFoam is also too slow at the moment to compete efficiently on price with MPP. However, the MPP industry should keep a close watch on the development of new starch-based packaging materials, as this development has just started and is a good environmental alternative to traditional packaging materials.

Corrugated box manufacturers are a major potential channel-to-market for moulded pulp products.

Packaging merchants are a potential channel-to-market (particularly for standard products)

Moulded pulp does not have a good image with the major retailers/supermarkets (it lacks a sophisticated and eye-catching/nice image)

Loading capacity/efficiency of packaging onto lorries/trailers is highly important

Perception that there is a big turnover of buyers in the UK retailing sector.

There is recognition in the retail sector that EPS packaging is not sustainable in the long term.

Pottery sector could be a good/potential market for MPP

Short lead times (as low as 5 days) are available for corrugated die-cut interiors/origami.

Perception that most white goods are too heavy to be adequately protected by moulded pulp.

12.1.3 Technical issues

Not viewed by customers as sophisticated/technical product

MPP products are not generally sold on a technical/specification basis, although the exception to this is the Drop Test/G Factor test.

Lack of confidence in reliability/consistency of MPP vs. EPS products

Limited technical specifications are used/published by moulded pulp manufacturers

Weight ratio of MPP to EPS is approximately 4.5:1

Grammage is the major measured specification

EPS is more voluminous and has inferior nesting/de-nesting properties compared to equivalent shape MPP, and therefore moulded pulp has an advantage in terms of the number of identical sized items (of competitive materials) that can be transported on a pallet, e.g.:

MPP = 24,600
EPS = 7,200
Ratio = 3.4

Drop tests/G Factor are an important test used by the EPS industry Flat sheets of MPP cannot be made as efficiently/cheaply as EPS

Improved printing characteristics and techniques are required for MPP egg packaging.

MPP will produce a stronger protective shape; at a slightly smaller size that EPS, thereby helping to reduce the size/weight of the outer packaging.

A new EEC regulation No 1935/2004, issued on 27 October 2004 called “On materials and articles intended to come into contact with food” is of major significance to the MPP industry.

After-pressing can effect a substantial improvement in the surface smoothness of a moulded pulp structure.

12.1.4 Production issues

Cost and preparation time for moulds is viewed as major hindrance compared to plastics or EPS, and is restricting the efficiency evolution of the industry.

Mould dried products are superior in terms of smoothness and size accuracy to tunnel dried products, but manufacturing speed is 50% slower than the other manufacturing methods.

Thermoforming technology is viewed as slow and costly
Moulds can be made from a variety of materials, including aluminium, brass, stainless steel and plastic resins. The outer gauze of the mould is normally made of stainless steel.

Slow speed/cost of drying of moulded pulp products is an issue.

No industry fibre furnish uniformity in terms of recovered fibre raw materials.

Energy costs for tunnel drying are too high.

The margins of MPP manufacturers have been hit by the increased costs for gas and electricity.

ONP (pre-consumer recovered fibre) is the major recycled raw material.

There is little or no use of wet end chemicals to aid development of innovative products.

All MPP products manufactured in the UK and Ireland use conventional/tunnel drying.

MPP manufacturers do not appreciate papermaking techniques, which could be advantageously applied to the manufacture of MPP.

Packaging costs at the dry-end of MPP machines are high and the industry requires investment in automated packing to reduce costs and improve efficiency.

Manufacturing MPP in colours is a problem for manufacturers (i.e. wash up time from one colour to another).

MPP for eggs requires a large capacity/output to gain economies of scale.

Mixed recovered paper is the lowest cost recovered fibre in both the UK and Europe.

12.2 Observations on UK MPP industry

It is clear that the moulded pulp industry in the UK is very small with only four current manufacturers, and a potential new entrant shortly to enter the market. The UK industry does not work in a coordinated fashion, and it is apparent that there is little communication between the manufacturers, with each believing they have special techniques, to which the others should not have access. The customers for each of the manufacturers are in most cases different, and there is generally little or no overlap.

Impressions gained from both the MPP manufacturers and MPP end-users is that the MPP industry is not progressive, is inward looking, and generally does not take a pro-active and innovative approach to the sales and marketing of its products. In comparison, the EPS industry, which is facing major environmental hurdles and in a market, which has excess capacity, is taking action (through its own trade associations) to project its case to the market, and address the environmental concerns and seek out new markets and opportunities.

In terms of the machinery for manufacturing moulded pulp products, this appears to have changed little over the last 3 decades with the result that output speeds and efficiencies are low, and this coupled with today’s rising imports from outside the UK, raw material development inactivity and rapidly escalating energy costs is moving the MPP manufacturers margins into considerably choppy waters.

Within the purchasing community of all market sectors (with the exception of egg packaging and medical disposables), there exists a massive chasm, with regard the awareness of moulded pulp in all its forms. Moulded pulp has a very low profile within both the commercial and industrial sectors, in comparison to other competing materials such as polystyrene. It is therefore critical for the future development of the UK moulded pulp industry, for the beneficial attributes of moulded pulp to be raised to a higher level, such that it is viewed as a major competing material to both EPS and corrugated origami.

The MPP industry must therefore position its marketing and awareness actions, so that the benefits of moulded pulp are fully (or better) understood. Such actions taken by the MPP industry must of course compare moulded pulp to the major competing materials.

12.3 Key Issues learned in Europe, China and North America

The following sections describe a number of key issues, which have been identified from the Chinese and North American MPP industries, and which can be used to assist the development of UK MPP industry.

12.4 Europe

12.4.1 Environmental issues

Environmental issues are very important for MPP companies in Europe, for the following reasons:
• Environmental image is very important for companies in their contacts with customers
• Some plastic materials and EPS are being replaced by MPP, corrugated and more environmentally friendly plastic materials
• No price premiums are given as customers are not willing to pay premiums for more environmentally friendly materials

The situation is different in North America, where environmental issues and an environmental image are less important.

Most MPP companies in Western Europe are not concerned by the environmental regulations, and they do not expect any changes in the environmental regulations that will have an impact on their businesses. However, the situation is somewhat different in France, where the companies think there may be changes in the environmental regulations, which will have both positive and negative effects on their production:
• Higher environmental fees expected for plastics, and composite materials.
• Rumour that VAT will be decreased for recyclable products.

The growth of MPP in industrial applications is considered to be “100% the result of” EPS substitution for environmental reasons.

12.4.2 Competing materials
The materials competing with MPP depend to a very high degree on the application of the product, although the main competing materials can be ranked in the following order:
• EPS
• Plastics
• Corrugated board
• Cartonboard

EPS is the main competing material because of the trend of substituting MPP for EPS. This replacement trend has increased the competition between MPP, plastics and board in some sectors (e.g. industrial packaging). These materials replace each other frequently depending on the price, environmental trends and company preferences. The demand for MPP is currently on the way up in some sectors because of the increased price of plastics. Corrugated board and cartonboard are on the other hand always price-competitive alternative materials, due to bulk production and low manufacturing costs. This is normally also the case for plastics.

12.4.3 Market issues
MPP producers prefer to sell their products directly to end-users such as consumer products companies and egg packers. They try to avoid using merchants and agents if they can, but naturally use these channels in markets where they sell smaller sales volumes.

The most important market driver is price, which is followed by service of the supplier and quality of the products. The number of customers per plant varies considerably depending on the production volume and nature of the product, but is often in the range of 20-300 customers.

European moulded pulp producers are of the opinion that prices have gone down over the past few years, especially in the egg packaging sector. In view of the increased competition from other materials, and the price pressure from customers, this trend is likely to continue.

12.5 China
There were fourteen interviews in total undertaken in China, and the breakdown of these is as follows:
• Associations and organisations (4)
• Moulded pulp product manufacturers (5)
• Moulded pulp machinery manufacturers (3)
• MPP end-users (2)

There are, currently, approximately 400 manufacturers of moulded pulp products in China; the majority of whom are focused on the manufacture of products for industrial packaging. A small number of manufacturers are involved in the manufacture of products for direct food packaging, although this market was stated to have limited volumes and low operating margins. Manufacturers are rapidly moving away from the commodity markets of egg packaging and fruit/vegetable trays.
The demand for moulded pulp products for industrial packaging applications is still expanding, and there are a number of companies, whose annual output has increased to 1,000-2,000 tonnes per annum. The main products produced are for mobile phones, domestic electronic devices, engineering items, sanitary ware, etc.

There is an interesting demand for moulded pulp pallet utilising heavy load thick wall constructions, and Huadi have developed a production line dedicated to moulded pulp manufacture for pallets and the construction industry.

All major wet-end forming processes are used, and the size of forming platens has now reached 1,000 mm x 1,000 mm. Tunnel drying is the main drying method.

Mould manufacture is predominantly in-house, although a number of external engineering companies are focused on the production of moulds.

Recovered fibre, much of which is imported, continues to rise in price. Energy costs for drying are very high and a number of moulded pulp manufacturers are targeting this to improve their energy efficiencies, and reduce the energy cost/item.

Moulded pulp products are still below the price of the equivalent expanded polystyrene shapes.

The China Moulded Pulp Packaging Association is the main organisation for bringing together moulded pulp manufacturers, mould and machinery producers and end-users.

Topack is a company which provides consultancy, research and development support and trading information on MPP products, moulds and production equipment.

The main issues highlighted from the interviews in China were as follows:

12.5.1 Trade Association

The MPPMAC (Moulded Pulp Packaging and Machinery Association of China) is the organisation representing MPP producers, machinery manufacturers, suppliers and end-users. The association organises events, including annual meetings, seminars and exhibitions within the sector.

The MPPMAC publishes data and newsletters on the latest applications, market consumption data, Government impacting policies, and regular updates on new technology and equipment. Technical bulletins are issued (on a regular basis) to advise of product quality/consistency problems, and a data bank of new and second hand equipment is maintained.

12.5.2 Technical training

Training to the MPP industry, which is coordinated by both MPPMAC and local consulting companies, covers the theory and practice of packaging design, mould design, fibre utilisation, production line troubleshooting techniques etc.

12.5.3 Research and Development

Technical projects in universities and colleges are funded by both the government and MPP manufacturing companies to evaluate specific research issues.

12.5.4 Trading information exchange

Several companies provide trading information on moulded pulp products, mould and equipment accessories, imports and exports of moulded pulp products and manufacturing equipment. Local MPP manufacturers in China also organise technical seminars with foreign companies to promote the use of MPP manufacturing techniques and machinery.

12.6 North America

A total of ten interviews were made in the United States and Canada. The breakdown of these interviews was as follows:

- IMPEPA (Joe-Grygny-President)
- MPP manufacturers (6)
- Mould manufacturers (2)
- MPP machinery manufacturers (1)

The interviews covered a cross-section of views from within the moulded pulp industry, and also included a detailed discussion with Joe Grygny the President of IMPEPA; the sole industry association which represents international moulded pulp manufacturers, machinery producers, mould manufacturers and end-users.

The outcome and responses from the interviews were very similar to the discussions in both the UK and Europe, and therefore reflect a common sense of agreement on the key issues facing the industry.
The interviews were more open than those conducted in Europe, although there was still clear evidence of the reticence within the industry of divulging information, which might enable a competitor to invade another company’s market position.

All the US manufacturers of moulded pulp products showed their fibre preparation, moulds, machines, and discussed their markets in considerable detail.

The key issues highlighted during the interviews were as follows:

- Manufacturers are generally insular and circumspect of each other
- IMPEPA has helped to considerably raise the industry/product profile (predominantly in North America)
- The key competing material is polystyrene (eps), which has recently increased in price (twice)
- Manufacturers’ main problems are:
  - high energy and labour costs
  - mould costs are too high and delivery times are too long
- Manufacturers are seeking to develop niche products
- The manufacture of prototype moulds for trials is too expensive
- Major use of Solid Works 3D solid-modelling software
- Recognition that improved solid-modelling software, incorporating product stress modelling criteria, should be developed to reduce time-to-market for product development.
- MPP manufacturers are aware of the need to increase the promotion of their products to the market, and the necessity to create increased demand/pull from potential end-users and specifiers.
- General recognition that the industry must evolve technically, and at a faster pace, than has historically been evident.
- ONP is the major fibrous raw material
- Price is the number one driver
- The view that the marketing of moulded pulp must become more scientific and technical
- Manufacturers are seeking innovative solutions from machinery manufacturers.
- Machine manufacturers believe the MPP manufacturers should be more progressive.
- Moisture content of moulded pulp products entering the drying tunnels is too low at 25%
- A number of companies are now seeking to reduce drying costs by removing more water during both the forming/pressing processes and by the development of more efficient drying tunnels.
- The environmental credentials of MPP help to open doors at new customers.
- Improved cushioning properties are required for moulded pulp to be considered for use in other applications.
- The threshold of production requires lifting.

12.6.1 IMPEPA (International Molded Pulp Environmental Packaging Association)

IMPEPA (International Molded Pulp Environmental Packaging Association), which is based in Milwaukee is essentially the only international association for molded pulp. IMPEPA is focused mainly on the North American Market, and its presence and impact in the UK and Europe is minimal.

IMPEPA assists individual moulded pulp manufacturers in a variety ways and in many cases for services, for which individual companies cannot afford to pay.

The main services offered by IMPEPA are as follows:

- Moulded pulp product design assistance
- Price estimating
- MPP manufacturer certification programmes
- Advertising in trade journals
- Moulded pulp lectures at universities and conferences
Interacting with environmental (and other related) agencies
Publishing MPP technical data
Research facility availability
Publish MPP market data
Work on additives & coatings
Cooperative prototype mould programme
Interact with foreign organizations

Additionally, IMPEPA assists with new developments in technology, equipment and processes, and applications and trends.

There is no similar association or organisation in the UK or Europe.

12.6.2 Interesting MPP Products manufactured in Europe, China and North America

During the interviews and visits, a number of interesting moulded pulp items were identified, which potentially could be of interest to UK MPP manufacturers. A list of these sectors applications (The majority of which are for packaging/cushioning) is as follows:

- Power tools
- Fireworks
- Pallets
- Water filters
- Automotive and motor cycle accessories
- End caps for rolls of film/paper
- Heavy white goods
- Roll stacking cradles
- Glassware
- Candles
- Lawnmowers

The opportunities to use MPP are endless and there are potentially many innovative applications of moulded pulp, particularly for protective packaging.

12.7 Common industry priorities and issues

It has been concluded from all the interviews that there are a number of common priorities and key issues, which run across several of the geographical areas.

It is evident that that there are a number of common themes and issues facing the MPP industry, irrespective of geographical location. It is important, for the future development of the UK MPP industry, to fully appreciate these factors. Whilst a number of the above items will not impact future strategy for the industry, they will assist to steer the industry towards a more fruitful course.
## 12-3 Key themes and issues

<table>
<thead>
<tr>
<th>Key themes and issues</th>
<th>UK</th>
<th>Europe</th>
<th>North America</th>
<th>China</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing Trade Association</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Market awareness problem</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Case study availability</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>MPP training availability</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>R &amp; D funding availability for MPP</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>R &amp; D funding uptake</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Main competing material</td>
<td>EPS</td>
<td>EPS</td>
<td>EPS</td>
<td>EPS</td>
</tr>
<tr>
<td>No1 customer purchasing driver</td>
<td>Price</td>
<td>Price</td>
<td>Price</td>
<td>Price</td>
</tr>
<tr>
<td>ONP is the main fibrous raw material</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>OCC is the main raw material</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Industrial sector is market with greatest potential</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Thermoforming method is expanding</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>MPP has good environmental credentials</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>MPP is unacceptable for direct food contact (recovered fibre)</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Coloured MPP is not promoted</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
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</tr>
</tbody>
</table>

In terms of priorities, which are common across the different geographical sectors, these are detailed in the following table. The common priorities clearly indicate a number of key areas to be addressed by both the industry itself, and other industry stakeholders, and have been integrated into the future approach for the UK MPP industry.

### 12-4 Industry priorities

<table>
<thead>
<tr>
<th>Industry priorities</th>
<th>UK</th>
<th>Europe</th>
<th>North America</th>
<th>China</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved MPP industry image</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Reduced MPP industry insularity</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Lower fibrous raw material costs</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Improved energy efficiency</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Reduced prototype and production mould costs</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Reduced mould manufacturing time</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Improved 3-D mould modelling techniques</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Increased technically oriented sales and marketing approach</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Future market growth for MPP products is viewed as modest</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Ongoing new-technique development</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
</tbody>
</table>
13 Raw materials

13.1 Global recovered paper market trends

The recovered paper market, which has historically been classed as local, has progressively moved over the last 10 years to become a global commodity sector, generally levelling prices for similar grades between the US, Japan and Europe. This change has predominantly been driven by the increased demands, for fibrous raw materials, to supply the ever-growing production of recovered fibre-based products in China.

The effects of the demand from China have been twofold and are as follows:

- To create volatility in the demand/supply balance
- To push prices to new highs

The chart below indicates the trend for recovered fibre prices from US West Coast and North German origins.

13-1 A global commodity: Monthly old corrugated at the dock and delivered to China

![Chart showing recovered fibre prices from US West Coast and North German origins.](image)

Source: Paperloop

This chart clearly shows the volatility and gradual increases in price which are occurring for OCC (old corrugated container recovered waste). It is forecast for the upward and volatile trend to continue, as the demand for recovered waste in China is expected to increase by four million tonnes over the next twelve months, and by a total approximately eighteen million tonnes in the period from 2005 to 2009.

The forecast trends for recovered paper consumption as defined by RISI/Paperloop in the period up to 2009 is as shown in the diagram below.

13-2 China recovered paper consumption

![Diagram showing China recovered paper consumption.](image)

Source: Paperloop
The graph exhibits the ever-increasing demand forecast for the consumption of recovered fibre in China. The effects of this demand are already patent in the US, Japan and Europe, in terms of upwardly pressurising prices. It is highly likely that this upward price pressure will continue.

13-3 Asia should contribute most heavily to growth in world consumption

![Graph showing consumption trends in Asia, Western Europe, and North America](image_url)

Source: Paperloop

Overall it is forecast that Asia (including China) will contribute most heavily to the growth in global consumption of recovered paper.

Set against the background of increased recovery rates in the three main supplying markets (i.e., Japan/USA/Europe) to Asia, and in particular China, as shown in the following graph, it is unlikely that the recovery rate in China will exceed 30%.

The forecast recovery rates for both Europe and Japan will exceed 60%, or double that of China, with the US recovery rate increasing to in excess of 50%.

13-4 Paper recovery rates

![Graph showing recovery rates for Japan, Western Europe, the US, and China](image_url)

Source: Paperloop

The prices for recovered fibre are not expected to stabilise in the period up to 2009, but will fluctuatingly increase up to that time, as exhibited below.
13-5 Five-year outlook: Prices for selected bulk grades in the US market

![Graph showing prices for selected bulk grades in the US market](image)

*Source: Paperloop*

The outcome of the forecast trends will be to pressurise the costs of manufacturers of paper and moulded pulp products, and ineluctably point the MPP industry towards the use of lower cost recovered fibre, in order to mitigate these increases.

13.2 UK MPP Manufacturers-Sourcing of Recovered Paper

The main raw material (which is predominantly recovered fibre) for UK MPP manufacturers, is sourced through a number of channels including:

- Waste paper merchants: 60%
- Local councils: 10%
- Waste management companies: 10%
- Corrugated case manufacturers: 20%

The majority of recovered fibre in the UK is sourced from waste paper companies, who are situated local to the MPP manufacturing plant. Interestingly, the UK MPP manufacturers are, for the most part, located near to dense population centres, ensuring that they can obtain a regular and consistent supply of the recovered fibre of their choice.

In Europe, there are a number of notable differences, in that the large groups have their own recycling operations while others buy in from several different sources. Noteworthy is that some competing companies buy waste paper from each other.

Huhtamaki runs its own waste paper recycling company in the Netherlands (Huhtamaki Paper Recycling, also called Leo Rijtsma), which operates as a separate company and thereby also supplies external companies (e.g. Renkum and Hartmann). Leo Rijtsma collects 700,000-800,000 tonnes of waste paper per year, and is regarded as a major waste paper collector in the Netherlands. The benefit from having an in-house recycling operation is the technology transfer when starting up new MPP operations, whereby Huhtamaki Paper Recycling assists in setting up the waste paper sourcing. Huhtamaki Paper Recycling exports waste paper across Europe and to the Far East, and in addition imports waste paper from the USA Huhtamaki takes all its waste paper needs from Leo Rijtsma.

Hartmann has a 33% share of a Danish waste material supplier, which is also owned by the local municipalities.

13.3 UK recovered fibre prices-January 2005

The prices for the main grades of recovered fibre within the UK market (in £ per tonne) are as shown below for January 2005:

- Mixed papers: 19-25
- OCC: 40-45
- Over-issue news: 55-60
- News and magazines: 45-50
- Coloured best pams: 62-66
76

- Coloured heavy letter 68-73
- Tear white shavings 75-91
- White heavy letter 98-108
- Woodfree CPO 130-145
- Best white No 2 165-175

Source: Packaging Intelligence Network

The above prices indicate the range of prices for individual recovered fibre grades, which will vary according to location and availability. The above prices are also shown are exclusive of PRN (packaging recovery notes) costs.

The current range (January 2005) for Paper PRN's in the UK, is from a low of £5.25 to a high of £7.50.

Export prices for recovered fibre are generally £5-£10 per tonne higher than UK prices. New government figures suggest that UK exports to China of recovered paper and cardboard are approximately 500,000 tonnes; a huge increase from 3 years ago. Total imports of recovered fibre into China are in excess of 13 million tonnes per annum.

Ironically, volumes of recovered paper from the UK will be used in China for the manufacture of moulded pulp products, which are subsequently exported to the UK.

### 13.4 Utilisation of fibrous raw materials by MPP manufacturers

A small tonnage (approximately 8%) of virgin fibre is used for the manufacture of moulded pulp products. This is used for a small percentage of egg boxes. The remaining fibre consumed is almost equally divided between the following three grades:

- Pre-consumer unprinted news
- Pre-consumer printed news
- Post-consumer mixed recovered paper

Both unprinted and printed news are used by all manufacturers, with the exception of one. Mixed recovered paper is solely used by one manufacturer, although they require this stream to contain a high percentage of newsprint. Both printed and unprinted news are used by manufacturers in varying percentages, depending on the degree of cleanliness that is accepted by their customers.

Waste preparation and treatment plants at manufacturers are generally basic in comparison to modern paper mills, and are equipped with simple screens and cleaning equipment. No fibre development or enhancement, such as refining, is effected on the waste, and the strategy quoted by the manufacturers is ‘to make the best job out of the waste material they purchase.

### 13.6 Raw material segmentation estimates for 2005

Source: Interviews with MPP producers, PendlePace estimates

Moulded pulp manufactured from newsprint is considered to create a softer product than New KLS, but both shape distortion and shrinkage are greater.

2 manufacturers consider the best fibre mix to be 50% newsprint and 50% New KLS, giving the most acceptable feel product with the correct rigidity and shape control.
Of financial potential to the moulded pulp industry, in order to reduce its raw material costs, is the ability to take in lower qualities of waste and to utilise more sophisticated fibre-cleaning systems along the lines of modern paper mills. All the manufacturers of moulded pulp products were not familiar with the modern methods of fibre preparation, cleaning and development in use in the paper industry. Even though the MPP industry is highly dependent on waste paper as its main raw material, its share of the recycled fibre consumption in the UK is very small, as shown in figure 13.7.

**13.7 Share of recycled fibre consumption in the UK 2003**

![Diagram showing share of recycled fibre consumption in the UK 2003](image)

Source: CEPI, PendlePace estimates

**13.5 Utilisation of chemicals**

Moulded pulp products, in the main, contain no chemicals. Exceptions are where water resistance is required. The water resistant properties are developed by adding wax to the fibre furnish. Other chemicals used in the wet-end moulding process are dyes, drainage aids, retention aids and defoamers. Spraying of resins/sealants has been used historically to create surfaces which are impervious to grease for direct food contact, although it is reported that only Hartmann have developed this technology.

**13.6 Increased Use of Recovered Fibre by UK MPP manufacturers**

**13.6.1 Market Growth**

From the earlier discussions of estimated growth volumes for both existing products/markets and for new products/markets, it has been concluded that the increased usage of recovered fibre will be restrained, unless the industry can move forward on a number key issues. These issues are fully detailed in the Way Forward section (Section 19) of the report and include the following key fundamental changes:

- A major improvement in the ability to produce cost competitive products
- A step change in the aesthetic characteristics of products, and at competitive prices
- A greater awareness and demand from the market
- Achievement of equal cushion strength performance vs. alternative/competitive materials
- Migration to increased utilisation of post-consumer recovered fibre

Until such criteria can be achieved by the industry, then the increased demand for moulded pulp products will remain subdued, and will only exhibit limited and incremental growth in the next 5-10 years, as exhibited in the following table.
13-8 Estimated future demand of MPP/recovered fibre

<table>
<thead>
<tr>
<th></th>
<th>Existing products (tonnes)</th>
<th>New products and markets (tonnes)</th>
<th>Estimated increased totals</th>
<th>Consumption per capita (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005 - 2010</td>
<td>+5,300</td>
<td>+3,000</td>
<td>+8,300</td>
<td>1.01 (2010)</td>
</tr>
<tr>
<td>2010 - 2014</td>
<td>+3,950</td>
<td>+3,000</td>
<td>+6,950</td>
<td>1.09 (2014)</td>
</tr>
</tbody>
</table>

On the basis of population forecasts, the MPP consumption per capita ratios are shown for 2010 and 2014. These consumption ratios, whilst increasing, are significantly below the current North American figure of 1.38. It is considered highly unlikely that the UK consumption will surpass these estimates unless there are major technological changes within the moulded pulp manufacturing process, which ultimately create market-lead demand.

The increased utilisation of recovered fibre will track the estimated product growth tonnage estimates in the above chart, and equate to an additional 8,300 tonnes of recovered fibre up to 2010, and a further 6,950 tonnes up to 2014.

13.7 Fibre suitability

Fibres used in the manufacture of moulded pulp products can be categorised as follows:

- Virgin pulp
- Post-consumer old corrugated container, OCC (Old KLS)
- Pre-consumer OCC (new KLS)
- Old newsprint (Over issue news/pre-consumer)
- Unprinted news (Pre-consumer)
- Mixed recovered fibre
- Mill broke

With the exception of old corrugated container waste (OCC/Old KLS) and paper mill broke, all the above fibres are used by the UK manufacturers of moulded pulp products, albeit in different percentages and depending on the application. As detailed earlier in the report, the predominant fibres used by UK manufacturers are New KLS, mixed recovered paper and ONP (over issue news).

The type of the fibrous raw material used for the manufacture of MPP depends on the application of the product; with hygiene, colour, strength, functionality, ease of processability and cost being the key elements in the selection of fibre.

13.8 Fibre application by products

13.8.1 Virgin pulp

Virgin pulp and pre-consumer (bleached) waste are the main raw materials for moulded pulp products used in direct food packaging, catering applications, medical and high value packaging.

Examples of products are:

- plates
- trays
- cups
- fast food clamshells
- lunch boxes
- soup bowls
- pharmaceutical vessel/container
- watches/pens
- mobile phones etc

Some companies use virgin pulp for high quality products, with high demands on strength, whiteness and purity (e.g. medical products in Sweden must be made from virgin pulp).
The price of virgin pulp is often too high, so when virgin pulp characteristics are required, many producers use side-run news or converting broke instead. Examples are:

- Huhtamaki Norway is believed to use broke from its Finnish paper cup operations for its Chinet plates
- Omni-Pac is reported to use side-run news for white products, including egg packaging
- There are no preferred suppliers of virgin pulp to the industry, and the MPP producers buy pulp where it is cheapest. Rottneros Utansjö and Södra Tofte have been named as suppliers (both are market pulp mills). CTMP has been mentioned as pulp grade, and is probably used because of high strength and low price. A comparison of the fibres used in MPP is made in table 13-9, which is based on comments from interviewed companies.

13.8.2 OCC (Old KLS) and New KLS

OCC (Old KLS) and New KLS are used as the main raw material in moulded pulp production for industrial products packaging. Both OCC and New KLS are ideal for the manufacture of moulded pulp products requiring higher strength, due to the content of long kraft fibre in the furnish.

Examples of products are:

- Televisions
- Computers (unit and monitor)
- Microwave ovens
- Dishwashers
- Electric contactors
- Motors
- Bearings
- Parts of industrial products
- Chemical bottles
- Furniture corners
- Pallets

13.8.3 ONP (Over issue news) and Unprinted News

Newsprint (both pre-consumer unprinted news and over-issue news) are used in the manufacture of moulded pulp products, where strength is not the key requirement, but more so in products which require good cushioning properties, softness, and good forming characteristics.

Examples of products are:

- Medical products (not packaging) (e.g. urinal etc)
- Horticultural products (plant pots)
- Egg boxes
- Egg trays

13.8.4 Mixture of OCC and ONP

For both strength and appearance of moulded pulp products, a mix of both OCC and ONP is used in different percentages according to the packaged item specification/requirements.

Examples of these products are:

- Video games
- Mobile phone/landline phone
- Cookers
- Small electric home appliances (shavers, speakers)
- Toasters
- Lamps
- Clocks
13.9 Application sectors

13.9.1 Catering/ direct food packaging applications

Virgin pulp is used for catering application due to its hygiene, colour and appearance.

Both chemical and mechanical virgin woodpulp are used for direct food contact applications. In all cases bleached fibre is used due to its aesthetic properties and cleanliness.

13.9.2 Industrial products packaging

OCC (Old corrugated container) and/or New KLS are the main raw material of moulded pulp products used for industrial product packaging. MPP, utilising this fibre furnish, are used for packaging and protecting heavier products (usually in excess of a weight of 3 – 5 Kg).

ONP alone (or mixed with OCC) is also used as the fibre furnish for industrial items. ONP has a shorter fibre length and produces a smoother moulded pulp surface in comparison to OCC based moulded pulp products. ONP is also used for lighter items (usually less than a weight of 2 – 4 Kg), subject to the contact area with the packaged item.

In many cases, a mixture of OCC and ONP is used for both strength and economic reasons.

13.9.3 Toy and gift and display packaging

High value gift packaging utilises bleached virgin pulp due to it’s white shade, although generally this sector is dominated by mechanical pulp. Mechanical wood pulp has a short fibre length and is ideal for creating complex moulded pulp structures, without bridging at the corners. Additionally, mechanical pulp is used when the overall dimensions of the product is small, and a more detailed/complex shape is required.

13.9.4 Pharmaceuticals

Mechanical/virgin wood pulps are also used in pharmaceutical packaging, such as containers for medicals (e.g. Health products).

13.9.5 Health care/ disposables

Over-issue news and unprinted news are the main raw materials for this application (e.g. urinals/kidney dishes etc). They are used in conjunction with waterproof additives such as wax and wet strength resins.

13.9.6 Pallets

MPP pallet production for transport applications (and as an alternative to wood and plastic pallets) utilise OCC for its higher strength characteristics. Adhesives and starch are used to further strengthen the structure of the pallet.

13.10 Fibre properties and performance

The choice of fibre for moulded pulp products is important, and the properties of the different fibres used in the furnish will greatly influence the characteristics of the final moulded pulp product.

Identical packaging structures made of different fibre types will produce products with different performance and specifications. Raw material with long fibres will develop greater strength, facilitating high loading ability for heavy item packages. Long fibre also provides superior product flexibility. Contrastingly, short fibre based raw material produces moulded pulp products which are more rigid, but with a lower strength threshold.

OCC/New KLS both contain long fibre, which is optimum for heavy products (i.e. over 5 Kg). Due to its high freeness (in the MPP manufacturing process), it is ideal for producing large moulded pulp structures. (e.g. height greater than 140 mm and thickness greater than 4mm). The main disadvantage is that the surface of the moulded pulp structure is rough. This is particularly the case with conventional tunnel drying, but the phenomenon is still quite evident even with mould dried/thermoformed products/after-pressing. High levels of shrinkage also occur with furnishes containing long fibres.

The fibre length of ONP is shorter and more stiff than OCC, and is therefore suitable for the packaging of lighter weight objects (i.e. less than 3 Kg) Products made with a shorter fibre furnish produce a smoother surface, with less shrinkage, thinner walls and more precise dimensions.

Maximisation of properties and specifications is achieved by mixing fibres, and will vary according to the requirements of the finished moulded pulp product. Inevitably, this creates a compromise between physical characteristics and the mould
forming effectiveness and dimensions of the final product. The type of fibre will also influence the mould construction in terms of mesh dimensions.

**13.10.1 Fibre selection criteria**

The main drivers for the selection of fibre (in order of importance) for a specific moulded pulp product are:

- Appearance of product (shade and surface smoothness)
- Functionality
- Weight of product
- Raw material cost
- Availability/quality of raw materials

The leading driver in the selection of fibrous raw materials for the production of a specific moulded pulp product is its appearance. This will determine the colour and greatly influence the type of fibre used; although the functionality requirement of the product will also affect the ultimate fibre choice. The fibre choice will also influence the surface smoothness/feel of the product and this is a key driver in terms of product acceptability against other competing materials (e.g. polystyrene). Customer acceptability of a product is paramount, and all other issues are sub-servient to this criteria.

The weight of the product is important and will greatly influence the functionality (e.g. impact strength/compressibility) of the product, and will also affect the efficiency of forming and drying of the product. The weight of the product will be carefully controlled during the MPP forming process to ensure compliance with product specifications.

Raw material cost is of lower significance, and will be ultimately determined by the higher importance drivers.

Of secondary importance are the process variables, which include:

- Forming parameters of MPP machine
- Cycle time
- Pulp consistency
- Product thickness
- Product height

Moulded pulp manufacturers are adept at manufacturing products, although product dimensions (i.e. thickness, height etc) will determine the mould forming section/type to be used. Small size/long run products will be focused towards rotary machine, whereas very large size/short run products will be more suitable for manufacture on reciprocating/swing type forming sections. Product height and thickness will also be influenced by fibre choice, pulp consistency and drainage rates.

The treatment of fibres (e.g. refining/defibrating etc.) is not a general or understood consideration in the MPP industry, but it is clear from the experience of the paper industry that the influence of fibre treatment on final product quality can be dramatic, and this is an area the MPP manufacturers should seek to investigate.

**13.10.2 Fibre analysis for moulded pulp structures**

The only documented research work on the properties of the different fibres used in the manufacture of moulded pulp products has been undertaken by USDA Forest Products Laboratory in Madison Wisconsin.

In comparison to the paper industry, however, which has studied cellulose fibres for many decades, it appears that the moulded pulp industry has carried out little or no fundamental research, and has not focussed its efforts on maximising fibre properties nor the potential product performance and economic benefits.

The work carried out in the paper industry has resulted in a clear understanding of individual fibre properties, processing conditions, formation, online properties and the final paper properties. This understanding has enabled the paper industry to move paper making to a more scientific approach, which is used for predicting performance characteristics.

While the raw material used for the manufacture of paper and moulded pulp products are identical, the forming process, fibre forming characteristics, densities and structural functionality are different to paper. Limited fibre analysis/research work has been carried out in the moulded pulp industry, and even less of this information has been published.
13.10.3 USDA research overview

Research work carried out at USDA Forest Products Laboratory in Wisconsin (and presented at the 1999 IMPEPA annual conference (www.impepa.com) was to evaluate the performance of different fibres and to establish the effect on moulded pulp structures.

In the research, 11 different fibre furnishes (with ash contents varying from 1.5% to 30%) were pulped in a laboratory pulper (10% consistency) and were then formed into 1000 g/m² sheets. Each of the 11 different fibre furnishes was formed into the finished and dried 1000 g/m² sheet by six different process schemes. The variables of the 6 process schemes were forming, vacuum, pressing, air-drying and hot press drying.

A series of tests were carried out on all samples, and an overview summary of the findings is as follows:

- Short fibres will form a finer moulded pulp structure than long fibres
- Short fibres will orientate themselves, predominantly parallel to the mould surface
- A “free” fibre furnish can accommodate a faster press rate and less dwell time than a slower draining furnish.
- Mat thickness varies considerably with fibre furnish. ONP creates a low thickness and OCC and office waste (+12% ash) a high thickness. Fibre length and ash content both affect MPP thickness.
- Mat thickness can be reduced by up to 47% by a small amount of pressing. ONP is least affected by pressure. This has implications for MPP machine design.
- The moisture content of the wet moulded pulp product is reduced by pressing, and more so as the ash content of the furnish increases.
- Wet MPP thickness reduces with increased pressure. OCC based MPP products are thicker than ONP/higher ash equivalents
- Fibre furnish has dramatic effect on shrinkage. ONP has the lowest shrinkage in comparison to virgin bleached hardwood pulp which has the highest. Applying pressure on the formed wet mat decreases shrinkage, and continuous pressure in a hot press eliminates shrinkage for all different furnishes.
- The Modulus of Elasticity is similar for all air-dried furnishes, although the mould hot drying process produces significant differences between different fibre furnishes.

13.11 Moulded pulp forming process vs. fibre criteria

Fibre selection, as stated earlier in the report, is a key driver in moulded pulp product functionality. The strength performance, aesthetics, smoothness, nestability and other specifications are also significantly influenced by the forming and drying methods.
13-9 Most commonly used fibrous raw materials with the different forming processes

<table>
<thead>
<tr>
<th>Raw material</th>
<th>Processing technique</th>
<th>Feature / application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virgin</td>
<td>In-mould / thermoforming</td>
<td>White smooth finish but expensive fibre</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Good aesthetics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Precise dimensions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Direct food contact packaging</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Process is ideal for colours</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Long runs</td>
</tr>
<tr>
<td>Virgin with water/greaseproof</td>
<td>In-mould / thermoforming</td>
<td>Precise dimension and smooth finish with water and grease resistance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Food packaging, catering disposables</td>
</tr>
<tr>
<td>ONP</td>
<td>Vacuum forming, tunnel drying, In-mould / thermoforming</td>
<td>Light grey in colour</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Suitable for small item packaging because of lower strength</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Long run (rotary)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Medium run (vacuum)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Smooth surface and accurate dimensions</td>
</tr>
<tr>
<td>OCC</td>
<td>Vacuum forming, tunnel drying, In-mould / thermoforming, After-press application</td>
<td>Brown colour</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rough surface finish</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High strength for heavy item package</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Heavy duty packaging</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ideal for industrial applications</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nesting can be improved</td>
</tr>
<tr>
<td>Combination of OCC and ONP (in varying percentages)</td>
<td>Vacuum forming, tunnel drying, After-press application</td>
<td>Softer feel than OCC only</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stronger than ONP only</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intermediate colour acceptable for most industrial packaging</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Suitable for packaging of light to heavy products</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Surface printing is good</td>
</tr>
<tr>
<td>Mixed recovered paper (no deinking)</td>
<td>Vacuum forming, tunnel drying, Thermoforming</td>
<td>Light grey in colour</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Suitable for light and heavy items</td>
</tr>
<tr>
<td></td>
<td></td>
<td>As vacuum + smooth finish</td>
</tr>
<tr>
<td>Mixed office waste (deinking)</td>
<td>Vacuum forming, tunnel drying, Thermoforming</td>
<td>White shade and good aesthetics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Suitable for disposable catering</td>
</tr>
<tr>
<td></td>
<td></td>
<td>As vacuum + white smooth finish</td>
</tr>
</tbody>
</table>

13.12 Conclusions and observations of fibre analysis

The above section of the report indicates there is a major opportunity to carry out fundamental analysis/research work surrounding fibre selection specific to the moulded pulp manufacturing industry.

In addition, utilisation of the experience and knowledge of the paper industry will contribute towards moving the moulded pulp industry towards a scientific approach for developing cushioning, packaging and other moulded pulp structural products.
14 MPP Manufacturing Process

14.1 Recycled Fibre Stock Preparation

The raw material preparation system for the production of moulded pulp is very similar, in principle, to that used in small paper mills.

The process starts with the batch pulper, to which is added a pre-determined volume of water, followed by the addition of a pre-weighed amount of raw material (waste paper). The pulper then dissolves the material for approximately 15 minutes into a well-beaten stock with a consistency of approximately 4%. Normally chemicals are added into the pulper to ensure uniform distribution throughout the fibre stock. Chemicals added to the pulper may include rosin, wax, alum, or other chemicals to impart special properties to the finished moulded pulp product.

The stock is then pumped to the pulper dump chest, where it is kept agitated. From the dump chest, the stock may be treated in a number of ways. It may be transferred direct a second/machine chest, where it is reduced in consistency to approximately 1.0%. This reduction in consistency in many operations is achieved manually, by a fixed addition of water. Alternatively, it may be reduced in consistency (via an in-line consistency meter), which will measure the stock consistency entering the consistency controller, and add the precise volume of water on a continuous basis, thereby ensuring that the desired/target consistency is achieved.

In a number of operations, and where generally lower qualities of recycled fibre are utilised, the stock may be cleaned in hi-consistency cyclone type cleaners. These rely on the centrifugal force to separate the heavy contraries (such as metal, dirt etc) from the lighter fibre fraction. The contraries will normally be sent to landfill. The clean fibre may also be passed through a refiner to develop the strength and characteristics of the fibres (not a widely used process).

The refiner consists of two rotating (and closely positioned) plates, through which the recycled fibre is passed. The surface of the plates is lined with metal bars. By varying the number, width, height and formation of the bars, there can be a subsequent and beneficial effect on the quality/performance of the refined pulp.

The purpose of refining recovered fibres is to improve the main properties of recycled fibre. Many of the fibres have high strength potential that refining can exploit. Refining will also help to correct the negative effects of earlier fibre treatment in the pulper, such as swelling, flexibility and fibre-to-fibre bonding potential. Strength enhancement is often a refining goal for packaging products, and certainly moulded pulp for protective packaging can fall into this category. Whist refining can increase certain strength characteristics, there is also an effect on other properties. Refining can affect freeness, and this will be reflected on the drainage time on the mould and the water removal properties.

An optimum compromise is therefore necessary, not only between cost-effectiveness and quality, but also between different quality parameters.

Recovered waste fibre usually comprises a mixture of different fibres types according to the origin of the material. This can result in differences in refining resistance or potential between the various stock components. In some plants, there are different stock preparation systems for different fibres to maximise the properties of the fibres.

From the machine chest, where the consistency is approximately 1%, the stock will be pumped direct to the pulp moulding machine. In more sophisticated continuous/rotary pulp moulding systems the stock to the moulding machine will be controlled by a flow meter, to ensure a uniform rate of addition to the machine. In term of the reciprocating type machines, the control of stock is not so complex, and a more manual type system is often utilised.

Both Rotary, Reciprocating and Thermoforming (in-mould) pulp moulding machines require vacuum to remove as much water as possible from the forming moulds. This vacuum is applied by large vacuum pumps, which extract water from the mould. Between the mould (from where the water is being removed) and the vacuum pump, there is always a vacuum separator, the purpose of which is to separate the water and the air removed from the mould. The removed air is normally expelled to atmosphere and the water is recycled (often via a filter/screen) back to a white water storage tank, from where it is re-utilised as dilution water in the pulper. High-pressure water for cleaning the moulds, in between cycles, is also usually recycled water.

All moulding machines have a requirement for a supply of air to release the newly formed fibre shape from the forming mould. This air is supplied from an air compressor system.

14.1.1 Typical stock preparation system layouts

Shown below are typical stock preparation system layouts. These were obtained from Emery International Developments in Toronto, and the second layout is attributable to EPPSI (Evergreen Pulp and Packaging Systems Inc). Both systems are very similar in design with minor differences.
14.2 Wet end forming methods

14.2.1 Moulded pulp product forming process

Moulded pulp products have been produced since the early 1940's. Egg trays were the first product manufactured, but the range of products manufactured has increased significantly since that time, and now includes fruit trays, simple containers, egg cartons, furniture corner protectors, industrial product packaging/partitions, and disposable products for catering and hospital applications etc.

With the increasing use (and varieties of design) of moulded pulp products, production equipment and techniques have also progressively evolved. New techniques for producing smooth surfaces, precise shapes and dimensions have been developed by the introduction of the in-mould (thermoforming) process.

Heavy load items with thick wall structures, and products with high drafts (heights) are also being manufactured. These developments have enabled MPP to enter markets from which they have been historically precluded. Further market opportunities have been offered by the drive (particularly in Europe) for environmental advancement in packaging and recycling.
14.2.2 Moulded pulp forming machines

Traditionally, the process for the manufacture of moulded pulp products consists of the following sequential stages:

- Pulping
- Moulding (wet-end)
- Drying
- Finishing

The wet-end of the moulding machine is the heart of the moulded pulp production process, and determines which type of moulds can make the required product. The drying section of the machine is the secondary part of the process and is designed to match the output rate of the moulding stage, and to produce a dried and saleable product.

14.2.3 Vertical reciprocating wet-end

The reciprocating wet-end forming method normally consists of one main forming platen (on which a number of individual forming moulds/dies are installed). This platen moves, vertically up and down (into/out) of the pulp holding tank. When the mould platen moves vertically down into the pulp holding tank, and it is fully immersed in the pulp solution, it stops, and as vacuum is applied to the inside of the mould, fibres are drawn onto screen surface of the mould (in the shape of the wet product). The water from the fibre stock is removed by the vacuum, passing through the holes inside the mould. This water, and small amounts of fibre, pass into the vacuum separator vessel, and are then returned to the white water tank.

After a pre-determined period of time (approximately 15-60 seconds), the required thickness of fibre has formed on the surface of the mould, and the mould then starts to move vertically into the upper position. As the forming mould moves to the top of it’s vertical stroke, it meets the transfer mould (of which a number are attached to the transferring platen), and transfers the wet formed shape to the transfer mould (to which vacuum is applied). As the wet shape is being transferred, the vacuum on the lower forming mould ceases to operate and is replaced by gentle blowing air, which assists the transfer of the wet product shape.

When the wet product has been fully transferred to the upper transfer mould, the lower forming mould commences to drop down back into the pulp tank, and re-starts the moulding process. Simultaneously, the transfer mould moves sideways, until it is positioned over the start of the drying tunnel conveyor. When in the correct position, the forming moulds drops vertically down, and aided by the cessation of the vacuum and the assistance of blowing air, deposits the wet-formed product onto the start of the drying tunnel conveyor. The forming mould then moves vertically/sideways and back to it’s original position, in preparation to receive the subsequent newly formed wet product from the forming mould.
High-pressure water sprays clean both the forming mould (and in a number of installations the transfer mould) to ensure that the surfaces are clean, thereby enabling an efficient and clean moulding and transfer process to continuously occur.

The most popular sizes of forming mould backing platens are 1200 mm x 1100 mm, 1070 mm x 660 mm, and 800 mm x 600 mm. The size of the mould and the dimensions of the platen determine the maximum number of mould shapes that can be accommodated on one platen. Productivity depends on the size of the platen, the number/dimensions of the mould shape and the cycle time for each forming cycle.

The distance between the forming platen and the transferring platen controls the height of the product that can be manufactured. This distance is adjustable and enables the height of the wet product to be altered according to customer requirements. The distance between the two platens is generally variable from 140mm to 350 mm, although in the maximum situation the distance can be up to 420 mm. As a general rule, the greater the distance, and therefore the higher the size of the wet product, the longer the cycle time.

A major advantage of the reciprocating forming process is the ability to simultaneously produce different shaped products, and with varying heights. This facility provides great flexibility in the production process, enabling several products in small quantities to be produced at the same time. This flexibility helps to reduce mould costs.

Some machines are designed to vary the vacuum distribution along the platen, in order to accommodate the different size of products.

The disadvantage of the reciprocating moulding process is that the productivity rate is relatively low, and in the case of complex products, uneven fibre deposition can occur resulting in the potential to create varying product wall thickness. These potential variations can affect the final quality and output rate of the finished products.

### 14.2.4 Swing movement wet-end

In this type of machine, the movement of the forming platen (on which the forming moulds are positioned) is a swing-type action between the slurry tank and the transfer plate. There are 2 forming platens positioned at 180°, and which alternately swing in and out of the pulp tank.

#### 14-4 Swing movement wet-end moulding process

![Diagram of Swing movement wet-end moulding process](source: PendlePace Ltd)

At the start of the cycle, the empty platen swings from its upper position into the pulp holding tank. When the moulding platen is fully immersed in the pulp solution, it stops, and as vacuum is applied to the inside of the mould, fibres are drawn onto the screen surface of the mould (in the shape of the wet product). The water from the fibre stock is removed by the vacuum, passing through the holes inside the mould. This water, and small amounts of fibre, pass into the vacuum separator vessel, and are then returned to the white water tank.

After a pre-determined period of time (approximately 15-50 seconds), the required thickness of fibre has formed on the surface of the mould, and the mould then starts to swing into the upper position. As the forming mould moves to the top position, it meets the transfer mould (of which a number are attached to the transferring platen), and transfers the wet formed shape to the transfer mould (to which vacuum is applied). As the wet shape is being transferred, the vacuum on the lower forming mould ceases to operate and is replaced by gentle blowing air, which assists the transfer of the wet product shape.

As the wet product is being fully transferred to the upper transfer mould, the counter forming mould has simultaneously swung back into the pulp tank, and re-started the moulding process. Immediately on transfer of the wet product, the transfer mould moves sideways, until it is positioned over the start of the drying tunnel conveyor. When in the correct position, the forming moulds drops vertically down, and aided by the cessation of the vacuum and the assistance of blowing air, deposits the wet-formed product onto the start of the drying tunnel conveyor. The forming mould then moves vertically/sideways and back to its original position, in preparation to receive the subsequent newly formed wet product from the forming mould.
This process can produce products with a relatively even wall thickness. In contrast to the vertical forming wet-end process, the swing movement of the forming platen can minimise/reduce localised fibre concentrations (in hollow areas) by pouring out excess slurry.

The disadvantages of the swing movement moulding process are that the height of the mould shape is limited, and that different shapes/heights of moulds cannot be accommodated on the mould-forming platform.

### 14.2.5 Rotary forming wet end

The highest output moulded pulp forming process is the rotary type wet-end. The forming section consists of up to eight moulding faces (as shown above) on a rotating drum. For each movement of the rotation of the drum, one forming face is immersed in the pulp tank and by the assistance of vacuum, the mould/screen surface picks up the fibre from the pulp stock and forms the product shape.

#### 14-5 Rotary forming moulding process

![Diagram of rotary forming moulding process](source: PendlePace Ltd)

The wet forming section consists of a series of wire screen covered wet-forming dies mounted on the moulding drum, and a matching set of transfer dies mounted on a transfer mechanism.

The forming die is made up of rigid corrosive resistant metal and consists of many component parts that are drilled with small drainage holes and covered by pre-formed stainless steel screens. The matching opposite transfer die has no screen and is drilled with small holes.

The forming die, mounted on the moulding drum is rotated at a uniform speed, immersing it in a taper flow vat containing the pulp stock (approximately, 1% consistency) of fibres. The taper flow vat moves the stock at the same relative tangential speed as the dies to reduce wash off of fibres. Vacuum draws the fibres onto the forming die screens as the suspending recycle water is drawn through the screen and drainage holes.

As the drum rotates, this forming face moves round and upwards and out of the pulp stock. Water in the slurry is further removed by vacuum, and then the wet product is transfer to a transfer mould.

When the matching transfer mould comes into contact with the freshly formed fibre product on the forming die, there is a gentle puff of air from the forming die, and vacuum in the transfer die gently lifts off and transfers the wet formed products (about 75% water at this stage) onto the transfer die.

The transfer mechanism consists of a series of transfer dies, rotating about a central shaft, and mounted on a series of pivot shafts. These are designed to locate, orient and mate the transfer dies in perfect synchronization by pivot and orientation cams, with the movement of the wet forming dies, and to remove and transfer the weak wet moulded products by vacuum at a high speed and then deposits them on dryer conveyor trays by an alternate gentle air puff through the transfer dies when they are above a matching dryer conveyor tray.

A cleaning solution and high-pressure water die cleaning systems allow the moulding dies to be cleaned in place on the machine without any of the normal cumbersome and time-consuming die removal.

The pulp stock is pumped to the machine, as required, from a machine control centre. Aluminum sulphate solution is automatically metered into the stock line by a metering pump. White water is also added to the stock and is automatically metered with a flowmeter proportioning and recording system. The level of stock in the moulding machine recycling chamber is automatically controlled by means of a differential pressure cell and level controller. This level controller automatically adjusts the magnitude of flows of white water and stock that has been proportioned. The automatic level and flow controls regulate constant weight and quality.

This type of the machine is suitable for high volume production of specific commodity type products (e.g. eggs cartons/egg trays).
One face of a drum in a rotating form machine can vary in size from 1181 mm x 335 mm to 2705 mm x 355 mm. Rotary machines can generally make products up to a depth of approximately 127mm. As the multiple plates across the rotary machine can hold many moulds, the initial mould costs can be extremely high.

The above process description is sourced from Emery International Developments. Shown below are photographs of the Emery 108 machine, which is the world’s widest and fastest rotary moulded pulp machine.

14-6 Emery 108 machine

14.2.6 Combined mould forming

For vessel/container-like products, a combined mould-forming machine is used. Bottle shaped products (with a large vessel size and a small opening) are produced by the combination moulds.

Essentially the combination mould is a two-piece set of moulds, which fit together. In operation the two parts of the mould are closed prior to being immersed in the pulp stock. The stock enters the central chamber and the pulp fibres are forced to the outer surface of the mould, forming the shape of the vessel.

At the end of the forming cycle, the combination mould is raised out of the pulp stock and the two moulds separate. The wet product is then removed out of the combination mould and is placed onto the conveyor for the drying process.

The combined mould machine is designed for high volume commodity specific products. The main application of the combination mould process is for the manufacture of disposable urine containers for hospitals, although the uniqueness of the process lends itself to the development of other speciality moulded pulp products.

14.2.7 Compression forming process

A patented technology (and machine) has been developed for the manufacture of high wall thickness board and shallow shaped products. The machine consists of a combination of both a vacuum and press system, for high consistency pulp stock.

A pulp concentration up to 20% is metered into the mould and the shape is formed utilising both pressure and vacuum. This patented technology can make a continuous layer of moulded pulp board, which can be used as modules to manufacture containers, partition/insulation board, construction board or pallets.

The normal operating width of the machine is 1000 mm and the length of the sheets can be cut to the customer’s requirements. The current thickness capability of the equipment is 10 mm to 12 mm, although thicker boards can be manufactured by using an alternative type of mould and reducing the pressing load. The current maximum speed of the compression moulding process is 1.5 m/min with a board grammage of 6-8 Kg/m².

14.2.8 High consistency forming

The vacuum forming technique can make MPP with a wall thickness up to 5 mm. With high consistency, forming cycle times increase dramatically with wall thicknesses greater than 5 mm; although a thickness of up to 15 mm can be produced using this method. High consistency forming uses fibre stock with a consistency of 10-20% and both vacuum and high pressure pressing are used to remove water, prior to drying. Products manufactured by this technique serve as an alternative material to replace wood, and can also be used in heavy load applications.
14-7 Forming process comparisons

<table>
<thead>
<tr>
<th>Forming process</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical reciprocating</td>
<td>Suitable for most types of MPP</td>
<td>The dimension of the forming platform restricts the number of the mould</td>
</tr>
<tr>
<td></td>
<td>Different types of moulds can be used at the same time</td>
<td>Mould base is needed when the height of different product is not the same</td>
</tr>
<tr>
<td></td>
<td>Flexible process and low cost of moulds</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Can produce high wall products</td>
<td></td>
</tr>
<tr>
<td>Swing movement</td>
<td>Output rates are higher than the vertical forming as a twin-headed process</td>
<td>Height of the products is limited</td>
</tr>
<tr>
<td></td>
<td>is used</td>
<td></td>
</tr>
<tr>
<td>Rotary forming</td>
<td>Ideal for commodity production for specific products</td>
<td>Height of the products is limited</td>
</tr>
<tr>
<td></td>
<td>High production efficiency</td>
<td>High initial mould cost</td>
</tr>
<tr>
<td></td>
<td>Automatic operation</td>
<td></td>
</tr>
<tr>
<td>Combined moulds</td>
<td>Designed for bottle shape type products with narrow neck opening</td>
<td>Limited product range</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High mould cost</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High maintenance cost</td>
</tr>
<tr>
<td>Compression forming</td>
<td>Precise shape and dimension</td>
<td>High mould cost</td>
</tr>
<tr>
<td></td>
<td>Smooth surface product</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Superior nesting properties</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Automatic operation</td>
<td></td>
</tr>
</tbody>
</table>

14.3 Pressing techniques

There are 3 types of main pressing process as follows:

- Wet pressing
- In-mould pressing
- After-pressing

Wet pressing is normally carried out to thick moulded pulp products, where there is a requirement for a product with a smoother reverse side.

The in mould press (also called thermoforming) technique is used where products are pressed and dried in moulds, immediately after the product has been formed.

The after-press process is used after the product has been formed and dried, and is used to smooth the surfaces prior to the packing stage.

14.3.1 Wet pressing

Wet pressing is a process carried out between the wet-end forming stage and the drying process. It is normally used where the requirement are for products with a smoother backside. In packaging items this is carried out, in order to achieve improved nestability of products and a reduction in transport.

Wet pressing is particularly suitable for smoothing thick wall items for heavy-duty product packaging.

14.3.2 After-pressing

After-pressing is a secondary process, carried out after the moulded pulp product has been dried in the drying tunnel.

The after-press consists of two moulds, both of which are identical in shape to the item, into which the dried moulded pulp product is placed. Both heat and pressure are applied to the product, helping to eliminate distortion and producing a product with a fine and smooth surface. The compression effect from the process assists the cushioning performance of the product.

The after-pressing process is more suitable for thin walled moulded pulp products, and has a significant aesthetic improving effect on the product. It is used for electronic packaging, and other similar applications. Additionally, a smoother product delivers improved nestability and reduced transport costs.

A number of machines are equipped with two or three after-presses to either give smoother products, and to handle high rates of production.

It is expensive in terms of energy (electricity) consumption.
14-8 Simplistic arrangement of the after-pressing process

![Diagram of heating elements]

Source: PendlePace Ltd

14.3.3 In-mould process (Thermoforming)

The in-mould process (thermoforming) is used in the manufacture of items, which require to have a precise/exact shape, and which have excellent aesthetics.

14-9 Outline of a typical three-mould set thermoforming process

![Diagram showing process flow]

Source: Ipsung Co. Ltd.

The lower fibre forming mould is dipped into the recycled pulp slurry, at which point vacuum is applied. This causes the mould to pick up fibre, which then forms into the shape of the mould. The lower forming mould then moves upwards out of the fibre slurry (carrying the wet fibrous moulded form) and meets the upper transfer mould. At this point, the vacuum on the lower mould ceases to operate, and the vacuum on the top mould comes into effect, thereby picking out the moulded form from the lower mould. The upper transfer mould then transfers the moulded fibre shape to the first heated lower drying mould, where it is pressed by the upper heated mould.

The partly dried moulded form is then transferred to the next drying mould, where it is subjected to further pressing and heat.

On leaving the second (or in many cases the third) drying mould, the dried form then passes to the packing stage. The moulds are heated electrically.

The key points concerning the mould drying process are as follows:

- The moulded pulp item is completely dried in the moulds
- No distortion or variation in the shape or size of the item occurs
- The mould drying process is very space efficient
- Press tonnage is approximately 150 tonnes
- The production rate is controlled by the dwell time and temperature of the mould
- An exceptionally smooth surface on both sides is created
- Printable on both sides
- The final product has lower draft angles and greater depth of form to enable creation of new product designs.
- Cycle time is extended at approximately 30 seconds.
- A small footprint in comparison to conventional moulded pulp manufacture
- Operating temperature is approximately 250° C.
- Excellent access for maintenance, tooling and machine components.
### 14.3.4 In-mould process die sequencing

#### 14-10 Sequencing of the forming mould and the pressing/drying moulds in the in-mould process

![Diagram of in-mould process die sequencing]

*Source: PendlePace Ltd*

### 14.3.5 Pressing method comparisons

<table>
<thead>
<tr>
<th>Pressing methods</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>After-pressing</td>
<td>Maintain the shape and dimensions of the item</td>
<td>Extra moulds are needed</td>
</tr>
<tr>
<td></td>
<td>Have smoother surface on both sides</td>
<td>Increased energy is required to operate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fully automatic operations are limited</td>
</tr>
<tr>
<td>In-mould pressing</td>
<td>Relatively low speed process</td>
<td>Suitable for long-run products</td>
</tr>
<tr>
<td></td>
<td>Accurate dimensions achieved</td>
<td>Very high mould prices</td>
</tr>
<tr>
<td></td>
<td>Smooth surfaces on two sides</td>
<td>High energy consumption</td>
</tr>
<tr>
<td>Wet pressing</td>
<td>Suitable for high wall thickness products</td>
<td>Unconventional mould design</td>
</tr>
<tr>
<td></td>
<td>Fully automatic operation</td>
<td>Synchronised forming equipment is required</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Extended drying time</td>
</tr>
</tbody>
</table>

### 14.4 Drying methods

There are two main types of drying processes using in the drying of moulded pulp products, which are:

- Tunnel drying
- In-mould drying

Additionally, there are a number of alternative (less prevalent) methods, including microwave drying, chamber drying etc.

#### 14.4.1 Tunnel drying

Tunnel drying is the most common and widely used form of drying, and probably accounts for approximately 85% of all drying installations.

There are two types of tunnel dryers:

- Single pass dryers
- Multi-pass dryers

#### 14.4.2 Single pass tunnel drying

A schematic diagram of a single pass tunnel dryer is shown below. Essentially the dryer consists of a series of interconnected drying tunnel modules, through which runs a single layer slatted conveyor. The length of the tunnel can be constructed to the drying requirements, but would normally be in the range of 15 metres to 50 metres. The normal widths for conventional drying tunnels are from 1.2 metres to 2.5 metres.

The number of modules and hence zones determines the drying capability of the total tunnel. The majority of tunnels usually have 5 zones for heating, but there can be as many as 7 and few as 3.
In operation, the wet moulded pulp product is deposited onto the conveyor at the entrance to the tunnel, and is then conveyed to the outgoing side by the slatted conveyor, which is always constructed of metal.

Normal energy for drying is direct natural gas (and very occasionally steam), and air circulation is achieved by a series of fans positioned along the length of the tunnel.

The temperature is raised quickly within the first drying zone to raise the water in the moulded pulp product to evaporation point, and then this elevated temperature is maintained to a position approximately 75% along the length of the tunnel, where after the temperature is reduced to enable the dried moulded pulp product to cool.

The tunnel dryer is a very basic piece of equipment, and has very gradually evolved over the last 30 years, with performance controls now including variable speed fans, individual zone temperature control and variable speed conveyors.

The single pass tunnel is used for a variety of products and is highly flexible in it’s ability to simultaneously dry different size items.

### 14.4.3 Multi-pass tunnel drying

In the multi-pass tunnel dryers, the conveyer passes up and down the tunnel a number of times.

This type of dryer is shorter but higher than the single pass tunnel dryer. Generally, the multi-pass dryer is used for commodity items; with egg trays and cartons being the predominant application.

### 14-12 Multi-pass dryer

The chamber dryer consists of a large drying room into which wet moulded pulp items are manually placed. When the room is full to capacity, the drying operation is started. When the items are considered dry, they are again removed (manually) from the chamber, wrapped and then despatched to customers. Chamber dryers can be heated by either the atmosphere, oil, steam or by direct gas heating. Chamber drying is no longer viewed as a commercially viable process in the USA or Europe, although Inmaco of the Netherlands offer a chamber drying system.

### 14.4.5 In-mould drying process

The in-mould (thermoforming) process has been described earlier in this section.
14-13 Drying method comparisons

<table>
<thead>
<tr>
<th>Drying methods</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chamber dryer</td>
<td>Flexible operation and suitable for different types of wet items</td>
<td>Labour intensive for transporting items in and out of dryer</td>
</tr>
<tr>
<td></td>
<td>Requires only a small footprint</td>
<td>Not commercially viable in USA and Europe</td>
</tr>
<tr>
<td>Single layer tunnel dryer</td>
<td>Simple to operate and suitable for different types of MPP</td>
<td>Large size equipment</td>
</tr>
<tr>
<td></td>
<td>Graduated/variable drying temperatures, which can be tailored to different products</td>
<td>High energy consumption</td>
</tr>
<tr>
<td></td>
<td>Ability to dry very large products</td>
<td></td>
</tr>
<tr>
<td>Multi layer tunnel dryer</td>
<td>Relatively small operating space required</td>
<td>Complex structure and difficult to maintain</td>
</tr>
<tr>
<td></td>
<td>Ability to minimise product distortion by an extended gradual drying process</td>
<td>Inflexible for different type of products</td>
</tr>
<tr>
<td></td>
<td>Height of the item is limited</td>
<td></td>
</tr>
<tr>
<td>In-mould drying</td>
<td>Fully automatic operation</td>
<td>Only suitable for thin wall item drying</td>
</tr>
<tr>
<td></td>
<td>Precise shape of made item</td>
<td>Very high mould costs</td>
</tr>
</tbody>
</table>

14.5 Packing methods

14.5.1 Manual packing

From the interviews and visits to manufacturers of moulded pulp products, it is apparent that manual packing is the most prevalent method employed, with the exception of commodity grades such as egg packaging (produced by the rotary process), and trays etc (produced by in-mould (thermoforming))

Tunnel dried products, including those after-pressed, are predominantly manually packed.

Key reasons for the use of manual packing lies in the variable size/roughness of tunnel dried products, and the lack of good nestability for this type of product.

Manual packing of moulded pulp products is a highly labour intensive (and costly) process.

14.5.2 Automatic packing

Automatic packing machines are used for specific commodity items, such as egg packing, fast-food cup-holders, etc. The automatic stacking and packing device collects the item from the end of the drying conveyor and places it in the required packaging for onward transport to the customer. Automatic packing lines are custom built for specific applications, and due their high cost, currently, have limited usage in the moulded pulp industry.

A leader in automatic packing, and used in the US moulded pulp industry is Festo & Co AG of Germany. Festo is a global leader in automation with both pneumatic and electronic components and systems. The company has over 20,000 systems in operation in several hundred variants. The company offers a turnkey automation system to many industries and is capable of developing bespoke systems for special packing applications.

14.6 Types of MPP machines (mould dried vs. tunnel dried)

Rotary forming is the most common European production method (seven out of ten interviewed companies), as it is much faster than in-mould drying.

Egg packaging is always made with rotary forming, as are a number of other MPP; whilst industrial packaging is normally made by reciprocating machines. This will probably change though as in-mould drying is too slow and expensive. Very few MPP producers buy in-mould machines when buying new machines nowadays, despite the high quality of this production method.

The downside for rotary machines is the minimum order size, which is usually in excess of 500,000 units. Orders for industrial packaging are often much smaller in size, and it is not profitable for manufacturers to produce such small orders on a rotary machine. Another problem is that the quality of products made in rotary machines is not as good as in-mould made products. The rotary-made products tend to shrink and distort slightly, even though the appearance of the products have improved significantly with the after-pressing method.

Most MPP manufacturers make their own machines and moulds. Usually they buy in the first machine from an external MPP machinery supplier, and then build their own machines based on the first machine's design. Normally each manufacturer makes some changes to the technology of the machines, which is why there are so many different types of machines. The actual difference between the machines is relatively limited.
Key drivers in the decision to completely gravitate towards tunnel drying are the lower cost of moulds, and the higher line speed.

The market for mould-dried products, which are superior in smoothness and tactile qualities, is therefore totally available to imports. However, if technology can be developed to overcome the downsides of this forming and drying process, then opportunities exist for new manufacturing capability within the UK. After-pressing, however, is a major opportunity to develop smoother products for specific applications.

It is interesting to note the variations in raw material used by the different manufacturers. These variations in fibre furnish are used by manufacturers, even though in some cases the different make-up materials are used for the same packaging for the same customer. It has been concluded that the MPP manufacturers do not generally manufacture to detailed technical specifications, except for the item grammage and in other requirements utilise a basic approach (e.g. feel to the hands, look, etc.).
15 MPP design, performance and mould manufacture

15.1 Moulded pulp structure design process

The design and manufacture of moulds in the moulded pulp industry has historically been a long, complex and expensive process. Evolutionary developments have been relatively slow over the last 30 years, and many MPP manufacturers have developed their own in-house/custom built processes for the design and manufacture of moulds.

Until the last few years the design of moulds has been a relatively basic process, involving a hit and miss approach, and supported by the expertise of the mould manufacturer. This has involved the initial mould design being modified a number of times to eventually meet its end-use requirements.

With the advent of CAD and 3-D solid modeling, this situation is gradually starting to change, although there still remains considerable development to take place to achieve a rapid, accurate and effective mould design process.

Shown in the schematic diagram below is a flow chart for the mould design and manufacturing process.

In simple terms the new/evolving methodology is as follows:
- Make a 3-dimensional model of the part to be packed (this is usually supplied by the manufacturer of the item to be packed)
- Place the model of the part to be packed into a block of material, from which the mould is being made
- Subtract the volume of the moulded part from the block of material (allowing for shrinkage of the moulded pulp product)
- Cut (utilising a CNC machine) the mould block into the forming die and transfer die parts
- Create a deckle frame and cavitate the rear side of the moulds
- Add holes for mounting and drainage.

The material used for making the moulds is generally shaped in a CNC-type cutting machine. The cutting path for the CNC machine requires a software programme to control its cutting path/actions.

The main solid modelling software is produced by a number of companies, and all of which, work on broadly the same principles. A number of these software companies sell software under the following names:
- Solid works (cost is approximately £5,000)
- Pro-station
- Micro Station
- Pro-engineer (cost is approximately £16,000)
The most widely used (and highly rated) software in the moulded pulp industry (ascertained from interviews) is SolidWorks.

Traditionally mould design has been achieved using surface modelling techniques. This approach is still used by many moulded pulp manufacturers, although the industry is now moving towards the new generation of solid-modelling software. This new software (which is considerably more automated) is 10-20 times faster than the traditional techniques. The new software combines the best of solid and surface modelling techniques in one integrated environment, and works on both open and closed (solid) 3-D models.

The ability to have a solid model to create the mould gives considerable flexibility in that it is very simple to make modifications to the mould. Mould design automation software generally segregates the surface information into parting surfaces, core surfaces and cavity surfaces, and ultimately produces the product shape. After this a Boolean operation is performed, subtracting the original part from the simplified core object. This operation is then re-performed to develop the exact draft angles for the mould. The essence of the software is to simplify the geometry of the part, and avoid the time involved in generating the parting line and the parting surface, enabling the core and cavity blocks to be easily generated.

The outcome is a significant reduction in the complexity of mould making, and as a result a large compression of the time to design and make a new mould.

### 15-2 Example of a mould design procedure

**Product features:**
- A product with a defined specification for weight, geometrical dimensions and fragility reference.
- Packed in a paperboard box (for transport and storage in the standing-up position)
- Dimensions of package

**Mould design:**
- Dimensions of package
- Style of moulded pulp structure

**Cushion structure:**
- Positioning of product in the package
- Space between the product and package for the cushion according to the transport requirements

**Mould design:**
- Influencing structure factors such as draft angle, contacting area, mould process and product packing convenience.
Mould design:
- Key issues to consider
- Radius across sections.
- Wire mesh joining
- Nesting of product

Valuation:
- Key issues to consider
- Product position along 3 directions
- Contacting area
- (cross-section view of the design)

Verification:
- Dimension fitness, after shrinkage from drying
- Total dimensions to inner packaging box
- Final aesthetics of the package

15.1.1 Mould criteria

The forming mould is drilled with numerous drainage holes to provide a path for the water to be sucked by vacuum through the screen. The diameter and spacing between the holes can be varied depending on the requirements of the finished product, the mould machine and the experience of the mould manufacturer. However, it is essential to ensure the holes are not too large, or the outer screen/gauze will deflect into them causing raised "blips" on the moulded pulp product, and which can actually damage the packaged product, e.g. eggs.

It is essential to keep the mould draft angles suitable for the application. Lower draft angles improve the compression resistance, whilst higher draft angles will enable a tight stack height of moulded pulp products and therefore minimisation of transport costs.

For the transfer moulding process a draft angle of 5 degrees or more provides for ease of transfer of the wet moulded pulp structure. For shallow moulded pulp structure, a 3-degree angle can be utilized. It is recommended that the moulded pulp sidewalls have the same slope to simplify design and processing.

The mould must be designed with a small clearance to enable the wet product to be removed from the mould and in particular to compensate for shrinkage in the drying process.

15-3 Typical clearances

<table>
<thead>
<tr>
<th>Clearances</th>
<th>Thin products</th>
<th>Thick products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screen</td>
<td>0.02”</td>
<td>Screen</td>
</tr>
<tr>
<td>Product (nominal)</td>
<td>0.06”</td>
<td>Product (nominal)</td>
</tr>
<tr>
<td>Transfer clearance</td>
<td>0.02”</td>
<td>Transfer clearance</td>
</tr>
<tr>
<td>Total clearance</td>
<td>0.10”</td>
<td>Total clearance</td>
</tr>
</tbody>
</table>

In terms of thermoformed moulded pulp products, the clearance/allowance for shrinkage will be minimal, whereas for reciprocating/tunnel conventionally formed products, the clearance/allowance will normally be in the range of 3-5%. It is also essential to ensure that the tooling compensates for areas which might over-form with pulp.
15.1.2 Basic theory

When a packaged item experiences an impact or shock (such as being dropped or hit during its handling or transport), the item will continue to momentarily accelerate and stop. This momentary degree of acceleration is approximately equal to the ratio of the drop height v the impact velocity. Damage is normally caused to a packaged item, when the degree of final deceleration is too high. The degree of deceleration and damage can be reduced substantially by the use of protective/cushion packaging.

The purpose of protective/cushion packaging design is to select materials and specially designed structures (usually the geometric shape, material, thickness and area) to keep the peak deceleration on impact below a level at which the item will be damaged.

A number of different materials, including moulded pulp, eps and corrugated die-cut shapes, are used in shell-like structures to act as cushioning material. The purpose of the cushion packaging is to absorb the energy from the impact/shock and to reduce the forces on the item at the impact point; thereby reducing the potential for damage.

15.1.3 Design considerations

In the design of protective packaging shapes, there is a fundamental difference between MPP and EPS. In EPS, the key criteria for a successful protective shape are material density, thickness and the contacting area. In terms of MPP, the main issues determining the cushioning success are the geometric shape, and the size and shape of the item.

There are three main considerations in moulded pulp packaging design:

- Product features
- Distribution environment
- Design of the moulded pulp structure

The key features of the product to be packaged include:

- Shape of the product
- Weight
- Dimension and mass centre
- Available contacting area with cushions
- Outer/secondary packaging carton/case
- Fragility of the product
- Number of items in a package

Key issues to be considered for the distribution of the product are:

- Type of transport and handling in storage and shipment
- Special requirements such as anti-static/moisture etc.
- Storage at high/low temperatures and humidities, vibration,
- Shock etc.

The third (and most critical) consideration is the actual design of the moulded pulp structure. Products with low fragility requirements are relatively easy to protect and need less cushioning. For highly fragile products, the cushion structure must be designed to absorb more energy in order to protect the packaged item. By using the proper cushioning design, substrate maximisation and size minimisation, optimum product protection can be achieved.

Moulded pulp cushion design is defined in three types:

- No edge, where the width of the perimeter (or border flange) section of the cushion structure is less than 3 mm. This type is frequently used as end caps, symmetrical pairs and general edge protection.
- Narrow edge in which the width of the border flange of the cushion is between 8 and 15mm and sometimes has a slightly rolled edge. Normally, this type of design is used to position and support a product and provide cushioning along five sides of the package, but not on the top of the package.
- Roll up, where the perimeter borders are rolled or formed, to half or full height of the depth of the cushion design. This style is frequently used for new product design.
15.1.4 Structural cushion factors

Although moulded pulp products have a long history of use as a packaging medium, their uptake as a cushioning material is relatively recent. Many of the existing moulded pulp cushion packages now in use, have been developed by trial and error and the initial design frequently requires modifications in order to perform acceptably.

MPP mould designers often utilise technical data from the eps industry to assist with design development, and this, in conjunction with the product parameters (e.g. size, weight etc.), transport, environmental, and tests demands (e.g. drop and vibration tests) has enabled initial mould designs to be relatively close to the final design.

The technical properties of expanded polystyrene are well known, widely published by the expanded polystyrene industry, and documented in great detail for criteria such as density, resilience rate, energy absorption, and cushioning properties. Additionally, these specifications can be changed relatively easily to meet customer’s requirements due to the consistency of the main raw material.

However for moulded pulp cushions, the material itself is porous and has different degrees of density and characteristics depending on the raw material and method of manufacture. A moulded pulp cushion is not a solid piece of material, but is a shell like structure. Additionally, the raw materials used for MPP manufacture are inconsistent and as such create variations in the finished moulded pulp product.

Moulded pulp packaging products are manufactured and used in the form of a geometric shell, in which the geometrical shape is designed to match the profile of the product to be packaged and support it in three dimensions; in addition to ensuring compliance with the customer’s packaging objectives.

When a packaged product experiences an external physical force such as shock, impact or vibration, the force is transmitted to the moulded pulp shape. These forces cause the moulded pulp shape to deform, and absorb the mechanical energy. The amount of energy absorbed by the deflection of moulded pulp depends on the fibrous raw materials, geometric design and shape. The higher the energy absorbed by the moulded pulp cushion, the less energy is transmitted to the packaged product; thereby reducing potential damage to the product.

Energy absorption relates to structural deformation. Because a moulded pulp structure usually consists of a number of different individual shapes, structural deformation is the combination of the individual shape design variations. By controlling the degree of deformation of the shape through structural design, over 95 % recovery of the shape can be achieved. The recovery, or resiliency rate of moulded pulp structures is very important because most packaged products will experience more than one dynamic shock in the actual distribution environment.

15.1.5 Moulded pulp cushioning design factors

Because moulded pulp protective packaging uses it's structure/geometry as the cushion design driver, the definition of the dimensions requires to be precisely stated as follows:

- Height of structure in contact with packaged item
- Perimeter length in contact with packaged item
- Wall slope or draft angle of the structure
- Radius of the cross links in the mould structure
- Average structure wall thickness

The above dimensions affect the performance of the moulded pulp structure to varying degrees. The loading ability of a moulded pulp cushion structure is directly proportional to its bottom perimeter and wall thickness. The height of the moulded pulp cushion structure has a relatively minor influence on the maximum loading ability, but it is important for total energy absorption.

Historically, the design of moulded pulp products for use as protective packaging has been, predominantly, based upon trial and error and previous experience, although this situation is now starting to change with the advent of new generation solid modelling software, such as Solid Works.

15.1.6 Moulded pulp packaging design procedures

It is a pre-condition that a product packaged with moulded pulp must provide adequate protection in the distribution environment (e.g. against impact, shock, vibration, and compression forces) in some instances, variations in temperature and humidity must also be considered for good product protection. In order to produce an efficient package design, it is necessary to obtain product information, distribution conditions and select the fibrous raw material and cushion structure design.
The critical issues to be included in the process for developing a moulded pulp packaging shape should include:

- Feature of the product to be packaged - weight, size, dimension, fragility
- Product position for symmetry
- Distribution/transport conditions
- Selection of fibrous raw material
- Structure design
- Cushioning points of contact with packaged product
- Mould arrangement
- Test simulation procedures
- Evaluation
- Exterior dimensions of secondary packaging
- Prototype mould production
- Produce moulded pulp sample
- Evaluation of sample
- Further modification (if required)

Detailed in the above list are the basic steps in creating a moulded pulp packaging design. In practical applications, there is considerable flexibility in the patterns or arrangements of the functioning structures. The goal of every design is to produce a rapid, simple, effective and competitively priced cushion product.

15.1.7 Moulded Pulp Product Performance specifications

Dynamic and static testing is a major segment of product and component evaluation, and is used globally for the evaluation of many products. Manufacturers wish to protect their products from damage and ensure it is delivered in pristine condition. Different industries have developed a wide variety of tests for different applications. These test vary widely from industry to industry, and also their uptake and acceptance has not been uniform within specific industries.

The MPP manufacturing industry appears to be slowly embracing a more scientific approach to the testing of its packaging products, although this evolution is yet to be developed on an industry wide basis.

In comparison to the EPS industry, the marketing of MPP is more aligned to “Does it Work”, rather than selling the product on a performance specification basis. There are, however, a small number of MPP producers who are progressively/continuously technically evaluating their products in comparison to EPS equivalents, and these should serve as a good example for the remainder of the MPP industry, particularly in the UK, to emulate.

The EPS industry, on the contrary, is highly organised, with detailed technical specifications for all grades of material, including performance tests (e.g. drop tests/vibration/crush tests etc.)

This section of the study seeks to highlight a number of tests that are used in both the EPS and MPP industry, and which are certainly worthy of being propagated throughout the UK MPP industry; as a means to develop a more sophisticated/technical approach to the sales and marketing of moulded pulp products.

The main tests to be highlighted in this section are as follows:

- Drop tests
- Vibration tests
- Crush tests

15.1.8 Drop and vibration tests

There are a wide number of vibration and drops tests employed in a variety of industries, all of which utilise the same principle of dropping an item from a fixed height, and then determining what damage (if any has occurred during the drop). Variations to the drop test can include the following criteria:

- Height
- Angle
- Speed
Atmospheric conditions

A number of local and international organisations publish standard tests, of whom the following are the leaders:

- ASTM (American Society for Testing and Materials; www.astm.org)
- British Standards (www.bsi-global.com)
- DIN (Deutsche Institute for Normung; www2.din.de)
- ISO (International Standards organisation; www.iso-standards-international.com)
- ISTA (International Safe Transit Association; www.ista.org)
- UN (United Nations; www.un.org)

Courier companies, such as UPS, TNT and FedEx also publish their own variations on drop tests. Within this sector UPS appears the most progressive.

Some shock tests are very simple and informal, with often drop height being the only common criteria. In most cases little or nothing is known about the energy impact profile. Drop tests often vary according to the size and weight of the product being evaluated.

15.1.9 ISTA drop and vibration tests

The International Safe Transit Association is a US based organisation, which is focussed on standards for the measurement of damage to goods which are to be shipped to customers.

ISTA’s web site states that packaging testing and certification helps to achieve the following:

- Generate a package that will adequately protect against shock, vibration, compression and/or atmospheric hazards of the distribution environment.
- Reduce or eliminate the need for trial shipments and gets new products to market faster while insuring their survival.
- Strengthen a company’s position in claims negotiations because it establishes the adequacy of the package, thus encouraging transport companies, etc to look for other causes of damage and to settle or accept settlement more quickly reducing claims and claims processing expenses.
- Customer satisfaction: Customers return if their product arrives in perfect condition. “All engineering, manufacturing, quality and sales efforts are wasted when your customer receives a damaged product.”
- Transport rate and cargo insurance negotiations for lower rates because of lower risk of damage in shipment.

The ISTA testing procedures are wide and varied, and cover numerous sizes and weights of products. The main testing procedure highlighted for the testing of moulded pulp products is ISTA Procedure 1A, which defines the basic requirements for fixed displacement vibration and shock testing of packaged products weighing less than 68 Kg.

In the diagrams below are the test equipment used by ISTA in their series of tests. These are designed to deliver reproducible results, both from test to test and from item to item.

The majority of these tests are carried out in laboratories, due to the high cost of the testing equipment and the requirement for accredited testing.
**15.1.10 Other drop and vibration specifications**

Asian companies are often more demanding in the application of drop and vibration tests (as they have global manufacturing plants), and a number of these companies have defined their own testing specification for both drop and vibration. The testing of the electronic part/item is carried out, when the item is fully packaged. The objectives of the tests are to assimilate real life. The parameters (shown below) for the tests are extremely wide and complex, and exhibit the lengthy procedures used for evaluation of protective packaging. The tables below are not the complete testing procedure but are for the purpose of indicating the stringent requirements placed upon packaging companies.

**15.1.11 Vibration**

**15-5 Testing procedure**

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Direction</th>
<th>Level</th>
<th>Duration time</th>
<th>Cycle time</th>
<th>Storage pre-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-55 Hz</td>
<td>Up-down</td>
<td>1.25 G</td>
<td>60 min / 30 min</td>
<td>1 cycle / 2 min</td>
<td>-20°(2h) +25° (5 h)</td>
</tr>
<tr>
<td>5-55 Hz</td>
<td>Up-down</td>
<td>0.75 G</td>
<td>30 min / 16 min</td>
<td>1 cycle / 2 min</td>
<td>-20° (2h) +25° (5 h)</td>
</tr>
<tr>
<td>5-55 Hz</td>
<td>Left-right</td>
<td>0.75 G</td>
<td>30 min / 16 min</td>
<td>1 cycle / 2 min</td>
<td>-20° (2h) +25° (5 h)</td>
</tr>
</tbody>
</table>
15.6 **Drop test height**

<table>
<thead>
<tr>
<th>Sample WT</th>
<th>Bottom</th>
<th>Other sides</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 10 kg</td>
<td>65 cm</td>
<td>50 cm</td>
</tr>
<tr>
<td>10-20 kg</td>
<td>60 cm</td>
<td>45 cm</td>
</tr>
<tr>
<td>20-30 kg</td>
<td>55 cm</td>
<td>40 cm</td>
</tr>
<tr>
<td>30-40 kg</td>
<td>50 cm</td>
<td>35 cm</td>
</tr>
<tr>
<td>40-50 kg</td>
<td>45 cm</td>
<td>30 cm</td>
</tr>
<tr>
<td>50-60 kg</td>
<td>40 cm</td>
<td>25 cm</td>
</tr>
<tr>
<td>Over 60 kg</td>
<td>35 cm</td>
<td>20 cm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Drop times</th>
<th>1 corner</th>
<th>1 corner</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 sides</td>
<td>3 sides</td>
</tr>
<tr>
<td></td>
<td>6 faces</td>
<td>6 faces</td>
</tr>
</tbody>
</table>

15.7 **Drop direction**

- Free drop <40 kg
  - 1 corner + 3 sides + 6 faces
  - Left back + bottom corner
  - Front bottom side
  - Right bottom side
  - Right front side
  - Top face
  - Left face
  - Right face
  - Back face
  - Bottom face

15.1.12 **Crush tests**

There are a number of crush tests, which are used to determine the crush resistance of packaging. The most realistic of these tests is the Box Crush test, and which is also called BCT. The BCT is normally carried out on both the primary and secondary packaging, but without the item to be protected in the box. When testing a moulded pulp structure, this would normally be placed inside the outer case/carton and then subjected to the BCT.

Compression strength is used to measure the compression strength of ready made cases/cartons and hence to compare test results, it is important that the boxes (to be tested) have the same geometrical shape, identical cutting, creasing and glue seam, etc: the only difference being the construction and strength of the internal protective packaging.

15.1.13 **Impact test results from PPM Inc.**

Impact tests carried out by Pacific Pulp Moulding (California), shown below, are a rare example of the MPP industry openly publishing technical results to support the technical performance case for moulded pulp products.

15.8 **Cushioning properties – better than foam!**

![Cushioning properties graph](Source: Pacific Pulp Moulding Inc)
15-9 Moulded pulp - television drop data

<table>
<thead>
<tr>
<th>Drop sequence from 68 cm</th>
<th>Maximum G level allowable</th>
<th>G level experiences</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edge 1</td>
<td>40</td>
<td>Less than 40</td>
<td>Passed</td>
</tr>
<tr>
<td>Edge 2</td>
<td>40</td>
<td>Less than 40</td>
<td>Passed</td>
</tr>
<tr>
<td>Edge 3</td>
<td>40</td>
<td>Less than 40</td>
<td>Passed</td>
</tr>
<tr>
<td>Surface 1</td>
<td>40</td>
<td>Less than 40</td>
<td>Passed</td>
</tr>
<tr>
<td>Surface 2</td>
<td>40</td>
<td>Less than 40</td>
<td>Passed</td>
</tr>
<tr>
<td>Surface 3</td>
<td>40</td>
<td>Less than 40</td>
<td>Passed</td>
</tr>
<tr>
<td>Surface 4</td>
<td>40</td>
<td>Less than 40</td>
<td>Passed</td>
</tr>
<tr>
<td>Surface 5</td>
<td>40</td>
<td>Less than 40</td>
<td>Passed</td>
</tr>
<tr>
<td>Surface 6</td>
<td>40</td>
<td>Less than 40</td>
<td>Passed</td>
</tr>
<tr>
<td>Surface 7</td>
<td>40</td>
<td>Less than 40</td>
<td>Passed</td>
</tr>
<tr>
<td>Corner 1</td>
<td>40</td>
<td>Less than 40</td>
<td>Passed</td>
</tr>
<tr>
<td>Corner 2</td>
<td>40</td>
<td>Less than 40</td>
<td>Passed</td>
</tr>
<tr>
<td>Corner 3</td>
<td>40</td>
<td>Less than 40</td>
<td>Passed</td>
</tr>
<tr>
<td>Corner 4</td>
<td>40</td>
<td>Less than 40</td>
<td>Passed</td>
</tr>
</tbody>
</table>

15-10 Vibration test specifications

<table>
<thead>
<tr>
<th>Vibration frequency</th>
<th>5-50 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSD</td>
<td>1.44 m squared / 5 (0.015 G/Hz)</td>
</tr>
<tr>
<td>RMS value</td>
<td>8.14 m/S (O.B.G)</td>
</tr>
<tr>
<td>Bottom surface: 3 h 30 min</td>
<td>Passed</td>
</tr>
<tr>
<td>Front surface: 2 h 30 min</td>
<td>Passed</td>
</tr>
<tr>
<td>Left surface: 5 h 30 min</td>
<td>Passed</td>
</tr>
<tr>
<td>Television weight</td>
<td>24.4 pounds</td>
</tr>
</tbody>
</table>

These results are excellent examples of pro-active and open marketing by an MPP manufacturer, and this approach should be developed and published by the MPP industry on a united front.

15.1.14 Conclusions on performance specifications

The EPS and corrugated packaging industries have developed (and indeed sell and market) their products in a sophisticated manner. Their marketing approach is supported by a vast array of product testing equipment, specifications and performance tests. Many of these tests are relatively simple, while others are of a more complex nature.

It is clear, however, that the approach of the EPS and corrugated industries is significantly more technical, in terms of product support, and perhaps this is a meaningful pointer, for assisting the MPP industry to develop the sophistication of its sales and marketing techniques, and bring them more in-line with competing and alternative materials; thereby taking a step change in levelling the playing field.

15.2 Prototype mould delivery

Rapid prototyping of an MPP mould, relies on the successful integration of the following inputs:

- Packaging Design
- 3-D solid modelling technology
- Cushioning objectives
In terms of cushioning objectives, this function can be classified in two ways.

### 15.11 3D-CAD mould design technology process

One of the functions of the MPP cushion is to provide product fixing or containment, in such a way, that the product packaged inside the container is firmly secured in its position.

With respect to protecting the product, this is determined by the shape and dimensions of the cushion structure, both of which assist mitigation of external forces, shock and vibration; and at an performance level at which the product will not be damaged.

Additionally, the prototype mould will be impacted by the following factors:

- Fibrous raw material furnish
- Wet-end forming technique
- Product properties (e.g. fragility, shape, weight supporting position etc.)
- Transportation environment

It is clear that computer technology, which is currently used for engineering design, is capable of 3-D generation of engineering parts, assembly and stress analysis. Models have also been designed for specification analysis of different types of materials and shapes. This technology has not yet been fully transferred to the design of moulded pulp structures.

Additionally, empirical data from the product design information can be utilised for finite element analysis. Simulation of a mould design, with certain pulp formulation, can be used to evaluate the function of the product before sampling and testing; any subsequent modifications being made on the computer.

Simplistically, the development of prototype moulds, and indeed production moulds, must move from being a hit and miss process to a scientific approach, which can circumvent the current cost and time delays in reducing time-to-market prototype products.

The positive effects of the ability to produce lower priced/faster delivered moulds will be hugely beneficial to the moulded pulp industry, and will help level the marketing playing field with EPS and corrugated cushion-shape manufacturers.

### 15.3 Key objective for computerised mould design

The ultimate objective should be to design and predict a moulded pulp product’s performance through computer modelling based on the fundamental fibre properties/characteristics and processing parameters and conditions.

### 15.4 Materials for manufacturing moulds

There are a variety of materials used in the manufacture of moulds: the main ones generally being metal and plastic. The factors which affect the choice of mould material are as follows:

- Cost
- Mould life requirement
- Moulding machine operation
Moulding conditions
Availability of mould making facilities
Delivery time of the mould

Other factors which influence the choice of material are as follows:
Continuous exposure to pulp and water
Temperature of pulp
Abrasive actions of the screens against the forming die.

In many cases the dies can consist of a number of materials, or the materials used for the forming die and transfer die can be different. e.g. a bronze forming die body can be used with an aluminium transfer die. A description of each of the main materials used in the manufacture of moulds is described below

### 15.4.1 Stainless steel

Stainless steel is the most robust and highest cost material, particularly in comparison to aluminium and bronze. It is therefore only used in highly demanding applications, where its key attributes are durability and corrosion resistance. Machined stainless steel is usually used in the production of moulds, but the drilling of holes for drainage is a slow and costly process. The use of stainless steel has declined substantially over recent years.

### 15.4.2 Bronze

Bronze (and the alloy Naval Bronze) has been used for many years, mainly for its durability. Bronze can be cast, and this makes it ideal for multi-cavity moulds; although subsequent finishing processes are required, increasing production time. Machining and drilling of bronze is easier than stainless due to its softer structure.

### 15.4.3 Aluminium

Aluminium is low cost and machines easily, lending itself to sand casting techniques. It is, however, susceptible to corrosion and can be eroded by bacteria, poor cleaning, high pH pulp solutions and from abrasion in the pulp moulding process. Actions taken to lengthen the life of aluminium moulds are to coat the top/operating surface with Teflon and epoxy types resins. Aluminium is easily machined and drilled, and lends itself to the rapid manufacture of moulds.

### 15.4.4 Brass

Brass is commonly used in the manufacture of both forming and transfer dies. Its use and properties are similar to bronze, although its employment and popularity has declined in recent years.

### 15.4.5 Plastics

Several types of plastics lend themselves to low/medium run-length mould production. These moulds are relatively low cost, possess easy machineability and have high resistance to corrosion.

Cast epoxy, and particularly those with high temperature resistance, are an attractive material for the manufacture of both forming and transfer moulds. The ability to make multiple cavities by moulding is a great plus point particularly in medium volume applications.

Epoxy/resin moulds are generally used for the production of sample moulds and short runs.

Epoxy/glass fibre composites (although more costly and not as easily produced) offer the advantages of not requiring machining or moulding of the cavity on the rear side of the mould.

Injection moulded plastic/high tensile polycarbon is the latest material to be developed for the production of moulds. It is extremely durable, but its production time and cost are high.

### 15.4.6 Materials for screens

Stainless steel is the preferred material for the screen or gauze formed over the body of the forming die. Various screen types and porosities are used. Typical mesh sizes are 40, 50 and 60. Depending on the wire diameter and mesh size used in the manufacture of the screen, the percentage open area varies. Stainless steel screens are normally welded along the seams.

Phosphor bronze screens (with similar mesh sizes/wire diameter to stainless steel) are used by a number of mould manufacturers. Phosphor bronze is easy to work with, and has greater stretch and deeper draw capabilities than stainless steel. Bronze screens are normally silver soldered along the seams. The downside of phosphor bronze is that it looses its stiffness (often going baggy) much quicker than stainless steel, thereby requiring more frequent re-screening (changing).
Vacuum formed plastic is used for screens to manufacture products that do not require a smooth surface and are not too deep.

Lycra is also utilised as a screening material.

The time to manufacture the screen and apply it to the surface of the mould is a slow process, and adds to the overall time to manufacture a mould for delivery to the moulded pulp manufacturer. Welding (stainless steel screens) or soldering (bronze screens) is a skilled operation and is an area for future major development.

A small number of moulds are produced with plastic screens, and perhaps this material offers the greatest opportunity for future screen development, providing that the plastic screen material will perfectly form to the shape of the mould, and in addition will maintain its shape during operation.

**15.4.7 Effect of moulding machine operation on moulds**

The type/make of moulding machine can influence the material for the mould and also its design. According to Pulp Moulded Dies Inc, the major influence on the mould is the amount of protection that is built into the moulding machine. It must be ascertained, as to what make of machine the mould is being fitted, and what degree of “spring back” the machine has. An easier spring back will protect the dies, and will enable lighter weight (and therefore lower price) moulds to be utilised.

Additionally, the mounting position of the die in relation to the forming platen will influence the mould design and robustness. For example, the following positions are variations on different mould machines:

- Above it (e.g. Silfurtun, Hartmann and Keyes)
- Partly in it (e.g. SPM, Emery and Leotech)

Consideration must also be given to the fitting of a number of moulds on the moulding machine to maximize use of the available moulding surface of the backing platen. Nesting the mould shapes will allow for use of more moulds and enable production of more moulded pulp products.

**15.4.8 Comparison of mould parameters**

The chart below shows estimate comparisons for the mould life, the cost per pair of moulds and the estimated time to manufacture moulds for the rotary process. Clearly the moulds made from epoxy resin are the quickest and cheapest to manufacture (and are often used for prototype moulds) in comparison to moulds made from injection moulded plastic high tensile polycarbon, which are used for high performance long-run situations.

The estimates were made following a number of the interviews.

**15-12 Comparison parameters for moulds manufactured from different materials**

<table>
<thead>
<tr>
<th>Time in Weeks</th>
<th>Cost per Pair</th>
<th>Life in Years</th>
<th>Mould Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 to 10</td>
<td>4,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>6,000</td>
<td>6 to 10</td>
<td>A</td>
</tr>
<tr>
<td>4 to 6</td>
<td>4,000</td>
<td>2</td>
<td>B</td>
</tr>
<tr>
<td>4</td>
<td>2,000</td>
<td>1/2</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>D</td>
</tr>
</tbody>
</table>

**Source:** PendlePace estimates
16 Best available technology

Shown below is the location of the main global producers of moulded pulp machinery. There are few manufacturers in Europe and even less in North America. Production in South Korea, Taiwan, and China is particularly strong.

**16-1 Global summary of MPP machinery manufacturers**

<table>
<thead>
<tr>
<th>Country</th>
<th>No of MPP machinery suppliers</th>
</tr>
</thead>
<tbody>
<tr>
<td>United Kingdom</td>
<td>1</td>
</tr>
<tr>
<td>Netherlands</td>
<td>2</td>
</tr>
<tr>
<td>Denmark</td>
<td>1</td>
</tr>
<tr>
<td>Canada</td>
<td>1</td>
</tr>
<tr>
<td>USA</td>
<td>1 (+2 ancillary equipment suppliers)</td>
</tr>
<tr>
<td>New Zealand</td>
<td>1</td>
</tr>
<tr>
<td>Australia</td>
<td>1</td>
</tr>
<tr>
<td>Taiwan</td>
<td>2</td>
</tr>
<tr>
<td>South Korea</td>
<td>3</td>
</tr>
<tr>
<td>South Africa</td>
<td>1</td>
</tr>
<tr>
<td>India</td>
<td>2</td>
</tr>
<tr>
<td>China</td>
<td>8</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>24 (+2 ancillary equipment suppliers)</strong></td>
</tr>
</tbody>
</table>

The diagram above details the leading global companies, which manufacture moulded pulp machinery. Additionally, the type of production process for which their machines are produced is identified.

**16-2 Major/leading global suppliers of MPP manufacturing machinery**

<table>
<thead>
<tr>
<th>Company</th>
<th>Country</th>
<th>Rotary</th>
<th>Thermoforming</th>
<th>Reciprocating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hartmann</td>
<td>Denmark</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Huhtamaki</td>
<td>Netherlands</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emery International</td>
<td>Canada</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inmaco</td>
<td>Netherlands</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fisher &amp; Paykel</td>
<td>New Zealand</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPPSI</td>
<td>Taiwan</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Twin Peak</td>
<td>Taiwan</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ipsung</td>
<td>South Korea</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPM</td>
<td>South Africa</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K.U. Sodalamathu</td>
<td>India</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nanya Moulded Pulp Eq</td>
<td>China</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

It is evident that rotary and thermoforming machines are the most widely available, in comparison to reciprocating (vertical/slush) machines, which are often developed and manufactured in-house by individual moulded pulp product manufacturers. The growing popularity of the thermoforming process is also evidenced by the high proportion of manufacturers.

**16.1 Productivity and performance**

There are a number of measures for the performance of comparative moulded pulp manufacturing machines. Although the manufacturers of the machines publish a wide range of data, in a number of ways, they contain a number of identical criteria. The main measures are as listed here.

- Productivity measures (output rate per day or per hour)
- Productivity measure (drops/minute)
- Suitability for product
• Energy consumption (electricity and gas)
• Manning levels
• Space requirement
• Water consumption
• Platen size
• Product data (height/perimeter/wall thickness etc.)
• Fibre furnish

16.1.1 Rotary machine productivity measures

Shown below are the machine and product characteristics for the two largest Emery International Rotary pulp moulding machines. It can be seen from these tables that there are considerable differences in the output of these rotary machines, depending on width and manning levels. Additionally, the consumption of energy and water varies according to output rate.

16-3 Characteristics for the two largest Emery rotary machines

<table>
<thead>
<tr>
<th>Machines</th>
<th>kWh/day</th>
<th>Water m³/day</th>
<th>Pulp tpd</th>
<th>Hourly staff</th>
<th>Drops/minute</th>
<th>Platen size mm</th>
<th>Egg trays</th>
</tr>
</thead>
<tbody>
<tr>
<td>108'' rotary</td>
<td>18,783</td>
<td>182</td>
<td>61</td>
<td>7</td>
<td>85</td>
<td>355 * 2,705</td>
<td>979</td>
</tr>
<tr>
<td>108'' rotary (fully configured)</td>
<td>18,783</td>
<td>182</td>
<td>67</td>
<td>34</td>
<td>85</td>
<td>355 * 2,705</td>
<td>-</td>
</tr>
<tr>
<td>67'' rotary</td>
<td>14,609</td>
<td>114</td>
<td>38</td>
<td>6</td>
<td>85</td>
<td>355 * 1,676</td>
<td>612</td>
</tr>
<tr>
<td>67'' rotary (fully configured)</td>
<td>14,609</td>
<td>114</td>
<td>40</td>
<td>15</td>
<td>85</td>
<td>355 * 1,767</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: Emery International Developments

It can be seen from the table that the annual output of the above rotary machines are as follows:
- 108 inch rotary: 23,450 tonnes
- 67 inch rotary: 14,000 tonnes
- 48 inch rotary: 9,430 tonnes

Performance and productivity for rotary machines are relatively easy to compare due to the very narrow range (and size) of products manufactured on this type of machines. Additionally, the number of global manufacturers of rotary machines is limited and so the manufacturers are competing on an identical basis.

In order to draw comparisons, data from Southern Pulp Machinery is shown below for their range of rotary moulded pulp machines. The size of machines produced by SPM is smaller than the Emery International machines, and this is reflected in the output rates, manning levels and space requirements.

16-4 Performance specification for the SPM model TF1 thermoforming machine

<table>
<thead>
<tr>
<th></th>
<th>SPM 400</th>
<th>SPM 800</th>
<th>SPM 1800</th>
<th>SPM 2100</th>
<th>SPM 5000</th>
<th>SPM 7000</th>
<th>TF1 Therm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egg trays</td>
<td>400</td>
<td>800</td>
<td>1800</td>
<td>2100</td>
<td>5000</td>
<td>7000</td>
<td>-</td>
</tr>
<tr>
<td>Water (kg)</td>
<td>26</td>
<td>52</td>
<td>117</td>
<td>136</td>
<td>325</td>
<td>468</td>
<td>30</td>
</tr>
<tr>
<td>Water (litres)</td>
<td>80</td>
<td>160</td>
<td>400</td>
<td>460</td>
<td>1,050</td>
<td>1,050</td>
<td>30</td>
</tr>
<tr>
<td>Electricity (kW)</td>
<td>50</td>
<td>100</td>
<td>180</td>
<td>190</td>
<td>475</td>
<td>684</td>
<td>40</td>
</tr>
<tr>
<td>Dryer gas (kg)</td>
<td>10</td>
<td>20</td>
<td>45</td>
<td>52</td>
<td>125</td>
<td>180</td>
<td>10</td>
</tr>
<tr>
<td>Direct staff</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Wax emulsion (kg)</td>
<td>0.25</td>
<td>0.5</td>
<td>1.2</td>
<td>1.4</td>
<td>3.25</td>
<td>4.7</td>
<td>0</td>
</tr>
<tr>
<td>Alum</td>
<td>0.5</td>
<td>1.0</td>
<td>2.4</td>
<td>2.8</td>
<td>6.5</td>
<td>9.4</td>
<td>0</td>
</tr>
<tr>
<td>Footprint (m)</td>
<td>6’9</td>
<td>6’9</td>
<td>6’48</td>
<td>6’48</td>
<td>6’75</td>
<td>6’75</td>
<td>6’2</td>
</tr>
</tbody>
</table>

Source: Southern Pulp Machinery
16.1.2 In-mould (thermoformed) process productivity measures

The specifications published by manufacturers of in-mould (thermoforming machines) are significantly less comprehensive than those published by the manufacturers of rotary forming machines.

Key criteria specified include the following:

- Platen size
- Cycle time (drops per hour)
- Operating temperature
- Machine footprint
- Number of drying moulds
- Power consumption

16-5 Specifications for in-mould machines published by Fisher and Paykel

<table>
<thead>
<tr>
<th>FP (machine type)</th>
<th>MT/FP-20</th>
<th>MT/FP-100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Platen size</td>
<td>1,200 mm</td>
<td>3,750 mm</td>
</tr>
<tr>
<td></td>
<td>1,200 mm</td>
<td>2,110 mm</td>
</tr>
<tr>
<td>Cycle time</td>
<td>30 s</td>
<td>30 s</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>250°C</td>
<td>250°C</td>
</tr>
<tr>
<td>Pressure</td>
<td>50 tonnes</td>
<td>150 tonnes</td>
</tr>
<tr>
<td>Max footprint</td>
<td>6,100 mm</td>
<td>13,000 mm</td>
</tr>
<tr>
<td></td>
<td>11,800 mm</td>
<td>24,000 mm</td>
</tr>
</tbody>
</table>

Source: Fisher and Paykel

16-6 Specifications for in-mould (thermoforming) machines published by Inmaco

<table>
<thead>
<tr>
<th>Inmaco (machine type)</th>
<th>MT/FP-20</th>
<th>MT/FP-50</th>
<th>MT/FP-100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum output (kg/h)</td>
<td>20</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Platen size (mm*mm)</td>
<td>800*500</td>
<td>850*650</td>
<td>850*650</td>
</tr>
<tr>
<td>Drops/min</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Maximum product height</td>
<td>150</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>Drying sections</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

Source: Inmaco

The most significant differences between SPM and Inmaco is the higher drops/minute of the Inmaco machine at 4/minute. However, the Fisher and Paykel machine has a far bigger platen size (by x 14), which will enable more moulds to be mounted on the platen, and more than compensate for the lower drop rate. However MPP manufacturers regard the platen size as too large due to the requirement for a very high number of expensive moulds. Both machines have a press drying temperature of approximately 250°C.

16.1.3 Conventional vs. thermoformed processes

Detailed below is a comparison published by EPPSI (Environmental Pulp and Packaging Systems Inc of Taiwan) comparing a number of parameters between the conventional moulded pulp forming/drying process and their own thermoforming process machines. The table clearly exhibits a number of the differences between the two processes. In particular, the differences in the manning levels, tooling accuracy and yield rates are of major significance.
### 16-7 Comparison of parameters conventional and thermoforming process machines

<table>
<thead>
<tr>
<th></th>
<th>Conventional</th>
<th>Thermoforming</th>
</tr>
</thead>
<tbody>
<tr>
<td>Footprint per line (m²)</td>
<td>1,500</td>
<td>500</td>
</tr>
<tr>
<td>Energy cost</td>
<td>Very high</td>
<td>Low</td>
</tr>
<tr>
<td>Manning level/shift</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td>Process</td>
<td>Manual</td>
<td>Fully automatic</td>
</tr>
<tr>
<td>Maintenance</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Tooling accuracy</td>
<td>&gt;0.8 mm</td>
<td>Precise = 0.05 mm</td>
</tr>
<tr>
<td>Tooling lead time</td>
<td>30 days</td>
<td>15 days</td>
</tr>
<tr>
<td>Additives</td>
<td>Wax + binder</td>
<td>None</td>
</tr>
<tr>
<td>Aesthetics</td>
<td>Rough (after-press required)</td>
<td>Smooth</td>
</tr>
<tr>
<td>Yield</td>
<td>90%</td>
<td>95%+</td>
</tr>
</tbody>
</table>

Source: EPPSI

### 16.2 Energy consumption

Energy consumption in the moulded pulp manufacturing varies from process to process. Rotary/Reciprocating products dried with a gas fired conventional drying tunnel have the highest energy consumption, in comparison to the in-mould/thermoforming process, which has lower total energy consumption. The main areas of energy consumption in the moulded pulp process are as follows:

- System power
- Pulping and stock preparation
- Wet-end forming including vacuum pump power
- Drying

High energy costs and energy efficiencies are key issues impacting the short/medium term financial performance of current MPP manufacturers and the opportunity for new manufacturing entrants to the market may be influenced by this factor.

### 16.3 Dimensions and sizes of moulded pulp products

Technically, there is no limit to the maximum size of a product in MPP production. However the forming platen controls the number/size of moulds that can be mounted on the platen.

Large forming platens are not suitable for small sized products, and also where there the run length is short. Generally, only large platens are suitable for large mould sizes.

### 16.4 Key MPP manufacturing process comparisons

Table 16-8 clearly exhibits the differences between the major processes. The highest output machines, and also the most expensive to purchase are the rotary type machines.

Purchase costs for the thermoforming and slush/reciprocating type machines are similar, although the characteristics of the products produced by the two methods are vastly different.

The other critical issue is the differences in the run-length requirement for the different type of machines. Due to its nature the rotary machine requires very long run-lengths to be cost effective, whereas the reciprocating/slush type machine can be cost effective with substantially shorter runs. A downside of the thermoforming process is the requirement for long run-lengths, slow output-rate and high cost of the moulds.
### 16-8 Comparisons between the three major methods of manufacturing moulded pulp products

<table>
<thead>
<tr>
<th></th>
<th>Thermoforming</th>
<th>Rotary</th>
<th>Reciprocating</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Purchase price (USD)</strong></td>
<td>650,000-800,000</td>
<td>600,000-20 million</td>
<td>260,000-480,000</td>
</tr>
<tr>
<td><strong>Output rate of single machine/day</strong></td>
<td>28,000-83,000 (small trays/cushion)</td>
<td>470,000-1.2 million (egg caron size)</td>
<td>17,000-28,000 (egg tray size)</td>
</tr>
<tr>
<td><strong>Annual output (tonnes)</strong></td>
<td>600-1,800</td>
<td>5,000-24,000</td>
<td>400-600</td>
</tr>
<tr>
<td><strong>Manning levels</strong></td>
<td>4</td>
<td>15</td>
<td>6</td>
</tr>
<tr>
<td><strong>Optimum run length</strong></td>
<td>100,000</td>
<td>500,000</td>
<td>10,000</td>
</tr>
<tr>
<td><strong>Die changing time (hours)</strong></td>
<td>3 h for set of 4 moulds</td>
<td>2-3 h for set of 3 moulds</td>
<td>2h for set of 3 moulds</td>
</tr>
<tr>
<td><strong>Product type</strong></td>
<td>Thin wall both sides smooth, High value and gift package.</td>
<td>Egg trays/cartons Fast food holders Commodity products</td>
<td>Rough surface before hot press. Most industrial/ thick wall/large products</td>
</tr>
<tr>
<td><strong>Machine size (m) forming only</strong></td>
<td>2.2 * 1.8 * 2.4</td>
<td>2.2 * 2.6 * 2.5</td>
<td>2.5 * 2.2 * 2.9</td>
</tr>
<tr>
<td><strong>Electricity usage (per day)</strong></td>
<td>5,800-9,600 kW</td>
<td>1,100-18,700 kW</td>
<td>5,000-6,800 kW</td>
</tr>
<tr>
<td><strong>Gas usage (dryer/day)</strong></td>
<td>0</td>
<td>600-1,100 kg</td>
<td>600-1,100 kg</td>
</tr>
<tr>
<td><strong>Oil usage (for dryer)</strong></td>
<td>0</td>
<td>10-15 kg/h</td>
<td>38-60 kg/h</td>
</tr>
<tr>
<td><strong>Production line space</strong></td>
<td>900-1,200 m²</td>
<td>900-1,200 m²</td>
<td>1,000 m²</td>
</tr>
<tr>
<td><strong>Control</strong></td>
<td>Automatic</td>
<td>Automatic</td>
<td>Manual/semi-auto</td>
</tr>
</tbody>
</table>

**Source:** PendlePace Estimates

A simplistic segmentation of the moulded pulp machinery manufacturing processes can be designated, as shown below, in terms of the different forming methods and market sectors serviced.

### 16-9 Segmentation of MPP machinery sector

<table>
<thead>
<tr>
<th>Forming process</th>
<th>Market sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotary (tunnel)</td>
<td>Commodity</td>
</tr>
<tr>
<td>In-mould / thermoforming</td>
<td>Industrial / consumer (thin wall)</td>
</tr>
<tr>
<td>Reciprocating (tunnel)</td>
<td>Industrial / niche (medium / Heavy wall)</td>
</tr>
<tr>
<td>Combined (tunnel)</td>
<td>Niche / vessel type market</td>
</tr>
</tbody>
</table>

Generally, the different types of machines are focused on specific sectors, with a relatively small overlap between them. It is therefore necessary to define the best currently available technology, and the name of the companies from whom the technology is available, for each of the above 4 sectors.
16-10 Leading manufacturers with the different forming processes

<table>
<thead>
<tr>
<th>Forming process</th>
<th>Leading manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotary (tunnel)</td>
<td>Huhtamaki (Leotech)</td>
</tr>
<tr>
<td></td>
<td>Emery International</td>
</tr>
<tr>
<td></td>
<td>Hartmann</td>
</tr>
<tr>
<td>In-mould / thermoforming</td>
<td>Southern Pulp Machinery</td>
</tr>
<tr>
<td></td>
<td>Fisher and Paykel</td>
</tr>
<tr>
<td></td>
<td>Inmaco</td>
</tr>
<tr>
<td>Reciprocating / slush (tunnel)</td>
<td>Southern Pulp Machinery</td>
</tr>
<tr>
<td></td>
<td>Emery International</td>
</tr>
<tr>
<td></td>
<td>Custom-built</td>
</tr>
<tr>
<td>Combined process (tunnel)</td>
<td>Custom-built</td>
</tr>
</tbody>
</table>

Note: this list is not exhaustive

The choice of best available technology is related to the characteristics of the moulded pulp product, in terms of its size, shape, aesthetics, strength requirements, etc. As such the choice of machine manufacturer, from the above forming process categories, will be influenced by the individual niche manufacturing characteristics/facilities available.

The choice of machine is not a simple decision and as such it will be necessary for the moulded pulp manufacturer to assess his requirements in comparison to the available alternative machine criteria and specifications.
17 MPP Industry structure

17.1 European MPP Manufacturers

We estimate the total number of MPP producers in Western Europe to be about 30, with an average production capacity of approximately 10,000 tonnes per plant. Most interviewed companies would not give out the production capacity of the plants, and we have therefore made estimates based on information received in the interviews and other available sources. The estimates should therefore be seen as indicative of the production capacity only.

The actual production per plant varies considerably – from 500 tonnes to 50,000 tonnes. Assuming the Western European production to be 300,000 tonnes, the UK's share is 11.5%.

There are three large producers of MPP in Europe: Huhtamaki (Finland), Hartmann (Denmark) and Omni-Pac (Germany). They have (or have had) production units in more than one country. Apart from these three companies, the production of MPP is generally local, but with relatively high shares of exports. Hartmann and Huhtamaki are becoming increasingly global in their production. Hartmann has invested in production in Croatia and Hungary, and has also entered the North American market through its acquisition of Cascades' egg packaging MPP plants. Huhtamaki has MPP plants all over the world, except for Asia.

We have concentrated on researching the MPP industry in the countries closest to the UK, as these countries also have the highest share of the trade with the UK. The producers of MPP in these countries can be seen in figure 17-1.

Except for Hartmann, Huhtamaki and Omni-Pac, the other MPP producers in Europe are relatively small and independent. From our interviews in the UK, it is known that several Western European producers are active in the UK market (besides the three ‘giants’), e.g. Schenk FibreTec and Buhl Paperform in Germany, and SEM (Société des Emballages Moulés) and Celluloses de la Loire in France.

17-1 Producers of MPP in selected Western European countries

The industry structure changes every year, and to a higher degree than for other pulp & paper grades. The barrier to entry is relatively small on the production and investment side, but very high on the market side, which many new companies discover too late. Large paper producers, such as Otor and SAICA, have entered and left this market within the past few years.

The large companies have been highly focused on egg packaging, and are still dominating this sector. The egg sector in Europe is under severe price pressure, and the cost of packaging is therefore under price pressure as well. This forces the egg packaging producers to produce long-runs to achieve the lower costs/higher efficiencies. The smaller producers also produce egg packaging, but many are focused on specialty niches, such as industrial, medical or bottle MPP packaging. The margins are higher in these sectors, and this has also attracted the large companies to supply these markets. The actual focus of each producer can be highly influenced by the industry in the country/region, e.g. in France where companies like SEM have focused on fruit, wine bottle and industrial packaging.
17.2 MPP consumption and production in North America

The consumption of MPP in North America is estimated at 450,000 tonnes. According to the 2002 Economic Census made by the US Census Bureau, there are 30 producers of MPP in the USA. The value of their shipments is £ 200 million, compared to £ 285 million in 1997.

We believe the number of MPP plants in the USA is higher than 30, based on a comparison on the total value of shipments with a consumption of 450,000 tonnes. The value of shipments would be less than £ 500 per tonne using these statistics, which is substantially lower than the UK value of shipments. The number of producers in North America is likely to be closer to 45 than 30.

17-2 Number of MPP producers and value of MPP shipments in the USA 1997 and 2002

Source: U.S. Census Bureau, 2002 Economic Census

17.3 UK Industry structure

There are currently four producers of MPP in the UK, with a combined production capacity of about 33,000 tonnes. The companies are:

- Huhtamaki Lurgan, Northern Ireland
- Vernacare, Bolton, England
- Cullen Packaging, Glasgow, Scotland
- Moulded Paper International, Gwent, Wales

The difficult situation for manufacturing industries in the UK during the last few years, has also affected the MPP industry. SCA has shut down its MPP operation in Newport. It moved one machine to another SCA plant in Sweden, and sold the other machine. Omni-Pac has also closed down its UK operations, and has now focused its production at its Elsfleth plant outside Hamburg, Germany.
17.4 UK company profiles

17.4.1 Huhtamaki Lurgan Ltd.
Huhtamaki (Lurgan), which is situated in Lurgan, 25 miles from Belfast, is the largest manufacturer of moulded pulp products in the United Kingdom, and was originally owned by Van Leer. The company is focussed on the production of egg packaging and also manufacturers moulded cup-holders for fast-food take-away restaurants.

Certain retailers (e.g. Morrisons) specify coloured egg packaging, in contrast to other retailers who prefer white or grey. The UK is the main market for all products. Their main competitors in the egg packaging sector are Omni-Pac (Germany) and Hartmann (Denmark).

17.4.2 Robert Cullen & Sons Ltd
Robert Cullen (or Cullen Packaging as it is also known) is based in Glasgow and is a designer and manufacturer of paper-based packaging, including corrugated and solid board cases, cartons and fitments and moulded pulp paper fitments made from waste paper. The company has been in existence since 1921.

The company suffered a severe fire in its MPP operation in December 2003, which completely destroyed their manufacturing operation. They are in the process of rebuilding a new MPP operation, which is expected to come on stream in mid 2005.

The company is registered with SEPA as an accredited reprocessor of waste paper. The company is also accredited for ISO 14001.

17.4.3 Vernacare
Vernacare (part of the Verna Group) and based in Bolton is a manufacturer of moulded pulp products for medical applications. The company is a major supplier to the National Health Service, local authorities, health care trusts and social services.

Vernacare introduced the first system for disposable receptacles for toileting patients, and claims to be the chosen supplier for 75% of UK hospitals. Since its inception, Vernacare has developed a wide range of supplies and disposables for the health services, and these include disposable gloves, skin cleaners, macerators, wipes, commodes, etc.

Vernacare supplies a wide range of disposable products and ancillaries, including a comprehensive variety of moulded pulp disposables for specific applications. The company manufactures its own range of moulded pulp products, and is the dominant supplier of these products to the National Health Service.

17.4.4 Moulded Pulp International Ltd
Moulded Paper is a relatively new manufacturer of moulded pulp products, and was formed in 2002. The company is based in Pontllanfraith near Newport. The ultimate owner of the company is USA Moulded Paper International LLC.

Moulded Paper International designs, engineers and manufactures moulded pulp packaging and protection items. The markets supplied by the company include eggs, electronics, perishables, medical and a wide range of industrial applications.

17.4.5 Omni-Pac Ltd
Omni-Pac is a subsidiary of Pactiv Corporation and used to manufacture moulded pulp products at its factory in Great Yarmouth, until it closed in June 2003. The main products produced were egg trays and cartons. The UK operation is now acting as a sales office for the German Omni-Pac operation based in Eislleth (estimated output is 25,000 tonnes).

17.5 European company profiles
The global market for MPP is dominated by three companies: Hartmann, Huhtamaki and Omni-Pac (Pactiv). These three companies have a global market share of more than 50%, according to Hartmann’s 2002 annual report.

17.5.1 Huhtamaki Moulded Fiber
Huhtamaki is a Finnish group focused on the production of rigid and flexible packaging based on plastics, paper, board, aluminium foil and moulded pulp. Huhtamaki has operations in 36 countries, and has grown very quickly during the 1990s, mainly through acquisitions.

The MPP operations of Huhtamaki became part of the group through Huhtamaki’s acquisition of the Van Leer group in 2000. The operations are part of both the consumer goods and food services divisions, but are in reality run
independently. There are no financials available for the MPP division of Huhtamaki, but the company states that 21% of net sales in 2003 came from the moulded fibre operations.

17-4 Sales by region in 2003

![Sales by region in 2003](Source: Huhtamaki Company Presentation 2004 “Taking Packaging Further”)

Huhtamaki divides its operations into two divisions, which both produce moulded pulp products:

- **Consumer goods**: A wide range of packaging for both food and non-food sectors
- **Food service**: Packaging for food service providers such as e.g. fast-food restaurants and catering companies

17-5 Sales by technology in 2003

![Sales by technology in 2003](Source: Huhtamaki Company Presentation 2004 “Taking Packaging Further”)

The majority (75%) of the moulded pulp production still goes to egg packaging, although Huhtamaki also supplies the following products:

- Fruit and vegetable trays
- Single-use tableware (Chinet range)
- Protective packaging for components and semi-manufacturers (automotive industry, cartridges)
- Packaging for heavier consumer goods, (e.g. electronic devices)
- Packaging for light consumer goods (e.g. mobile phones, shavers)
- Hospital products

Huhtamaki claims to be the world’s largest producer of moulded fibre, and it is a truly global company with MPP plants in the following European locations:

- Franeker, Netherlands
- Honefoss, Norway
- Lurgan, United Kingdom
- Auneau, France
- Okrisky, Czech Republic
- Moscow, Russia

The company also has four MPP plants in the USA (disposable products only, no egg packaging), two plants in South Africa and one plant each in Australia, New Zealand and Egypt as well as 50% of an MPP producer in Malaysia. Huhtamaki’s market position in MPP is very strong in all regions (except for Asia), which is illustrated in table 17-7. Huhtamaki supplies a large number of the big global groups in consumer products and fast-food, e.g. Kraft, Unilever, McDonald’s, Coca-Cola and Sodexho.
17-7 Market position for Huhtamaki Moulded Fibre

<table>
<thead>
<tr>
<th>Region</th>
<th>Market position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe</td>
<td>***</td>
</tr>
<tr>
<td>North America</td>
<td>***</td>
</tr>
<tr>
<td>South America</td>
<td>***</td>
</tr>
<tr>
<td>Asia</td>
<td></td>
</tr>
<tr>
<td>Oceania</td>
<td>***</td>
</tr>
<tr>
<td>Africa</td>
<td>***</td>
</tr>
<tr>
<td>TOTAL</td>
<td>***</td>
</tr>
</tbody>
</table>

Explanation:  
*** Strong (#1-2)  
** Average (#3-5 and/pr stronger in segments)  
* Present in market

Source: Huhtamaki Annual Report 2003

The moulded pulp products are all made of 100% recovered fibre, both pre-consumer (50%) and post-consumer (50%). The Chinet tableware range is made from 100% post-consumer bleached paper broke from Huhtamaki’s paper cup production plants.

17-8 Breakdown of raw materials and utilities

Source: Huhtamaki Annual Report 2003

Huhtamaki manufactures its own moulded pulp machines and has patents on its MPP technology, which it also sells and licenses to external companies. The technology is called Leotech, and is part of Huhtamaki Moulded Fibre Technology which is based in Franeker, the Netherlands.

17.5.2 Hartmann A/S

Hartmann is a Danish packaging group focused on the production of moulded pulp products. It is headquartered in Copenhagen, and is listed on the Copenhagen Stock Exchange. Its products can mainly be found in the following categories:

- Egg packaging: egg cartons and trays
- Industrial packaging: mobile phones, personal care, light bulbs, tubes/retail displays, medicine bottles, optical & digital device, home diagnostics, fluorescent, cushioning, hortipot, shoe fillers and fittings
- Hospital trays: disposable kidney bowls
- Fruit packaging: apple and melon trays
- Coreboard & liner
- Hartmann technology

Hartmann developed an ovenable food packaging called dualpack in 2001, which it decided to discontinue in December 2004 due to heavy financial losses.

The products are made from recycled paper only. No virgin pulp is used, as the Tønder plant in Denmark has a deinking plant. Waste paper is obtained both through own collection companies and external waste paper suppliers. An example is Danfiber A/S, a leading Danish supplier of all kinds of waste materials, which is 1/3 owned by Hartmann and co-owned by Danish municipalities.

Hartmann acquired Cascades’ North American egg packaging MPP operations in 2002, and thereby gained 25% of the North American market for moulded pulp egg packaging. The two plants in Canada and the USA have been closed down since the acquisition, and a new Canadian plant was built in 2003 (capacity of more than 400 million units per year). Hartmann has had great difficulties in the start-up of the plant, and this has caused very high losses for the group.

Hartmann has production in twelve countries around the world:
Brødrene Hartmann, Denmark
Hartmann-Schwedt, Germany
Hartmann-Varkaus, Finland
Cemosa, Spain (20%)
Hartmann-Bábolna, Hungary
Hartmann papirna, Croatia
Hartmann, Canada
Hartmann-Mai, Israel
Hartmann-Mapol (Sorocaba and Montes Claros), Brazil
Hartmann-PPM, Argentina
Hartmann, Malaysia


Hartmann has a relatively poor level of profitability for the MPP sector, and the profitability dropped drastically in 2003 due to the problems with the dualpack and North American operations. The South American operations are also heavy loss-making but improving. The European egg and fruit packaging segment and the Skjern paper mill have more stable profitability levels (11% and 7% respectively in 2003). The industrial packaging division of Hartmann, on the other hand, is a financial success, with an EBIT level of 18% in 2003. The industrial packaging products are mainly made in Hungary, where there is a large market for these products from global consumer goods companies.

The operations also include the Danish paper mill Skjern Papirfabrik, which has a production capacity of 50,000 tonnes of coreboard and recycled corrugated paper per year. The paper mill is reportedly up for sale.

Hartmann Technology supplies MPP machines to Hartmann plants, external companies and licensees. The products cover machines, moulds and tooling as well as service. The machinery customers can be viewed as part of the Hartmann sphere, as licenses are involved and this requires close cooperation with the Hartmann group. The machines are double rotary moulding machines with capacity ranging from 1,800 pieces per hour up to 18,000 pieces per hour (based on 30-egg trays). Hartmann machinery can be found all over the world, including the following companies:

- Fabrique d’Emballeages A. Sadi SNC EBF, Algeria
- Usine d’Emballeages Avi coles Belkhichane Frères, Algeria
- SARL SIFA SUD, AlgeriA
- Hartmann-PPM Argentina
- Huhtamaki, Australia
- Zelenoborsky Peat Processing Plant, Belorussia
- Hartmann-Mapol do Brasil Ltda., Brazil
- Hartmann-Mapol Montes Claros Ltda., Brazil
- Cascades Moulded Pulp Group, Canada
- CHIMOLSA, Chilena De Moldeados S.A., Chile
- COMOLSA, Colombiana De Moldeados S.A., Colombia
- Hartmann-Bilokalnik Ambalaža d.o.o., Croatia

Source: Hartmann annual report 2003
Omni-Pac

Omni-Pac is the European moulded pulp subsidiary of American group Pactiv Corporation. Omni-Pac is one of the three largest MPP producers in the world. It has one plant in Europe, located in Elsfleth in northern Germany. Its UK plant in Great Yarmouth closed down in 2004, and therefore no longer supplies the UK market, and now operates solely as a sales company for the products produced at the Omni-Pac plant in Germany.

Pactiv is a large American specialty packaging company, and is the leading North American supplier of MPP. It has operations in fourteen countries, and had net sales of USD 3.1 billion in 2003. The company makes packaging based on aluminium, foam, plastics, moulded pulp and paperboard. Pactiv was earlier known under the name Tenneco.

The majority (70 %) of the sales comes from egg packaging, but the product range also includes the following sectors:

- Fruit packaging
- Vegetable packaging
- Medical products
- Meat packaging
- Individual packaging

All kinds of fibres, recycled and virgin, are used for Omni-Pac’s moulded pulp products. The majority is recycled paper based. An increasing share of the products, also for egg packaging, have high demands on whiteness, which require
either side-run news or virgin pulp in the furnish. Omni-Pac does not have its own waste paper company, but buys in waste paper from external sources.

According to Omni-Pac, its Elsfleth plant is the most modern MPP facility in Europe. They manufacture their own machines and moulds, but do not sell them externally unlike the main competitors Huhtamaki and Hartmann. Omni-Pac has a close cooperation with its American parent company, especially regarding mould making, production technology and product development.

17.5.4 Erin Horticulture Ltd.
Erin Horticulture is based in Birr Ireland, approximately 2 hours west of Dublin. The company is a manufacturer of moulded pulp products and is focused on the supply of moulded pulp products to the horticulture and market garden sectors.

17.5.5 Celluloses de la Loire
Celluloses de la Loire (CDL) was founded in 1977, and is situated south-west of Paris. It has been part of the OFIC group since 1985, and today employs about 90 people.

Production is predominantly of egg trays. The products are made from recovered fibre only, with a split of approximately 50-50 between post and pre-consumer waste. The waste paper is bought from external French sources.

The egg trays are sold all over Europe, and after Omni-Pac’s closure of their UK plant, CDL exports of egg trays to the UK has increased significantly.

CDL make their own machinery from their own design, and they also manufacture their own moulds. They also have their own development department.

17.5.6 Ecofeutre
Ecofeutre is a relatively new MPP producer, which was started up by the Glon group in order to supply their own egg packing companies. The Glon group is one of the largest food companies in France, with about 20 companies involved in food production, from farming for food processing. The establishment of Ecofeutre was due to a new regulation that came into force in 1998, whereby the companies could no longer reuse egg trays. Earlier egg trays could be reused up to three times. This new regulation increased the Glon group’s egg tray demand dramatically, and as the group found the prices of MPP egg packaging to be too high after the new regulation, they decided to set up their own MPP plant.

17.5.7 SOFREC – Société des Emballages Moulés
SOFREC-Société des Emballages Moulés is a merger of the MPP producer Société des Emballages Moulés and the MPP machinery manufacturer SOFREC.

Société des Emballages Moulés (SEM) was established in the 1940s as a pulp and paper trader. They started their MPP production in the 1960s at site in the Champagne region. The first application was wine bottle packaging. Later they have added fruit and vegetable packaging, and in the 1990’s SEM started producing MPP for the industrial packaging sector. SEM employs 90 people.

SOFREC was (before the merger) developing and marketing MPP machinery. The merged company has, however, ceased these activities, although when they receive an order for an MPP machine, they utilise the necessary resources from their production unit. SEM has sold machinery all over the world, and interestingly the competing Spanish MPP producer, Cemosa, has bought equipment from SEM. MPP machines have also been sold to China.

The company has developed and patented their own production technology, which is a rotary mould holding unit with eight moulds. After-pressing is also used. Only recovered paper is used, and they use office waste, ONP or OCC depending on the product. The waste paper is sourced through the company’s own waste paper collection company, which source waste paper from all over Europe.

France is the main market, but SOFREC-SEM sells all over the world. They have a development department in Paris, and they have (for example) developed a top cover for the Tetra Pak Brik liquid packaging, which is used when stacking the Tetra Briks as stacking is otherwise impossible with the plastic caps.
17.6 North American company profiles

17.6.1 Fibercel Inc
Fibercel Inc. is a manufacturer of moulded pulp products and is situated in Portville, New York. Fibercel also has a second plant in Tennessee.

The main products produced by the company are thick wall moulded pulp items. The main markets serviced are the automotive industry, ink cartridges, furniture industry, industrial products and the construction industry. Sales are predominantly to the US market.

17.6.2 Tek Pak Inc
Tek Pak is a manufacturer of moulds and is located in Batavia, a suburb of Chicago. The biggest market for Tek Pak is the manufacture of moulds for the plastic thermoforming industry.

All the moulds produced are manufactured from aluminium, due to its low cost, availability and ease of engineering. Additionally, the thermal conductivity of aluminium is 3-4 times that of steel. The mould supplied by Tek Pak can be heated with steam and/or electric.

17.6.3 Orcon Industries Corporation
Orcon Industries, which has a turnover of USD 11 million, is based in Le Roy New York and is a manufacturer of packaging structures. The main products produced by Orcon are tri-wall corrugated cases, injection moulded EPS packaging and thermoformed moulded pulp products.

17.6.4 Keiding Inc.
Keiding Inc is an independent manufacturer of moulded pulp products, employing 20 personnel, and located in Milwaukee, Wisconsin. The company has recently changed ownership and is now owned by Jim Gehl and his son.

The products manufactured are predominantly IMPEPA Type 1 products, which are thick wall products for industrial type packaging, and floral and nursery containers. Major customers include automotive manufacturers, DIY tool suppliers, and horticultural distributors. Minimum order size is 10,000 items.

17.6.5 Henry Molded Products
Henry is a well-known manufacturer of moulded pulp products and is based in a modern factory in Lebanon Pennsylvania. The company also has an operation in Tennessee, and employs a total of 120 people

17.6.6 Pactiv Corporation
Pactiv Corporation is a USD 3.4 billion turnover company with headquarters at Lake Forest, 10 miles north of Chicago. The company projects itself as a leading provider of advanced packaging solutions and operates in a wide number of markets, and has 79 operations throughout the world.

Omni-Pac is the moulded pulp European subsidiary of Pactiv, and is based in Elsfleth, Germany. Omni-Pac manufactures its moulded pulp products from either waste paper or virgin fibre. The main markets serviced from the German plant are fruit, egg packaging, medical products, meat packaging, vegetable packaging and individual packaging.

In the US, Pactiv has a number of operations manufacturing moulded pulp products, and is supplying a variety of markets including take-away cup carriers, catering applications, egg packaging, tableware and punnets for fruit.

The company has developed a range of products under the brand name Chinet, which is manufactured from very clean (pre-consumer board off-cuts) white waste and is used in applications for direct food contact. The Chinet range is extensive and includes moulded pulp plates, trays, bowls etc. The Chinet range is manufactured on a patented intermittent rotary machine equipped with thermoforming presses, and which, following forming and pressing/drying, is subsequently laminated with a very thin film of PET onto the surface. Pactiv is reported to have 30 machines producing the Chinet range. Growth in the tableware market is estimated at 3-4% over the next 5-year period. A brief summary of the patented process is as follows.

Chinet is an inexpensive, disposable, three-dimensionally contoured container, suitable for many purposes including holding food during exposure to high temperatures for long times in either a microwave or a conventional oven without any detrimental effect to the container or the food. The container consists of an essentially impervious liner of polyethylene terephthalate directly bonded by its own substance to a pre-formed contoured base obtained by molding to final shape nonbrowning substantially 100% bleached kraft wood pulp from an aqueous slurry thereof against an open-face suction mold, and drying the same under pressure imposed by a mating pair of heated dies. The liner is formed by bonding to the pulp base a 0.5-2.0 mil thick film of thermoformable, substantially amorphous, substantially unoriented polyethylene terephthalate having a molecular weight which is understood to be in excess of 15,000. The film is bonded to the base by pre-heating the base, rapidly pre-heating the film and then quickly pressing the film into contact with the
base at a temperature in the range of 300\degree-375\degree F., the pressing being done by vacuum in the range of about 20 inches of mercury applied through the base for no longer than about 1 second, and finally cooling so that the liner thereafter will not shrink-separate away from the contoured base as a result of subsequently exposing the container to a temperature of up to 400\degree F.

Pactiv have five large plants in the US, and utilise the rotary (+ tunnel drying) forming process for egg packaging and rotary (+ thermoforming combined) for the food service Chinet range.

17.6.7 JEG Corporation

JEG Corporation is an independent and is situated in Lebanon, Pennsylvania.

The main products produced are heavy wall, industrial, short run and niche/special applications. Typical uses are for protective packaging, air conditioning corner pads, electric motor and compressor packaging.

17.6.8 Pulp Moulding Die Inc

Pulp Moulding Die Inc. is a manufacturer of moulds based in Ajax near Toronto in Canada.

The company sells moulds on a global basis.

Moulds materials are usually bronze or stainless steel, and screens are also made from stainless steel.

17.6.9 Emery International Developments

Emery is probably the best-known manufacturer of rotary moulded pulp machines, and is based in Markham, near Toronto in Canada. Emery sell their machines on a global basis, although sales to Africa, China and South America are low.

In addition to manufacturing a wide range of rotary machines, Emery also produce reciprocating and thermoforming machines. Emery manufacture their own multi-pass drying tunnels (gas fired at 350 deg. F) with their rotary machines. The company also supplies offset printing units, which can print up to ten colours on egg boxes/cartons.

17.7 Chinese company profiles

17.7.1 Beijing Xili Pangpu Moulded Pulp Products Ltd

Xili Pangpu has been manufacturing moulded pulp products for approximately 10 years, having previously produced a wide range of expanded polystyrene protective packaging products. This experience, from the EPS market, has enabled Xili Pangpu to focus on niche areas for its moulded pulp products within the protective packaging market, and particularly in applications where the specific advantages of MPP are recognised by the end-user.

The company has four production lines with a total output of 2,000 tonnes per annum. The main raw materials are virgin fibre, newsprint and OCC (old corrugated containers). The main markets supplied by Xili are fruit trays, egg packaging, electronics, mobile phones and industrial packaging applications.

Mould design and manufacture is in-house, but this service is also offered to other MPP manufacturers. Mould design and manufacture is either by conventional processes, or by 3-D CAD design and CNC machine cutting.

The company manufactures moulded pulp machines, single-pass drying tunnels (oil fired), after-presses and other associated equipment.
17.7.2  Nanya Moulded Pulp Equipment Ltd.

Nanya has been producing moulded pulp manufacturing machines for in excess of ten years. The main types of machines produced are both reciprocating and thermoforming processes. The company also supplies tunnel dryers (gas or oil fired) and after-pressing equipment, and has also recently developed a thermoforming machine with a large platen size of 1,000 mm x 1,000 mm.

An after-sales service and training of operators is also offered to customers.

Nanya has sold in excess of 100 different models of machines to China, Japan and the Philippines.

17.7.3  Guangzhou Huanyuan Environmentally Friendly Packaging Technology Co., Ltd

Guangzhou Huanyuan is situated in the Tianhe district of Guangzhou, and was formed four years ago, from the assets of the former Yuanlong Molded Machinery Company.

The company produces a range of moulded pulp manufacturing machinery including stock preparation equipment, forming equipment, tunnel dryers and after-pressing equipment.

Types of machines supplied are reciprocating, swing and thermoforming wet-ends. The thermoforming machines are fully automatic, and produce excellent products, which are very smooth on both sides. A total of seven MPP manufacturing lines have been sold, and two new orders are currently in the process of being manufactured.

The company is carrying out considerable research and development into the reduction of costs in drying tunnel applications.

17.7.4  Ningbo Haiji Moulded pulp Packaging Product Ltd.

Ningbo Haiji is a manufacturer of moulded pulp products, with turnover of approximately 8 million RMB, and is situated in the Yinzhou Central district.

The company was established in 2001, and has three production lines in operation. The main products produced by the company are focused on the industrial packaging sector.

The company also manufactures moulded pulp forming machines.

17.7.5  Qingdao Huiyu Moulded Pulp Products Ltd

Huiyu, which was established in 2000, is a manufacturer of moulded pulp products, and is located in Jiaonan in the Qingdao economic development zone.

Four production lines are currently in operation, and two further lines will be installed during the course of 2005. The main products produced are for the electronics industry, solar energy pipes, heaters, mobile phones, DVD and MP3 players.

The company has eleven main customers, mostly situated in the Shandong region. The largest volumes of products are supplied for solar energy pipe packaging (RMB 7 million), mobile phone packaging (RMB 5 million), and soybean machine packaging (RMB 3 million).

The company's sales efforts are focused on the packaging sector, although they are currently developing a new product for the building industry.

17.7.6  Tianjin Jianlong Moulded Pulp Products Ltd

Tianjin Jianlong is a manufacturer of moulded pulp products, and was established in 1997 by the Yuanlong Moulded Pulp Machinery Company. The company became independent with new management in 2000.

The company has two production lines (1 x swing + 1 x reciprocating), and has annual sales of approximately 400 tonnes. The key focus markets are for pharmaceutical and electronic packaging.

17.7.7  Tianjinshi Huadi Packaging Technology Ltd

Huadi is a relatively new business, producing moulded pulp products, and was started in 2000.

The main product line sold by the company is moulded pulp pallets. These can be made up to 12 mm thick (in a width of 1,000 mm), and are produced at a rate of four metres per minute. Annual output is approximately 12,000 tonnes per annum.
18 MPP manufacturers financial performance

18.1 Overview

The interviews have given two contradictory indications of profitability in the sector - in the first case, it is a profitable niche, while the contrary view is that price pressure in the market is the cause of low profitability. The variability in profitability is also verified in the available financials.

Our conclusion is that the profitability varies considerably depending on:

- The company size does not seem to be as important to the profitability as indicated by interviewees. This is probably because the smaller producers have focused on the more profitable application areas, and avoid competing with the large producers in the high volume but less profitable segments.

- The profitability varies considerably with the market focus of the companies. The medical and industrial packaging sectors are the most profitable. The large producers seem to be making money from egg and fruit/vegetable packaging, which is likely to result from their ability to efficiently produce these products in very large volumes.

There is limited information available on the financial performance of UK MPP producers, for several reasons:

- Huhtamaki Lurgan and Vernacare have given full financial statements for 2003
- Robert Cullen & Sons has excluded the turnover from the financial statements
- Moulded Paper International was not operational in 2003

Table 18-1 shows the available financials for UK producers of MPP for the year 2003. Huhtamaki Lurgan’s and Vernacare’s profitability is at a ‘normal’ level for the paper industry, with EBIT margins of 10-12% of turnover.

18-1 Financial performance of MPP producers in the UK 2003

<table>
<thead>
<tr>
<th></th>
<th>Huhtamaki Lurgan</th>
<th>Vernacare Ltd.</th>
<th>Robert Cullen &amp; Sons Ltd.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turnover (Million £)</td>
<td>17.8</td>
<td>48.5</td>
<td>n.a.</td>
</tr>
<tr>
<td>EBITDA (Million £)</td>
<td>3.0</td>
<td>6.8</td>
<td>0.9</td>
</tr>
<tr>
<td>EBITDA/Turnover</td>
<td>16.8%</td>
<td>14.1%</td>
<td>n.a.</td>
</tr>
<tr>
<td>EBIT (Million £)</td>
<td>1.8</td>
<td>5.6</td>
<td>0.1</td>
</tr>
<tr>
<td>EBIT/Turnover</td>
<td>10.0%</td>
<td>11.6%</td>
<td>n.a.</td>
</tr>
<tr>
<td>Profit after tax (Million £)</td>
<td>1.5</td>
<td>3.6</td>
<td>-0.1</td>
</tr>
<tr>
<td>Profit after tax/Turnover</td>
<td>8.7%</td>
<td>7.4%</td>
<td>n.a.</td>
</tr>
<tr>
<td>Employees</td>
<td>158</td>
<td>1,275</td>
<td>167</td>
</tr>
<tr>
<td>Exports/Turnover</td>
<td>n.a.</td>
<td>5.33%</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

Table 18-2 lists key financials for selected European MPP producers. The selected companies are probably not representative of the MPP industry, for the following reasons:

- Omni-Pac Sweden is quoted as saying that MPP is a profitable industry, but the financials show that the company is loss-making. However, Omni-Pac Sweden is a sales company only, and it is impossible to see from the financials what the actual profitability of the company is as the German production costs are not directly visible in these financials

- Ecofeutre shows very high profitability in terms of EBITDA margin, while the EBIT and net profit margins are at a relatively low level. This is likely to be due to investments they are currently undertaking. The EBIT margin includes a provision of EUR 107 million - without the provision, Ecofeutre has an EBIT margin of about 10%.
Huhtamaki Norway’s financials may be affected positively and negatively by several factors. The plant makes mainly higher margin products such as the Chinet disposable tableware range. However, these products also have high raw material costs as they bring in high quality paperboard broke from other Huhtamaki plants. Additionally, the location in Norway is geographically remote from the major European markets, and transport costs are therefore high.

18-2 Financial performance of European MPP producers 2003

<table>
<thead>
<tr>
<th></th>
<th>Hartmann</th>
<th>Omni-Pac Sweden¹</th>
<th>Ecofeutre</th>
<th>Huhtamaki Norway²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turnover (Million £)</td>
<td>142.6</td>
<td>4.4</td>
<td>1.3</td>
<td>16.2</td>
</tr>
<tr>
<td>EBITDA (Million £)</td>
<td>14.0</td>
<td>-0.02</td>
<td>0.37</td>
<td>1.1</td>
</tr>
<tr>
<td>EBITDA/Turnover</td>
<td>9.8%</td>
<td>n.m.</td>
<td>28.1%</td>
<td>6.7%</td>
</tr>
<tr>
<td>EBIT (Million £)</td>
<td>3.4</td>
<td>-0.02</td>
<td>0.05</td>
<td>0.7</td>
</tr>
<tr>
<td>EBIT/Turnover</td>
<td>2.4%</td>
<td>n.m.</td>
<td>3.9%</td>
<td>4.3%</td>
</tr>
<tr>
<td>Profit after tax (Million £)</td>
<td>-0.06</td>
<td>-0.01</td>
<td>0.01</td>
<td>0.6</td>
</tr>
<tr>
<td>Profit after tax/Turnover</td>
<td>n.m.</td>
<td>n.m.</td>
<td>0.7%</td>
<td>3.8%</td>
</tr>
<tr>
<td>Employees</td>
<td>2,363</td>
<td>4</td>
<td>20</td>
<td>127</td>
</tr>
</tbody>
</table>

¹ Sales company only.  
² May include other products than MPP.  
Source: Company annual reports, ORT, Bolagsverket and Bronnoysundregistrene.

19 The way forward for UK MPP industry

19.1 Positive factors for developing UK MPP manufacturing base

The UK still remains a large market in terms of general manufacturing, even when mirrored against the background of a reduction in its size and infrastructure over the last 10-20 years.

There is, undoubtedly, an opportunity for the moulded pulp product industry to capitalize on a number of factors and issues, and these indicate a number of potential growth market sectors.

The key factors indicating a potential future opportunity for MPP manufacturers in the UK market can be summarized as follows:

- High availability of recovered fibrous raw material at low prices (compared to expanded polystyrene)
- Large population
- Substantial general UK manufacturing infrastructure
- Increasing environmental awareness
- Small current number of manufacturers of moulded pulp products
- Current MPP manufacturing capacity is polarized towards 2 main markets (e.g. egg packaging and medical applications)
- Major opportunities to replace expanded polystyrene; particularly in the protective packaging (high priority), and potentially in the construction insulation sector (low priority)
- Emerging 3D solid modeling techniques, which will favourably effect the delivery and price of moulds.
- Introduction of emerging mould design technologies can reduce the potential cost and preparation time for moulds (including prototype moulds)
- Potential markets for moulded pulp packaging are the automotive sector, bathroom industry, electronic, electrical, construction and industrial applications.

19.2 Negative factors against developing UK MPP manufacturing base

In terms of factors mitigating against the development of the UK moulded pulp manufacturing base, these have been discussed in detail, in preceding sections of the report, and are also summarized below.
- Cautious and insular industry
- Major lack of market awareness of moulded pulp products
- Only profitable in long-run niche or commodity markets
- Restrictions of short-run applications
- Restrictions of ability to consistently compete competitively with EPS
- High energy costs
- High labour costs
- Long lead times and high cost of mould making
- Inferior performance perception

Of particular note is the cautious and insular nature of the MPP industry; and the negative impact this has on the industry learning from itself, and also from other packaging and industrial sectors. It is evident that the slow evolution in technology is retarding the progress of the industry, and this exhibits itself, in the ups and downs of the industry (not only in the UK), in terms of a general highly variable financial performance from MPP manufacturers, but also from the number of MPP machinery manufacturers, who have, come and gone, or simply disappeared over the last 10-15 years.

The recent increases in the price of crude oil are currently encouraging packaging companies and end users to investigate the cost benefits of moulded pulp products. However, feedback from the interviews indicates that at an oil price of approx $65/barrel, EPS is still just competitive with moulded pulp structures.

It is believed that for MPP to have a clear competitive advantage over EPS, the price of oil must move to be permanently in excess of approximately $70/barrel.

Clearly, the MPP industry cannot rely on the oil price for its long-term salvation, and must therefore take steps to sufficiently reduce its base cost structure; thereby effectively de-coupling its cost competitive position from the oil barrel price.

### 19.3 Key issues for the development of a competitive UK MPP industry

The lack of awareness of moulded pulp products by potential customers, packaging companies, end-users, etc, is a major issue, which must be addressed by the industry if it is to expand its presence in the total packaging market. Currently, external knowledge of the industry, its products and participants is low, and this coupled with a lack of industry representation is enabling competitors to gain market share, and effectively leave the moulded pulp industry in a static position. We believe a focused effort on increasing the awareness of moulded pulp products and its benefits, could increase the consumption of moulded pulp products by up to 15,000 tonnes per annum. This figure is based on the general low awareness of moulded pulp products at consumers, but mostly in industrial segments where many packaging managers have not even considered moulded pulp as a packaging alternative.

Competition from alternative packaging mediums, including expanded polystyrene, die-cut corrugated shapes and pre-formed plastic structures, is intense and competitive. It is, therefore, important for the medium/long term future, that the industry focuses its evolutionary efforts in reducing its costs and improving its efficiencies in a number of key areas. Specific areas to be targeted include energy and labour.

Increased competitiveness of the industry is a critical issue to be addressed both in the short and medium term. The key areas for operational improvement, which have been highlighted during the study are as follows:

- The ability to manufacture short/medium run lengths at competitive prices
- A reduction in the cost of manufacturing moulds for prototype and production products
- A reduction in the time to design mould structures, by the further evolution of 3D solid modelling software.
- Improvements in wet-end pressing and product drying techniques (to reduce energy consumption)
- The uptake of suitable/coordinated automated packing equipment (to reduce manning levels)

### 19.4 Road map for successful development of UK MPP industry

It has been concluded from the findings of the study, that a number of issues must be addressed, and that appropriate actions should be taken (in the short, medium and long term), in order to move forward the development of the moulded pulp industry; and as a result to generate an increase in the consumption of recovered fibre.
19-1 Key Recommendations for the development of the UK moulded pulp industry

<table>
<thead>
<tr>
<th>Priority Ranking</th>
<th>Issue</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Increased product awareness</td>
<td>Formation of trade association</td>
</tr>
<tr>
<td>2</td>
<td>Increased product awareness</td>
<td>Implement successful case studies to demonstrate benefits of MPP</td>
</tr>
<tr>
<td>3</td>
<td>Reduction raw material costs</td>
<td>Development of lower recovered fibre cost options</td>
</tr>
<tr>
<td>4</td>
<td>Improvement in energy efficiency costs</td>
<td>Development of improved wet-pressing techniques</td>
</tr>
<tr>
<td>5</td>
<td>Reduction in labour costs</td>
<td>Uptake of automated product packing equipment</td>
</tr>
<tr>
<td>6</td>
<td>Reduced time to market for products</td>
<td>Development of mould design software database</td>
</tr>
<tr>
<td>7</td>
<td>Increased competitiveness vs. EPS</td>
<td>Ability to manufacture short/medium run lengths at competitive prices Lower price moulds</td>
</tr>
<tr>
<td>8</td>
<td>Investigation of alternative low-cost drying methods</td>
<td>Global benchmarking study</td>
</tr>
</tbody>
</table>

19.5 Formation of a UK/European moulded pulp association

There is currently no organisation or association in the UK (or Europe) to represent the interests of the UK moulded pulp manufacturing industry, or to promote the merits of moulded pulp vs other competing materials.

IMPEPA (International Molded Pulp Environmental Packaging Association), which is based in Milwaukee, Wisconsin, is essentially the only international association for promoting moulded pulp. IMPEPA is mainly focussed on the North American Market, and its presence and impact in the UK and Europe is minimal.

It is recommended that a moulded pulp association is formed. This is more likely to succeed as a European association than being solely UK based. The size of the association should reflect the MPP industry, and should be low cost and small but also highly pro-active.

The key objectives of the proposed moulded pulp association would be as follows:

- To represent the UK and European moulded pulp industry on a broad front.
- To promote the moulded pulp industry through
  - press releases
  - articles in magazines
  - fact sheets
  - exhibitions
  - position papers
- To monitor and analyse issues likely to impact MPP industry
- To work with related trade associations (e.g. packaging organisations, etc)
- To develop a European data base of all moulded pulp manufacturers
- To promote moulded pulp products on a focussed and targeted basis
- To set up a web-site, including a member's area
- To assist with training and health and safety issues
- To assist with new developments in technology, equipment, processes, applications and trends

The above list, whilst not exhaustive, gives a good overview of the objectives and aims of a moulded pulp trade association.

IMPEPA have offered their assistance in the formation of a UK/European association, and view such a move as a logical extension to their North American activities.
19.6 Implement a UK moulded pulp case study

There is a major opportunity to increase the usage of moulded pulp in the UK, simply by raising its product awareness/profile in the market. However, it is clear that moulded pulp is viewed (by those aware of it) as a product with limited performance capabilities and aesthetics, and therefore there is a requirement to convince industry at large of its merits.

In order to promote the increased use and benefits of moulded pulp products in the UK (and as a consequence the increased use of recovered fibre) it is recommended that a Case Study is undertaken, so that this can act as a leading example for major/potential UK customers of MPP.

A number of well-known companies have dismissed moulded pulp packaging as an unsuitable and unacceptable form of protective packaging. These companies have historically tested moulded pulp packaging, but have found its protective performance unacceptable, and have therefore chosen to use alternative materials.

It is therefore considered that if a case study could be undertaken, with a company which has rejected MPP as a suitable packaging medium, and this was successful and promoted to industry at large, the interest and uptake in moulded pulp products could be dramatic.

The outline and contributors for a UK moulded pulp case study are as shown in the following diagram.

19.7 Increased usage of lower cost recovered fibre

With the ever-increasing volatility in the price of recovered fibrous raw materials, and the unlikely prospect of the return to a stable situation, it is recognized that the MPP industry (as part of the objectives to become more cost competitive), must seek to increase the usage of the lowest cost materials.

Current prices (January 2005) for the main recycled fibrous raw materials in the UK are as follows:

- Mixed recovered paper £ 19 - 25 per tonne
- OCC £ 40 - 45 per tonne
- News and Magazines £ 45 - 50 per tonne
- Coloured best pams £ 62 - 66 per tonne
- Over-issue news £ 55 - 60 per tonne

From these figures, it is evident that the MPP industry must increase its usage of mixed recovered paper at the expense of both OCC and over-issue news. However, this transition will only materialise, if the implementation of fibre
development techniques (as developed and practiced by the paper industry) are employed. Utilisation of fibre development techniques will enable the maximum amount of mixed recovered paper to be incorporated into moulded pulp products, without a detrimental influence on the technical and aesthetic specifications.

Recovered mixed paper appears to be more used in the rest of Western Europe than in the UK. Many European producers have stated that they use mixed recovered paper as it is the cheapest raw material available. Naturally, the recovered paper grade used is highly dependent on the moulded pulp product produced and the specifications required for its end-use. An increased quality demand from customers will have an impact on the recovered paper grades used, with a potential increase also of virgin pulp consumption in the industry. This could, however, lead to an increased interest in deinked pulp, which is used by few producers in the MPP industry today. As an example, Hartmann use deinked pulp for its high quality white products, instead of purchased virgin pulp.

The current volume of 19200 tonnes of pre-consumer recovered fibre utilised by the UK MPP industry equates to 59% of total fibre usage. Post-consumer recovered fibre equates to 32% of total consumption.

### 19.3 Current consumption of fibrous raw materials by the UK MPP industry

<table>
<thead>
<tr>
<th></th>
<th>New KLS</th>
<th>Unprinted news</th>
<th>Printed news</th>
<th>Mixed recovered</th>
<th>Virgin fibre</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-consumer</td>
<td>2,950</td>
<td>8,425</td>
<td>7,825</td>
<td></td>
<td></td>
<td>19,200</td>
</tr>
<tr>
<td>Post-consumer</td>
<td></td>
<td></td>
<td></td>
<td>10,450</td>
<td></td>
<td>10,450</td>
</tr>
<tr>
<td>Virgin</td>
<td></td>
<td></td>
<td></td>
<td>2,850</td>
<td></td>
<td>2,850</td>
</tr>
</tbody>
</table>

Should the moulded pulp industry choose to evaluate the options for improved fibre cleaning and development techniques, then there exist major opportunities to migrate fibre usage from higher-priced pre-consumer ONP/over-issue news and new KLS, towards the use of lower-priced post-consumer mixed paper/other grades.

It is recommended that a study should be undertaken to assess the options and viability of replacing the existing tonnage of pre-consumer recovered fibre with lower-priced post-consumer recovered paper. Should such a study identify the viability of migrating to post-consumer fibre, then increases in consumption of post-consumer fibre, as detailed below are potentially achievable.

- Replace existing pre-consumer fibre 19,200 tonnes
- Market growth to 2010 8,300 tonnes
- Market growth to 2014 6,950 tonnes
- Total potential increase in UK usage of post-consumer fibre (up to 2010) 27,500 tonnes
- Total potential increase in UK usage of post-consumer fibre (up to 2014) 34,450 tonnes

### 19.8 Improvements in wet-pressing techniques

In comparison to the paper industry, slow progress has been made over the last 20-30 years in the drying technology for moulded pulp products. The paper industry, however, has made exceptional progress in reducing drying costs, by focusing major efforts on improved pressing technology, thereby removing as much water by pressing before presenting the wet paper product to the drying section.

At present, the average moisture content of a moulded pulp product entering the drying tunnel is approximately 70-75%. In the paper industry, the equivalent figure is 50-55%. Wet fibre physics define that a 1% reduction in moisture content is equivalent to a reduction in drying costs (or increase in speed) of 4%. If a moulded pulp product could be wet-pressed after the forming stage to achieve similar moisture content to paper, then the production speed of an MPP machine could be doubled. The effect of such an increase in speed on the fortunes of the MPP industry would be dramatic, enabling a generation step change to occur in competitiveness.

It is estimated that the potential reduction in costs, and improvement in competitiveness, would enable the MPP industry to produce its products at a meaningfully lower price than equivalent shaped EPS products: thereby opening a significant part of the EPS industry to conversion to moulded pulp structures. Initial, unconfirmed calculations, estimate the potential volume, if such reductions in cost could be achieved, to be in the region of 25,000 tonnes per annum (approx 20% of EPS market).

In order to accurately quantify and qualify this estimate, it will be necessary to carry out a detailed cost analysis of moulded pulp manufacturing costs, and to benchmark against EPS prices. This work is not included in this report.
It is believed that a research and development project at a suitable university could be undertaken, to develop the wet-pressing technology of moulded pulp to its maximum.

19.9 Uptake of automated packing equipment

The labour cost element in the manufacture of moulded pulp products is high, and is an area where the industry can help itself to reduce costs.

The advent of robotic and automated packing systems must be embraced by the MPP industry, and should form another element of its strategy to reduce costs.

There are a number of leading edge companies manufacturing automated packing systems, and the capability to custom design these for specific and difficult applications exists.

19.10 Development of mould design software database

The dynamics surrounding the manufacture of moulds is a major factor restraining the development of the moulded pulp industry, in terms of both mould cost and mould manufacturing time. These are key components of the manufacturing chain, which require to be urgently addressed by the MPP industry in order to contribute towards the evolution of a cost competitive packaging sector.

New product packaging design is still a bottleneck for MPP production because it involves many factors from raw material, forming techniques to transport requirements.

Once the design is ready, this can be manufactured by any conventional machining or CNC machine.

One of the biggest problems facing the MPP industry is the extended time to reliably produce a package design from the product to be packed. This process can be truncated by the development of a sophisticated mould design software; the outline process for the development of which, is as shown in diagram 21-3.

19-4 Mould design software database

The process for designing the new software database shows the inputs required to the development process. These inputs require the integration of the current solid modelling software with sophisticated stress modelling software. Additional input is required from packaging and fibre engineers, and from drop test data.

The output of the mould design software database will be to enable rapid development of mould shapes, which are designed to protect the product according to the required specification, and at the lowest cost. The objective is to deliver such an output within hours, as opposed to the current extended period of days.

The software database will enable time-to-market for products, to be substantially reduced, and to compete effectively with the current EPS rapid service.

19.11 Ability to manufacture short/medium run lengths at competitive prices

A major positive for EPS packaging is its ability to deliver short/medium run length products at competitive prices, and which are lower in price than equivalent moulded pulp shapes.

At present this capability does not exist for moulded pulp products.
It is evident that until the moulded pulp industry can move to a higher technology platform that the ability to effectively compete against EPS will not be achieved. This will require the development of new technology machinery, which can run at production speeds equivalent to EPS, with low price, quick-change mould facilities.

Such technology may, for example, be a medium size rotary machine (e.g. 48 in wide) development which is equipped with advanced wet-pressing capability, followed by in-mould drying. The result from such a machine will be a high-speed operation, producing smooth/good aesthetic products at a low drying cost.

The development of such a machine is a number of years away.

**19.12 Low-cost drying methods**

Drying energy efficiency is a major issue requiring technology input. Current drying costs are high and contribute significantly to the non-competitive position of moulded pulp products.

It is also clear that until the moulded pulp industry can move to a higher technology drying platform, using less energy and more efficiently, that this situation will not be achieved.

Energy remains, and will continue to be, a major cost in the manufacture of moulded pulp products. It is clear, as detailed in section 19.8, that initiatives must be introduced to improve wet-pressing techniques. However, it is also evident that the development of reduced-cost/increased efficient drying methods must be accelerated, to further reinforce the evolution of a low-cost-structure industry.

Alternative methods of drying such as infra-red, dielectric drying, microwave, etc. should be benchmarked in detail to determine alternatives to the current hot-air/gas drying tunnel approach. Additionally the benchmarking should include drying method experiences from other industries, and which could be transferred into the moulded pulp sector.

This benchmarking study has not formed part of this project.

**19.13 Alternative Strategy**

An alternative option (for consideration), utilising existing manufacturing technology, is to appraise the feasibility of constructing a European size (with global-leading efficiencies) plant for the manufacture of egg packaging in an assisted area. The objective of the plant would be to satisfy the current total (and projected) UK consumption of egg packaging, and in addition to supply a significant element of European egg packaging demand. The target tonnage for the plant would be approximately 50,000 tonnes per annum, and would be equipped to utilise post-consumer recovered fibre as the sole raw material.

Such a plant would potentially consist of two large rotary pulp moulding machines (similar to Emery rotary type 108), each capable of manufacturing 24,000 tonnes per annum of egg packaging.

The likely owners of such a plant would be one of the existing major European manufacturers of egg packaging.