

Founding and requirements of starting a plastics product factory

Case Hämeen Lanka

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<p>Abstract:</p> <p>This thesis is a study on finding a suitable product or product group to manufacture at an predefined domestic factory site, which offers certain infrastructural services, but simultaneously has its own drawbacks. The main objects of the thesis is to provide feasibility of producing plastic goods in Finland, analyse and define a suitable product or product group. A suitable manufacturing process and raw material must be chosen, and a layout of the factory must be defined to produce these goods. Lastly, profitability calculations based on the product or product group have been made to estimate if its manufacture is profitable enough to execute. Research for this thesis has been conducted by factory visits, field studies and observations, interviewing experts in the field and fellow students, literature studies, drawings and calculations covering profitability, required manpower, and raw material pricing and production machinery were based on life-like figures.</p> <p>As an result, a suitable product was found, the manufacture of preforms to produce beverage bottles mainly for domestic producers. The study covers several scenarios on production, what kind of production methods were considered and what kind of methods can be possibly used to decrease the production costs. The author concludes that the biggest profitability factor is raw material costs, and their vigorous fluctuations. Thus the increasing research into bioplastics and their future possibilities of utilisation is vital and important also to improve the preforms enviromentally-friendliness, their biggest current drawback being carbon dioxide permeability.</p>	
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GLOSSARY

CSD	Carbonated soft drinks
CCTV	Closed circuit Television
CO ₂	Carbon Dioxide
FOB	Free on board, the seller will incur the delivery expenses to get the goods to the destination.
JIT	Just in time
JOT	Just on time
Molten	A material liquidified by heat
Preform	An object that has been subjected to preliminary, usually incomplete shaping or molding before undergoing complete or final processing.
Granulate	Form something into grains or particles
PA	Polyamide, also known as Nylon
PLA	Poly-lactic acid, a bioplastic made using corn as an raw-material
PET	Polyethylene terephthalate, a plastic used for bottle preforms
Polysole	A High performance plastic made from plants. Bio-compostable.
SME	Small and medium enterprises

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FOREWORD

I would like to thank the following people who have inspired me to write this thesis and helped me along the way. First I would like to thank my thesis supervisor Mr Henry Clay Ericsson for his time, suggestions and indomitable help to get the work done. My study colleagues Mr Bimo Murti, Mr Simo Toivonen & Mr Markus Lindgren for their help in inspiring with ideas and feedback, my friend Mr Jani-Matti Häätinen in IT support on using Excel and ideas, and my brother Mr Michael Fletcher for his help. I would also like to express my gratitude on Mr Tuomas Häme for providing me information on the actual factory site, and Mrs Paula Kokkonen providing information on medical goods. There is not enough space to thank all my friends who have given me support and sometimes a push to get the job done when I have needed it. Last of all, I would like to thank my mother Mrs Maikki Id for being strong and supporting me during all of these years.

Pa & R, this is for you.

1 INTRODUCTION

1.1 Background

The production of Plastics goods in Finland has diminished considerably during the 1st decade of 2000 - 2010. This has largely been due to economic recession and profit margins getting smaller for example in the cases of subcontracting work or Perlos and Eimo for Nokia mobile phones. Both of these have been acquired by competitors (Eimo acquired by Foxconn and Perlos by Lite-on Technologies)and have moved their production first to eastern Europe and later into China [1] , making thousands of people redundant in the plastic industry field. Finland has however had a long history of plastics production, the first plastics production company in Finland was Sarvis Oy, which was founded in 1921. This was only 12 years after the first completely synthetic plastic Bakelite was patented in the United States.

1.2 Objective

There are several objectives for the purpose of this thesis;

1. Provide a feasibility study of producing plastic goods in Finland.
2. Analyse and define a plastic product or -group that could be manufactured in Finland, and sold to domestic and possibly international markets.
3. Define the correct manufacturing process and raw material for the product(s) to be produced.
4. Prepare a layout of the factory to define how the possible production of these goods could be carried out.
5. Make profitability calculations based on the beforementioned product or product group to estimate if its manufacture is profitable enough to execute.

1.3 Methology

Research for this thesis has been carried out using the following methods:

1.3.1 Factory visits, field studies and observations

Visits were conducted to beverage production plants, the Hämeen Lanka premises and field visits to the Padasjoki industrial estate. On-site observations were done at beverage production plants (filling out and blow-moulding of bottles from preforms etc.)

1.3.2 Interviews

Interviews were conducted with an expert from the beverage production industry, the Padasjoki municipal manager (Heikki Jaakkola), thesis writers (Valeria Poliyakova) & Bimo Murti; both of graduates from the Arcada University of applied sciences.

1.3.3 Literature studies

Information was harvested from the internet on articles, e-books, teaching material and brochures concerning for example preform manufacture, chemical characteristics of raw materials, general news of the plastic packaging industry and reading thesis works written in relation to the subject. In addition to this, printed material such as magazines, brochures and hand-outs were also researched.

1.3.4 Drawings

Existing factory layout drawings of Hämeen Lanka's premises and AutoCAD/Visio-based layout proposal drawings were used.

1.3.5 Calculations

Calculations, estimations and future forecasts were carried out. Calculations concerning profitability, required manpower, and raw material pricing and production machinery were based on life-like figures.

2 THE EXISTING FACTORY

2.1 Factory premises

Hämeen Lanka`s factory site in Kaukela was chosen based on personal interest. The factory is a large part of local history, and it has been closed since 2007. Diverse plans to convert the site into for example a logistics center have been considered, but they have not lead to any kind of concrete actions.

In October 2012 the yarning machinery was sold and shipped to China. Also the scrap metal is being taken away. In November 2012, the whole factory will be empty.

2.2 Background

Hämeen Lanka was founded into the village of Kaukela in the Padasjoki municipality in 1948. Padasjoki is located in the province of Southern Finland and is part of the Päijänne Tavastia region. The company used to produce(spinn) 500 tons of wool annually for making carpet yarns, and 90% of the production was exported. In 2007, Hämeen Lanka was sold to Danspin, a danish competitor. The most functional production lines were moved to Danspins factory in Estonia. The Kaukela factory was closed down, and 33 people were made redundant. The turnover in 2006-7 was estimated to be 10 MEUR for the whole company, including the Estonian factory site.



Picture 1 Geographical overview of Padasjoki. Picture source Google Maps

Picture 2 Dismantling old machinery from the Siporex part of the building. Picture source Paul Fletcher

2.3 Survey of premises

The premises are situated at Kaukelantie 322, Padasjoki. In overall, the factory building is in good condition although it has been empty since October 2007 when the previous production operations ceased [34]



Picture 3 outside view of factory premises. Picture source Paul Fletcher

2.4 Measurements of the building

The site is divided into three parts: the old part, the Siporex part and the cold storage.

- Old part (built 1958 - 1959) total area 3714 m², spread out over 3 floors. (Approximately 1200m²/floor)
- Siporex part (white, built behind old part in 1974 total area 2.330 m² (3 floors)
- Cold storage (built in 1974) total area 1.375 m² (1 floor) [65]

2.5 Water

The factory site lacks proper drainage systems and waterpipe infrastructure. The closest municipal waterpipes are in the Padasjoki center 8 kilometres away. Water is supplied to the factory from the Miestämä lake via a pumpstation located approximately 0.5 km away. In 2002 the water intake for yarn processing and cooling was approximately 75 000 m³. Dirty waters were mainly generated from sanitary-, cooling- and processing water, and lead back to the lake via a concrete-encased biological cleaning station. Due to the cleaning station , the factory had an enviromental permit valid until 2014. [35]

2.5.1 Drinking water

Drinking water was brought from the municipal waterworks and stored in containers on-site. The environmental permit states that a suitable local supply source was not found [35].

2.6 Heating and electricity consumption



Heating and steam for the processing work for the previous production process is provided via a 1.3 MW oilburner. The oilburner was renewed in 2001. Burning fumes from the oilburner were led into a 25m-high chimney located at the right hand end of the factory. When the factory was fully operational in 2002; 208,3 tonnes of heavy fuel oil was consumed. Electricity consumption in 2003 was 1,32 Gwh [36]

Picture 4 Factory oil burner Picture source Paul Fletcher

2.7 Main building – old part

The factory has 3 floors, which are approximately 3-4 meters high and each floor is interconnected with each other with more than one elevator. The corridors are long and narrow in many places, as visible in picture 6 below. The concrete floor is very robust, so carrying capacity is not a problem. The walls are surfaced with bricks. All floors have radiators for heating, so maintaining a constant temperature would not be a problem. In general the condition inside the building is good; no humidity related damages are visible. Figures 1- 3 provide more information on the factory layout.



Picture 5 some of the dismantled yarn-spinning machinery Picture source Paul Fletcher



Picture 6 General view of the corridor Picture source Paul Fletcher

2.8 Siporex part of the building

The Siporex part built behind the old part of the building, is very brightly lit inside due to the large windows and as it set directly towards the sun. This together with the large open and high spaces at both ends of the building make it the ideal location for the production facility. See figure 1 for more information.



Picture 7 Siporex building Picture source Paul Fletcher



Picture 8 Cold storage Picture source Paul Fletcher

2.9 Cold storage

The cold warehouse which is partly visible in Figure 1 & Picture 8 below, is built from wood and has a tin roof. It cannot sustain a constant temperature or humidity.

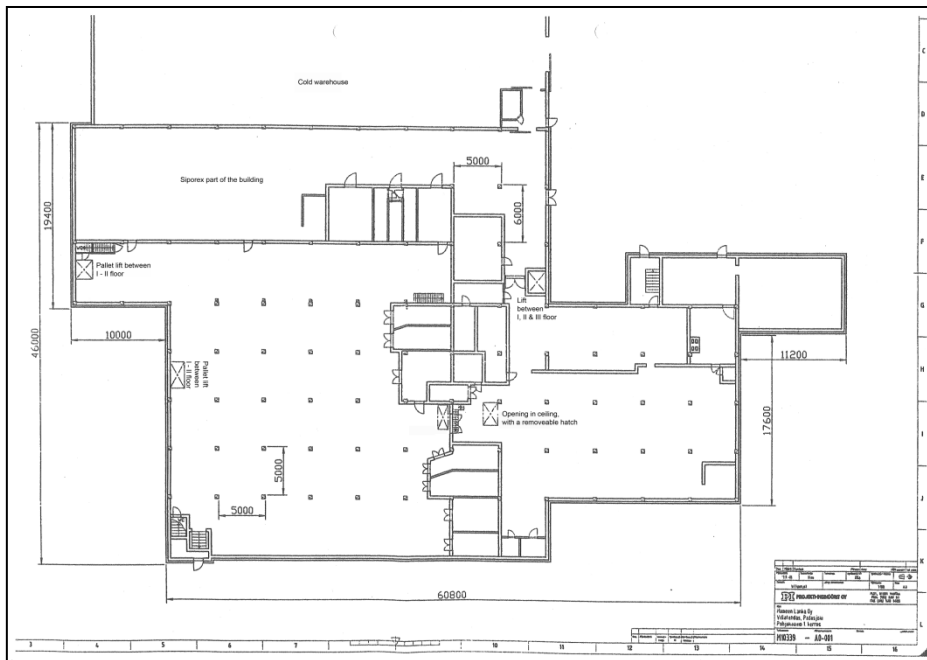


Figure 1 Hämeen Lanka 1st floor layout Source PI Projekti-Insinöörit

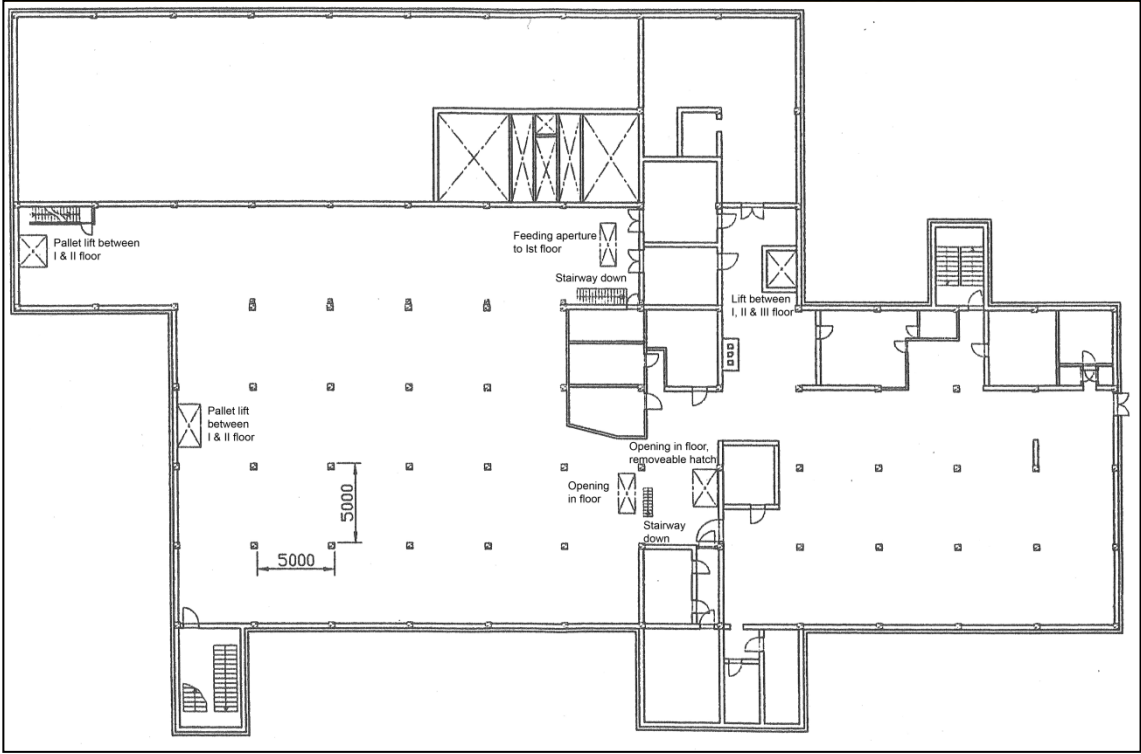


Figure 2 Hämeen Lanka factory layout 2nd floor Source PI Projekti-Insinöör

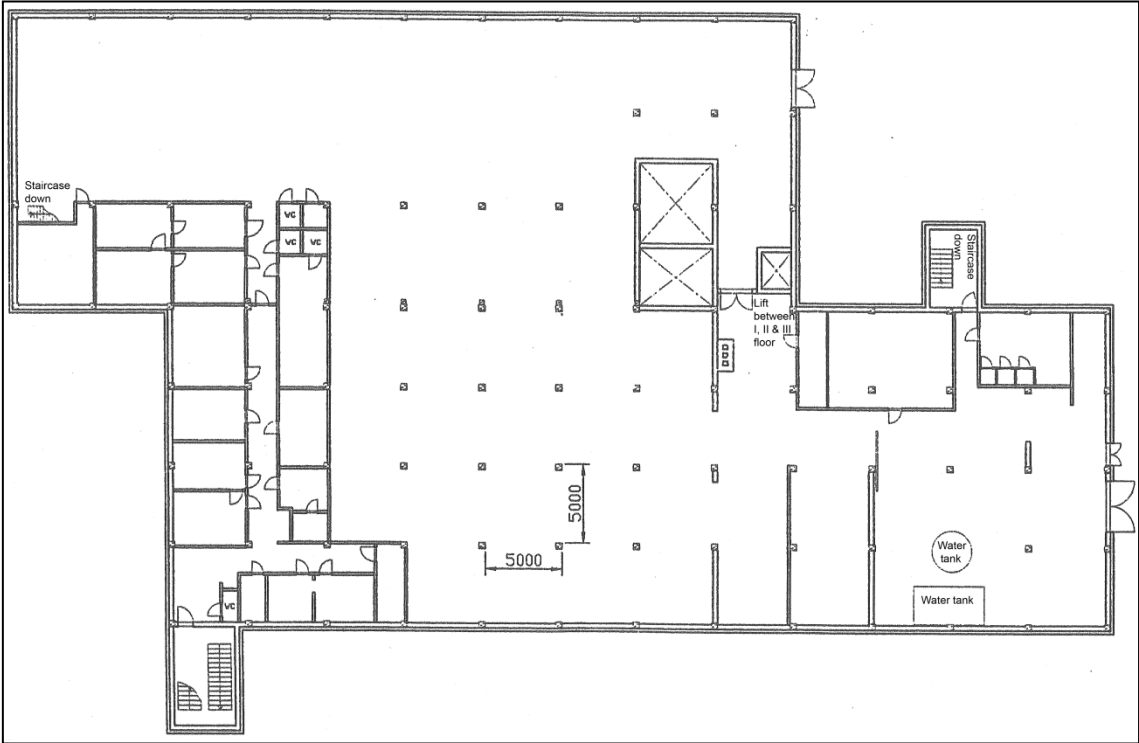


Figure 3 Hämeen Lanka factory layout 3rd floor Source PI Projekti-Insinöör

3 ALTERNATIVES OF PLASTIC PRODUCTS FOR MANUFACTURE

3.1 Type of product to manufacture

Diverse products or product families which could facilitate a constant income were researched. During preliminary research such items as house-hold utensils, kitchenware, plastic cabling, buoys, roadwork fencing and stoppers were considered. Production figures and profit estimates on these products proved to be difficult or impossible to acquire. Information related to medical products such as syringes, insulin pens, and beverage bottle preforms were possible to access through personal contacts and the web. In addition to this, information concerning general plastic utensils were acquired through some major producer websites and media, this information led to partly choosing the product categories. Finally three diverse product groups were compared to each other to make the decision on what kind of products would be chosen.

3.1.1 Medical goods

Insulin needles and syringes were among the products considered for production, as their need is increasing. The age structure of people in need of these is growing due to people suffering from diabetes and for geriatric needs. The total number of people with diabetes is projected to rise from 171 million in 2000 to 366 million in 2030 [13]

3.1.2 Household utensils

This product group consists of products for domestic use, such as buckets, tubs, kitchenware and snow-work tools. Finnish companies Plasto, Plastex & Orthex all produce them, so domestic competition is tough. Production of these diversified goods require a lot of machines and personnel to run them. This leads to a loss in production efficiency, as the batches are relatively small in size (in 1000s of pieces at a time) and the products are often available in different colours and sizes. Changing the products colour and the moulds or other tooling during production leads to production downtime, during which

nothing can be produced on these machines. Also the need of seasonal products can be difficult to forecast, creating a surplus of unsold goods and a waste of warehouse space.

As an example, Orthex manufactures approximately 200 different products, and have approximately 500 active production titles as some titles are available in several colours [37]. During a factory visit to Orthex it was observed that the assembly of many goods require hand-labour, thus making product assembly time-consuming and expensive.



Figure 4 attaching a string onto a sleigh at Orthex. Picture source <http://www.yrittajat.fi/File/09e7932f-9ccd-42f8-a6c2-fb7ed200ab51/orthex2.jpg>

Figure 5 A cowskin-style letterbox Picture source <http://www.dilishop.fi/Postilaatikko-Lehmae> post box

Figure 6: Orthex retail store Picture source <http://www.tjt-kaluste.fi/myymalalakalusteet.shtml>

3.1.3 Preform manufacture for bottles for soft drinks and mineral waters

In 2010 over 320 million liters of soft drinks and mineral waters were sold in Finland (figure 2). The figure excludes alcoholic drinks. Bottles for these drinks are manufactured from plastic preforms supplied to the bottling plant, and they are filled after being blow-moulded into bottle shape on the bottling line.

3.2 Comparison of production figures and their generation of turnover

3.2.1 Insulin needles and syringes

Finland has public healthcare, so these products are supplied free of charge for medical use such as diabetes, so accurate figures on the needs for syringes and insulin needles are easy to get. Free market sales are not substantial. In Table 1 calculations have been made to define the sales figures of insulin needles and syringes for the public healthcare

market. These figures have been received from the Helsinki town procurement office which covers the Helsinki region [17]. The whole country estimation is based on a conversation with Helsinki deputy mayor Paula Kokkonen [18]

Syringe				Amount for whole Finland			
Size/Length	Amount	Price each	Subtotal				
0,3 ml 8 mm	240 000	0,16 €	38 400,00 €	Amount for whole Finland (Helsinki accounts for 10 % of total need) 1261114 Turnover tax 23 %) 290056,2 Total sum for whole Finland 1 551 170 €			
½ ml 12,7 mm	86 300	0,13 €	11 219,00 €				
0,5 ml 8 mm	45 700	0,09 €	4 204,40 €				
1ml 12,7 mm	14 000	0,09 €	1 288,00 €				
Insulin pen Single use				Source of information: information request from Helsinki town procurement office Information received by email from Procurement officer Riitta Hintikka 6th September 2010. Information of total amounts for whole of Finland received from Mrs. Paula Kokkonen, Deputy Mayor of the City of Helsinki September 2010			
29 G 10 mm	2 000	0,07 €	142,00 €				
29 G 12 mm	19 000	0,07 €	1 349,00 €				
30 G 8 mm	86 800	0,07 €	6 162,80 €				
31 G 5 mm	346 000	0,07 €	24 566,00 €				
31 G 6 mm	284 700	0,07 €	20 213,70 €				
31 G 8 mm	261 500	0,07 €	18 566,50 €				
Total purchases for Helsinki			126 111,40 €				

Table 1 Need for syringes & insulin pens for medical use in Finland 2010

3.2.2 Soft drinks and mineral water preforms

Table 2 below describes the domestic sales of soft drinks and mineral waters in 2000 and 2005 – 2010. The statistics are from the Finnish Food and Drinks Industries' Federation (Elintarviketeollisuusliitto or ETL) website.

DOMESTIC SALES OF FINNISH FOOD PRODUCTS 2000 AND 2005 - 2010							
	2000	2005	2006	2007	2008	2009	2010
SOFT DRINKS AND MINERAL WATERS (including breweries' imports)							
1,000 litres							
Sugar sweetened soft drinks							
Cola	93 222	79 390	77 716	75 336	73 461	73 727	74 088
Lemon, Lime	32 919	22 497	21 423	17 863			
Orange	60 875	46 222	46 023	47 994	60 144	58 462	55 527
Others	38 644	41 522	44 345	42 234	42 838	42 261	43 063
Total	225 660	189 631	189 507	183 427	176 443	174 450	172 678
Sugar-free soft drinks	67 340	83 279	92 099	95 203	93 611	93 412	91 178
Soft drinks total	293 000	272 910	281 606	278 630	270 054	267 862	263 856
Mineral waters	57 037	63 203	68 070	68 688	64 384	58 900	64 921

Table 2 Domestic sales of domestic soft drinks and mineral waters Source: http://www.etl.fi/www/en/statistics/files/Domestic_sales_of_Finnish_food_products.pdf fetched 20th September 2011

These figures were used as an reference for calculations on needs for preforms for bottling beverages in Finland, and what kind of sales they would generate.

- According to my expert source from the industry, the average price for 0.5 l preforms is 4.5 ¢ (0,045 €/each) and 1.5 l preforms 6.4 ¢ (0,0645 €/each) (2010).
- 30 % of these drinks are bottled into 0.5 l bottles and 70 % into 1.5 l bottles.
- According to table 3, 84,9 % of the total volume of sold soft drinks and mineral waters in 2010 were packed into bottles. According to the used expert source, usage of glass bottles is small and would not clearly affect these figures.

Panimo- ja virvoitusjuomateollisuusliitto ry

Kotimaanmyynti pakkauksittain, %

Tiasto ei sisällä Panimo- ja virvoitusjuomateollisuuden ulkopuolisten toimijoiden myyntilukuja eikä panimotuotteiden tilastoimatonta yksityistuntoa.

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Olut												
Pullo	72,2	72,9	73,5	73,0	72,0	73,5	70,1	61,2	45,8	33,5	24,3	20,3
Astia	22,2	21,8	20,9	20,3	20,0	18,3	17,3	16,7	16,0	14,8	13,7	13,5
Toikki	5,6	5,5	5,6	6,8	8,0	8,3	12,5	22,1	38,2	51,7	62,0	66,1
Siideri ja long drink												
Pullo	89,6	88,6	87,8	89,1	88,9	87,9	81,8	71,1	62,6	49,3	41,0	40,0
Astia	9,3	10,2	10,5	9,7	9,8	9,6	10,2	19,1	14,2	10,5	11,2	11,8
Toikki	1,1	1,2	1,7	1,2	1,4	2,4	8,1	9,8	33,6	40,2	47,8	48,2
Virvoitusjuomat ja kivennäisvedet												
Pullo	88,7	88,0	88,2	88,2	88,9	87,1	85,9	85,7	84,9	84,4	85,3	84,9
Astia	10,1	10,5	10,5	10,5	10,9	11,5	12,0	11,6	11,9	12,2	11,8	11,9
Toikki	1,2	1,5	1,3	1,3	1,1	1,5	2,2	2,7	3,2	3,5	2,9	3,3

Table 3 Domestic sales per package type. Source

http://www.panimoliitto.fi/panimoliitto/liitetiedostot/pdf/pakkaukset1999_2010.pdf fetched 6th October 2011

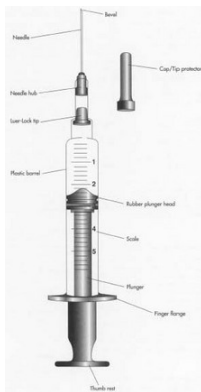
See table 4 below for a total sales estimation based on these figures.

Beverages and mineral waters sold in Finland in 2010 in total (1000s of litres)	Total
Soft drinks	263856
Mineral waters	64921
Total:	328777
According to table 5 , 84,9 % of these drinks were sold in bottles, thus the correct figure for bottles is (328777 X 1000 litres/100) X 84,9	279131673
Out of which an estimated 270 M litres is bottled into plastic bottles with preforms	
0.5 l preforms: (270 M litres X 0.3) / 0.5 litres =	81000000
1.5 l preforms: (270 M litres X 0.7) / 1.5 litres =	189000000
81000000 X 0,045 €+ 189000000 X 0,0645 €= 15835500 €	
Price source: Expert working in the beverage and brewery industry	
Estimate of total turnover of beverage & mineral water preforms for domestic markets	15,835 MEUR

Table 4 Estimate of beverage and mineral water preform market turnover in Finland 2010

3.3 Choosing the product

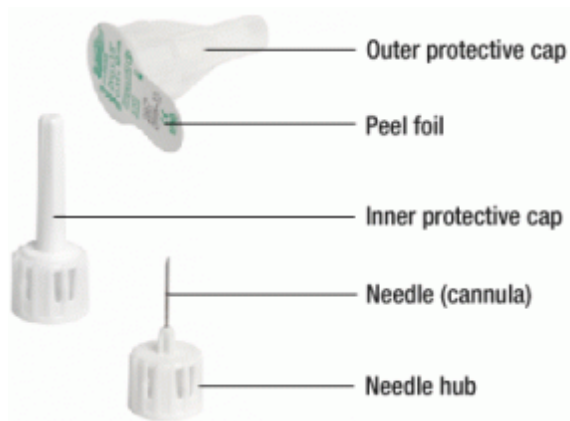
3.3.1 Syringes, insulin pen needles and similar medical goods



Production of these goods is complex compared to preforms. As hypodermic syringes are in direct contact with the interior of the body, government regulations require that they are made from biocompatible materials which are pharmacologically inert [23]. This affects the price of the products as other plastics cannot be used. The products must be sterile and nontoxic, so they must be made in clean room facilities, increasing the costs of the production facility. See figure 7 for a diagram of the different parts of a syringe.

Figure 7 Diagram of a hypodermic syringe. Source: <http://www.madehow.com/images/hpm>

In addition to this, these products are far more complex to manufacture than preforms which don't have moving parts or traversing seals to transport the liquid to the tip.



Insulin pen needles do not consist of many parts, but have similar challenges as syringes, being always packed and sealed individually. Figure 8 describes the needle construction in detail. According to table 4, the domestic sales of syringe & insulin needles was 1,5 MEUR in 2010.

Figure 8 Insulin pen needle. Source <http://www.diabeticlive.com/wp-content/uploads/2010/06/BD-Pen-Needles-300x210.gif>

These figures do not cover sales for private or veterinary use, but the joint sales figures are so small that further research into this product sector was unnecessary.

3.3.2 Household utensils

As mentioned in paragraph 3.1.2, the domestic market was very competitive. In 2010 Orthex had a turnover of 13.6 MEUR and 90 employees [25]. Plastex, situated close to Orthex in Lohja had a turnover of 4.5 MEUR and employed 33 people [32]. Plasto in the Åland islands makes toys and kitchenware and its daughter company Plastopak plastic packaging. Their turnover was 4.2 MEUR [26] employing 50 people in 2010.

3.3.3 Preform manufacture

The manufacture of preforms is a relatively simple process, the end-product has no moving parts or large variations in appearance or construction. The dimensions of the end product are modified by the mould in which they manufactured and the production process is always the same. In addition to the change in dimensions, the raw materials and the colour and transparency characteristics change. As of October 2012, there is no large-scale preform manufacture in Finland. Preformia which used to process recycled post-consumer plastic bottles into preforms went bankrupt in May 2011 [28].

According to the expert consulted for this thesis, the manufacturers which supply most preforms to Finnish customers are Plastitehase (Estonia), Pretainer (Lithuania) and Returpak (Sweden). Graham packaging Company Oy produces preforms in small-scale and non-standard 0.2 l, 0.35 l & 0.75 l sizes for Pernod-Ricard Finland [33].

3.4 Choice of product for manufacture

The decision on what to manufacture was based on several factors. Estimations on generated turnover were compared, preforms providing the largest. Household goods are produced by several domestic manufacturers, and the market is somewhat saturated. Syringes and insulin needles offer a much smaller market in Finland, and overseas sales would be needed to increase sales/turnover. Production machinery for them are very expensive and require the use of Bioplastics and cleanroom facilities. In addition to this, some domestic production already exists. See figure 9 for a graphical representation of turnover various product and product group alternatives, which are described in chapter 3.1 and their financial information in chapter 3.2.

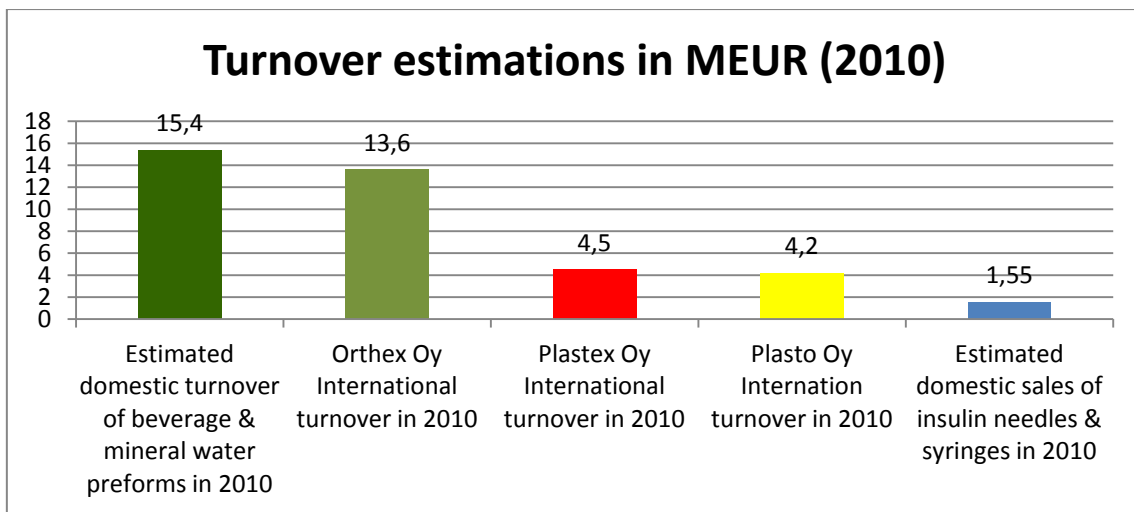


Figure 9 Turnover estimations of production alternative based on 2010 turnover. Figure by Paul Fletcher.

Logistical location

The Hämeen Lanka premises is located with good transportation possibilities to domestic beverage- and alcoholic drink manufacturers and harbour and railway hubs. The site offers an strong advantage over foreign competitors: a possibility for almost

immediate delivery. This would facilitate the beverage producers to bottle drinks using JOT/JIT-like principles. According to the expert working in the beverage industry, foreign competitors have a lead time of at least 4 weeks. A shorter lead time and saving warehouse space at the bottling plant are considerable competitive advantages compared to foreign producers. Storing preforms and their raw materials for a long time increases the risk of humidity to the products to become non-marketable. Markus Portmans thesis in Arcada [45] arrived at the following conclusion:

PET Preforms start to absorb humidity almost immediately after being manufactured by injection moulding. Even after a time period of two days the possible humidity that the preform has absorbed can have substantial effect in the expansion properties of PET material. If the preform has been too long in a humid atmosphere, it is impossible to produce high quality bottles out of such preforms. It is important to keep the shelf-life as short as possible. The recommended time span is less than 2 days, at a temperature of 24 °C and in a dry warehouse. (see: RIVA Packing Solutions, fetched 3.6.2009) [44]

3.5 Transportation of preforms to mineral water and beverage manufacturers and harbours

As visualised in figures 10 and 11, transportation of ready goods could be arranged to any of the larger producers from the factory during one working day. The longest distance from the factory is to Olvi Oy in Iisalmi. The driving time to Olvi is approximately 5 hours and the distance less than 350 kilometres. The working day definition according to the Finnish Working hour's act (605/1996) is 8 hours a day [30]. This enables lorry deliveries driven safely to all of the bottling plants and harbours with overseas connections described in table 5, all during one working day.

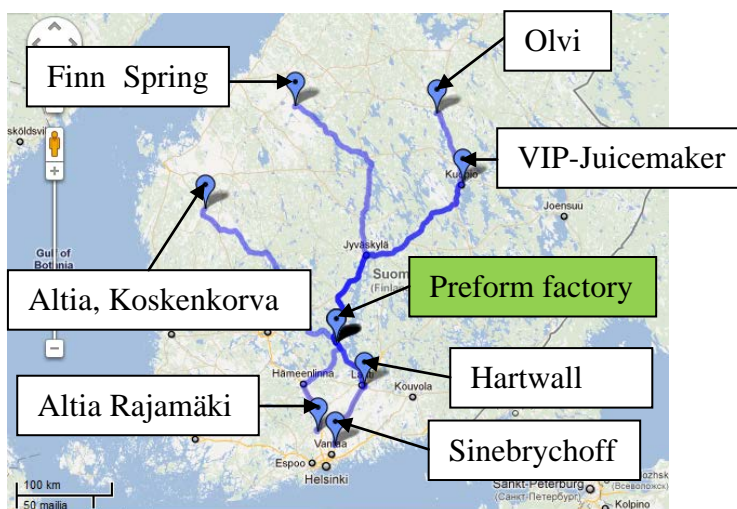


Figure 10 Locations of largest beverage producers & bottling plants in Finland. Picture source: Google Maps & Paul Fletcher

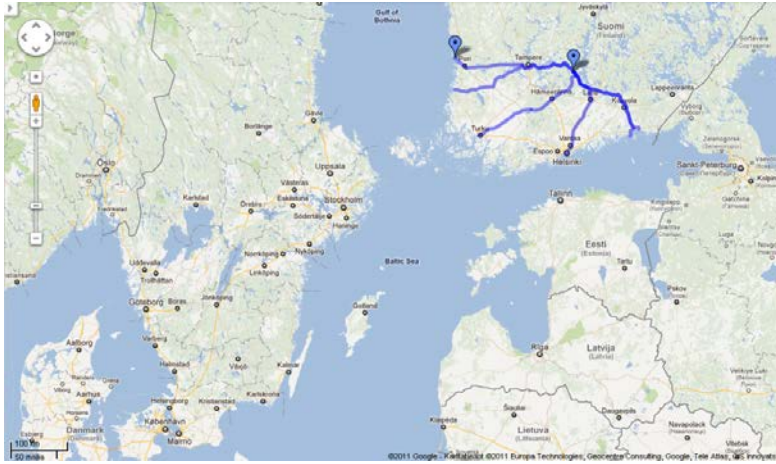


Figure 11 the main Finnish harbours on the southern coast. Picture source: Google Maps & Paul Fletcher

Company	Distance from factory	Driving time	Harbours	Distance	Driving time
Finn Spring	324 km	4h 44 min	Turku	220 km	3h 26 min
Olvi	345 km	4h 51 min	Pori	223 km	3h 15 min
Vip-Juicemaker	263 km	3h 45 min	Rauma	235 km	3h 30 min
Altia, Koskenkorva	245 km	3h 52 min	Kotka	179 km	2 h 45 min
Sinebrychoff	140 km	1h 43 min	Hamina	172 km	2h 37 min
Altia, Rajamäki	137 km	1h 37 min	Helsinki (Länsisatama)	169 km	2h 9 min
Hartwall	65,7 km	1h 3 min			

Table 5 Logistical information of customers. Source of information route calculations from Google Maps

The Hämeen Lanka factory site offers a production facility with sufficient services for preform manufacture;

1. The building is rigid, sound and dry
2. It is equipped with elevators to move between each floor at ease
3. The building is equipped with proper electrical connections and heating
4. An adequate water supply is available close by. The cooling waters from the preform production process can be used for heating, and lead back to the Miestämä Lake via the cleaning station without soiling the water or contaminating the environment.
5. Main roads infrastructure towards all main four cardinal point directions are close by
6. All of the domestic beverage producers and breweries are reachable in less than 5 hours driving time.

4 LITERATURE REVIEW

4.1 Beverage bottle preform manufacture

Beverage bottles are nowadays manufactured normally by using preforms or blow moulding. Normally, the raw material of the preform is PET (Polyethylene Terephthalate).

The wall thickness of the preform is approximately 4 mm and 20 mm of diameter from the thickest point of the preform and the weight is close to 24g if the preform is for a ½ l o bottle, which at the modern industry standard. The cap-part is the only part which is not affected during the manufacture of the final product. The usage of pre-manufactured preforms has made the bottling process to be fast, effective and cost-saving thanks to the space requirements of product itself.

A preform is a material that has undergone preliminary shaping but is not yet in its final form. [5]



Picture 9 Bottle preforms. Source:
<http://www.putoksnis.lt/article/archive/208/>

4.2 The preform manufacturing process

In stage one of the manufacturing process a preform is produced by high-pressure injection moulding in which the pellets of resin which have initially been dried are melted at temperatures of about 275°C. If colour is required for the final design, then it can be added during the melting process at the required dosage, just prior to being injected into the mould. Once melted the molten plastic is injected into a precision mould; the mould is cooled with chilled water, which solidifies the PET.

At this point in the process the bottle neck finish, to which the closure will eventually be applied by the bottler, is produced very accurately. From this point on the handling of the preform through packaging, distribution to the bottler and the bottle blowing machine are important in order to prevent the finish from being damaged, as this can ultimately affect, as a result of micro leakage, not only capping but product performance through to the point of consumption by the consumer.

A preform can be made and stored for up to six months before it is converted into a bottle suitable for filling. Beyond this time period production of consistently good quality bottles becomes more difficult, due to the preforms attracting moisture from the atmosphere. [6]

4.2.1 The Preform manufacturing process in 6 steps

How PET (PolyEthylene Terephthalate) bottles are made

Six essential steps to stretch blow molding a PET bottle:

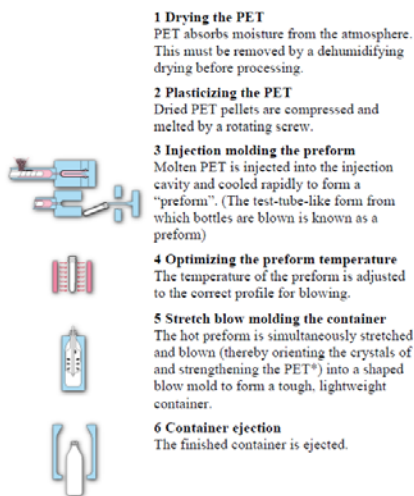


Figure 12 Preform manufacture process. Source: http://mse-gsd1.matsceng.ohio-state.edu/~glenn/HS_Mat_Sci/Unfiled_Content/ASM_07Disc/MST/EMTECH_%20Handouts/EMTECH_Demos.pdf

4.3 Materials used for beverage preform manufacture

For the manufacture of preforms, PET is mainly used which is available as virgin in granular form. For special applications, PLA is also processed, which is gained from renewable raw materials, such as corn. [7] Earlier on, some nylon was mixed with the preform or the preform was made completely of PA (Nylon) to increase the hardness of

fully-blown bottle. However there were problems with the surface finish, as the bottle was used several times before being ground back to granulate. The surface of the fully-blown bottle became subject to scratches and appeared soiled on the surface. Soon the type of bottle which was re-used several times before being crushed, was pulled off the market at least in Finland.

Today, more and more PET and PLA are recycled in the production process. Genuine regrind from PET or PLA bottles is preferred in order to guarantee the quality of the bottles. If amorphous regrind is used, it must be crystallised before drying. [8]

4.3.1 Poly(ethylene terephthalate) Overview

Poly(ethylene terephthalate) (PET) is used in a variety of commercial applications, from soft drink containers to fibers used to make textiles or tire cords. PET has been used as a commercial fibre since as far back as 1953. The excellent mechanical and thermal properties of PET give it a wide variety of uses for everyday items. Stretched PET provides a good barrier against carbon dioxide, making it an ideal container for carbonated soft drinks. The repeat unit of PET is shown in Figure 2 below.

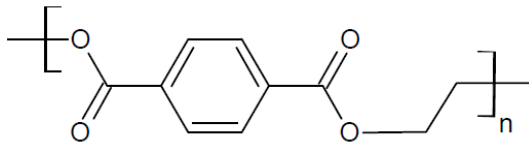


Figure 13: The repeat unit of PET. Source: *Surface Properties of Poly(ethylene terephthalate)*, Thomas Matthews

Injection stretch blow moulded PET bottles offer glasslike clarity, excellent gas barrier properties and good overall mechanical strength. [9]

4.3.2 Polylactic acid (PLA Overview)

Polylactic acid (PLA) is a rigid thermoplastic polymer that can be semi-crystalline or totally amorphous, depending on the stereo purity of the polymer backbone. L(-)-lactic acid is the natural and most common form of the acid, but D(-)-lactic acid can also be produced by microorganisms or through racemization and this “impurity” acts much

like comonomers in other polymers such as polyethylene terephthalate (PET) or polyethylene (PE).

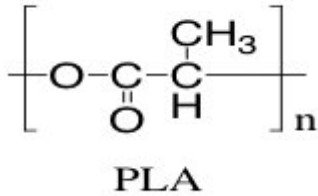


Figure 14: Poly(lactic acid) (PLA) Source: <http://www.uweb.engr.washington.edu/research/tutorials/plagla.html>

In PET, diethylene glycol or isophthalic acid is copolymerized into the backbone at low levels (1–10%) to control the rate of crystallization. In the same way, D-lactic acid units are incorporated into L-PLA to optimize the crystallization kinetics for specific fabrication processes and applications.

PLA is a unique polymer that in many ways behaves like PET, but also performs a lot like polypropylene (PP), a polyolefin. Ultimately it may be the polymer with the broadest range of applications because of its ability to be stress crystallized, thermally crystallized, impact modified, filled, copolymerized, and processed in most polymer processing equipment.

It can be formed into transparent films, fibers, or injection molded into blow moldable preforms for bottles, like PET. PLA also has excellent organoleptic characteristics and is excellent for food contact and related packaging applications. [10]

4.4 Disadvantages when using Polyethylene Terephthalate as a raw material

4.4.1 Appearance and crystallisation-related issues

PET becomes increasingly brittle and opaque at increasing crystallization levels. Extremely crystalline PET is effectively white. This can be clearly seen on the neck of some returnable bottles already in the market. A further optimization has been the use of another plastic, PEN (Polyethylene Naphthalate), in manufacturing bottles. This plastic

displays considerably better barrier properties than PET, but is significantly more expensive [6]. Due to this, PEN is not used at the present for perform manufacture

4.4.2 Carbon dioxide permeability

Gas permeability is a major difficulty here, as it can lead to problems within the beverage. Because these processes occur as diffusion, independent of pressure, even a carbonated beverage takes up oxygen and at the same time releases carbon dioxide. The intruding oxygen can damage beverage ingredients, in particular vitamins and flavors. In addition, PET can absorb flavor components of the beverage. This is a result of the structure of the plastic. The long polymer molecules are tangled within each other like a sponge. In this "sponge", flavor components are stored and later released again. When the crystallization level increases, this sponge structure becomes "untangled" and less foreign material may be absorbed. This has made the development of returnable PET bottles possible, despite the possibility of flavor absorption. At the same time, crystallization of the material also improves its resistance to heat, so that hot-fill PET bottles can also be produced using the same technology

However, these disadvantages mean that the shelf life of a beverage in PET is usually shorter than in glass bottles. But through appropriate recipe design, the manufacturer of flavor systems can offset many of the disadvantages of PET. [11]

Both PLA and PET have a similar problem with CO₂ permeability, though the permeability with PLA is much worse than with PE. See the Disadvantages of PLA for more information.

4.5 Disadvantages when using Polylactic acid as a raw material

4.5.1 Heat stability

PLA must be commercially composted, it will not decompose under home composting conditions. One of the biggest drawbacks of it is that it has a relatively low melting

temperature (173-178 °C) meaning that there is always a danger of the material sticking to the mould of the injection molding machine.

Typically, a manufactured PLA-based product cannot be microwaved, due to the abovementioned low melting temperature point, thus eliminating the possibility of re-using for example a bottle by “sterilizing” it in a microwave oven before use.

PLA films are inferior to ordinary polymer materials in heat stability. The deformation process for example for LDPE bottle made of PLA can begin at 50-60°C.

4.5.2 Composting

Polylactic acid products require commercial composting environment & controlled conditions (e.g. 10 days at 140 degrees, moisture, oxygen, microbes) Partly because of this PLA could take up as much landfill space as conventional plastic packaging. Bottles made from PLA are not suitable for conventional bottle recycling – they must be sorted.

4.5.3 Using PLA for beverages with Carbon dioxide as a protective gas or for fizz

Oxygen barrier characteristics of PLA are approximately 10 times worse than the ones of PET, PP, and polyvinylchloride (PVC). This is why PLA packaging is mainly used for packing dry and some frozen food, and liquids with a short shelf lifespan. The high diffusion constant CO₂ does not allow using packages made from PLA for bottling carbonated beverages. This limits the field of bottling application to milk, fruit juices, water, and vegetable oil.

4.5.4 Moral issues

As PLA is manufactured from corn starch there is always a moral issues associated with using a basic foodstuff based product for packaging, even though the PLA is manufactured from genetically modified corn, not the normal No. 2 yellow dent field corn. Also the production corn pricing - subject to supply & demand are impacted by corn-based ethanol affects the production of the PLA-based end-product. [12]

4.6 Conclusion of the literature survey

New bio- and other plastics are being under development and constantly entering the market. Materials used for preform manufacture will evolve towards more environmentally friendly and oxygen resistive materials. Environmental friendliness, along with the ability of withstanding higher melting temperatures and better resistance to oxygen/CO₂ permeability are key issues to be solved to move on to more nature-friendly material options. Materials such as Polysole, which is a totally biodegradable plastic material that can be used for example in blow molding and injection molding applications. It is made using entirely natural materials and organic additives.

"Polysole® is completely bio-based as the polymer utilizes proprietary additives that are entirely natural and organic. The company has, ensured that there is no compromise on the renewable content of the material, which is an industry-leading development." [44]

In today's booming bio-plastics market, many base biopolymers come from a natural feedstock, but compounding these biopolymers for additional performance is accomplished using synthetic additives.

Many of the biopolymers used for engineering applications are blended with other oil-based polymers, which leads to a significant reduction in the renewable content. Polysole® is a totally biodegradable plastic material that can be used in film, sheet, blow molding and injection molding applications. Made using entirely natural materials and organic additives, Polysole® is a 100% biodegradable and non-toxic thermoplastic. Its superior process capability and strength offers opportunities for manufacturers of all kinds to save money, increase product safety and to beat the competition. [13]

However, PET offers much better overall characteristics compared to for example PLA or Polysole at the moment. PLAs problem with Carbon dioxide permeability, heat stability and a very low melting point of 173-178 °C compared to the melting point of PETs 250 – 260 ° C leaves no question which raw material to us. Pet's biggest problem is the re-use of the recycled material, as its quality isn't a similar quality of the virgin raw material.

5 PRODUCT DECISION

Preform production was chosen based on estimated sales figures, less product diversity and the logistical location of the factory for possible domestic customers. As alcoholic drink bottles are more demanding on materials used for their manufacture, and the thread/cap-closure, they are left outside the production scope and this thesis work.

6 MANUFACTURING PROCESSES AND MATERIALS

6.1 Manufacturing method

6.1.1 In general

Several manufacturing methods were considered. These methods include one- and two-stage blow moulding and thermoforming. All these methods possess drawbacks preventing their effective use. However, the biggest drawback is the existing preform-based bottling technology used by beverage producers such as Hartwall, Sinebrychoff and Olvi. This fact alone effectively eliminated the need to research alternatives further.

Other substantial drawbacks are the quality or finish of the product, raw material optimisation, possible surface strain and tensions on the end product, production speed, end product size, subcontracting issues and even technical competence of production staff.

6.1.2 Injection moulding

The most common manufacturing method for preforms is (IM) Injection moulding. See figure 15 below how an injection moulding machine operates. Injection moulding is a simple manufacturing process where plastic raw materials such as PET granulates are fed into a hopper (1). The granules will traverse from the hopper using gravity into a heated barrel (2, 3) and crushed via a rotating screw into a molten form. If colour is needed to change colour of the preform, it is added into the molten plastic. The heated liquid plastic has a temperature of 250 °C (PET) [38]. For PLA the melting point is

lower, between 173-178 °C [46]. The screw propels the molten plastic through a nozzle (4) into a two-sided mould (5) which defines the shape of the preform.

When the mould (5) is filled with the pre-programmed amount of molten plastic, it is closed by a hydraulic clamp (6) force, generated by an electric motor and a hydraulic pump (7). The clamp will hold the mould together for the time period which is needed for the product to cool down. The mould is cooled with external water cooling during the process to ensure that the preform solidifies fast and homogeneously as possible. After cooling down the end product(s) they are ejected from the mould by ejector pins (8) which push the preform(s) out of the mould. The mould is re-opened and filled using molten plastic fed constantly through the hopper and the traversing screw.

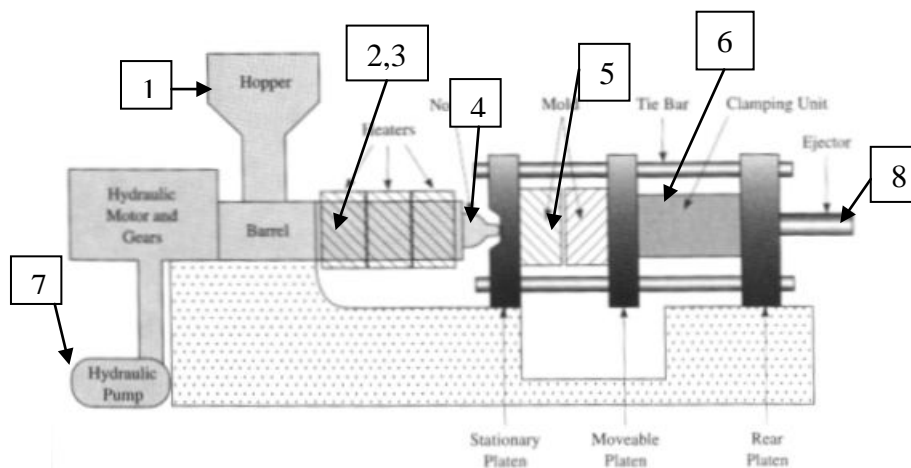


Figure 15 Diagram of an injection moulding machine. Picture source: <http://www.cheresources.com/content/articles/bulk-solids/basics-of-injection-molding>

Due to the need to manufacture vast quantities of the product, the production process has to be fast and accurate, as automated and error-resistant as possible and economically viable. Preform production batches are large. Due to this, the preform mould has a numerous amount of cavities to make more preforms at once. These moulds have 4 - 144 cavities, each cavity producing a preform during each production cycle. The average amount of cavities in a mould is between 48-72 [23] cavities such as in the Husky moulding machine used by Putoksnis in Lithuania [24] and [25]). At the present there are moulds available with 144-192 cavities, increasing production efficiency, but increasing the required clamping force to be 500 or even 600 tonnes (for 192 cavities). As a injection moulding machines operation can run the manufacturing unmanned, thus production could be run automatically during night-time and weekend

shifts. Production efficiency can be improved by automation such as a robot arm, pallet conveyor system or an automated hopper feeding the plastic granules to the injection moulding machines.



Figure 16: 72-cavity mould. Picture source: <http://www.mega-machinery.com/preform-mold02.pdf>

6.1.3 Drawbacks on injection moulding

The biggest drawback of Injection moulding is the actual investment price. This can be divided into two parts; **1. The price of preform mould.** The development and production of a good mould is expensive. Depending on the size and quality, the price can range from 50 000 € up to 300 000 € each. The larger the production batches are, the lower the end product costs will be. Due to this, products which are manufactured with short production batches might not be economically viable. **2. The injection moulding machine,** computer-controlled and equipped with a large scale production 24g preform mould for 0.5 l – 1.5 l bottles costs between 1 – 2 MEUR. The estimated annual production capacity of such a machine is 100 Million preforms. It must be noted that when the preform size or neck closure would change, only a different mould must be purchased, not the whole injection moulding machine.

6.1.4 The future of preform production

The main shape of preforms is unlikely to change much in the coming years. Beverage producers have made huge investments into their present systems, and no clear improvements regarding bottling technology is visible at the moment. The main differences are in volume and weight of the preform. Chapter 14 on Discussion covers this in more detail, covering some existing cost-cutting alternatives. See figures 17 & 18

for examples on some preform sizes and dimensions. In Finland, the most common preforms for 0,5 l bottles weigh 21-26 g and 41.5-43 g for 1,5 bottle sizes.

	500 mL (17 OZ) Carbonated Soft Drink Neck finish: 28 mm PCO Weight: 21-25 grams
	500 mL (17 oz) Bottled Water Neck finish: 26 mm PCF Weight: 10-14 grams
	500 mL (17 oz) RTD tea / hotfill Neck finish: 28 mm Weight: 23-27 grams
	473 mL (16 oz) Dairy Neck finish: 30-38 mm Weight: 22-26 grams
	500 mL (17 oz) Aseptic juice Neck finish: 38mm Bericap Weight: 18-24 grams
	591 mL (20 oz) Hotfill juice Neck finish: 38mm VHS Weight: 29-32 grams
	3-5 gal (384-640 oz) Water Neck finish: HOD Standard Weight: 300-380 grams
	1.5 l (51 oz) Sparkling Water Neck finish: 25-30 mm Weight: 25-36 grams

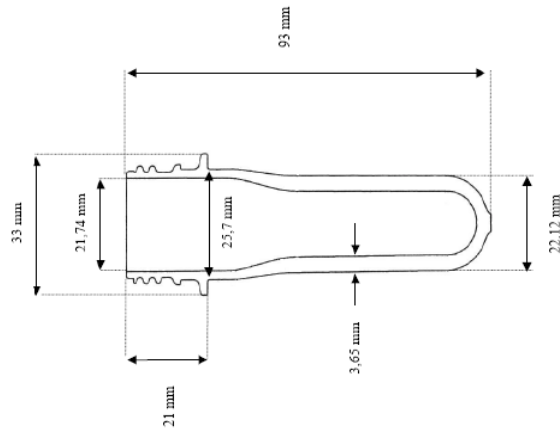


Figure 17 Example measurements of 24 g preform [53]

Figure 18 Husky HyPET Preform product examples. Picture source HyPET Systems brochure, <http://www.husky.ca/documentlibrary.aspx?id=2147483911>

7 FACTORY LAYOUT

The factory is laid out over three floors. Each floor is relatively low, so an injection moulding machines higher than 3 m cannot be installed or operated in the old part without cutting a hole in the roof above. The Husky HYPET range were the most suitable, as they can be installed as lower layout configurations. The premise has three elevators, which can be used for transportation of goods between the storeys.



Picture 10 Factory floor height vs. a person's height. Picture Paul Fletcher

The external cold storage is not dry, so goods stored there would be subjected to humidity. This makes the use of it obsolete, apart from as a docking station for incoming raw material and supply traffic, and outgoing traffic to customers.

The whole building is too large for the presently planned production plant and production capacity. However, as the building is on several floors, the top floors could be used as a warehouse for the ready products and the raw materials. Heat inside the building rises upwards, so gravity-controlled air conditioning could possibly be utilised in keeping the ready products and raw materials dry. Keeping the raw materials dry is vital.

PET Preforms start to absorb humidity almost immediately after being manufactured by injection moulding [45]. Also humidity in the raw materials can pose problems, even though the Injection moulding machine(s) are equipped with driers. It is good to keep the material at as a homogenous state as possible during the production process.

If gravitational air-conditioning will not work, an indoor ventilation solution can be used for keeping the facilities dry. It could be partly powered by solar panels which are installed onto the roof and building windows. In addition to this, the injection moulding machines produce a lot of heat. This heat could be used to decrease heating costs, by circulating the heated-up cooling water into the buildings radiator network.

8 LAYOUT OF PRODUCTION FACILITIES

Figure 19 describes the working layout of the factory. As visible from pictures 2 & 7, the Siporex part of the building offers the best facilities height-wise for the installation of the machines. It has direct access to the cold storage, which could be used as a docking station, so that a lorry reverses into it or in front of it and is loaded there. The production cells are facilitated in such a way that unloading the preforms into a container for the fork lift trucks, or to drive to the lifts would be as easy as possible. This could be done by using a fork trolley, as a sales batch of 1000 preforms weighs either 24 or 41, 5 kg. So weight is not a major problem for transfer inside the factory site.

The 2nd and 3rd floor or old part of the main building as in figure 19 below can also be used as a warehouse facility, or as an intermediate storage, see figures 2 & 3 for the storeys layout drawings. The hoppers of the injection moulding machines would be filled via transfer pipes from the 2nd floor, so raw materials would be kept there, and PET raw material would be transported there from the outside by using the factory elevators.

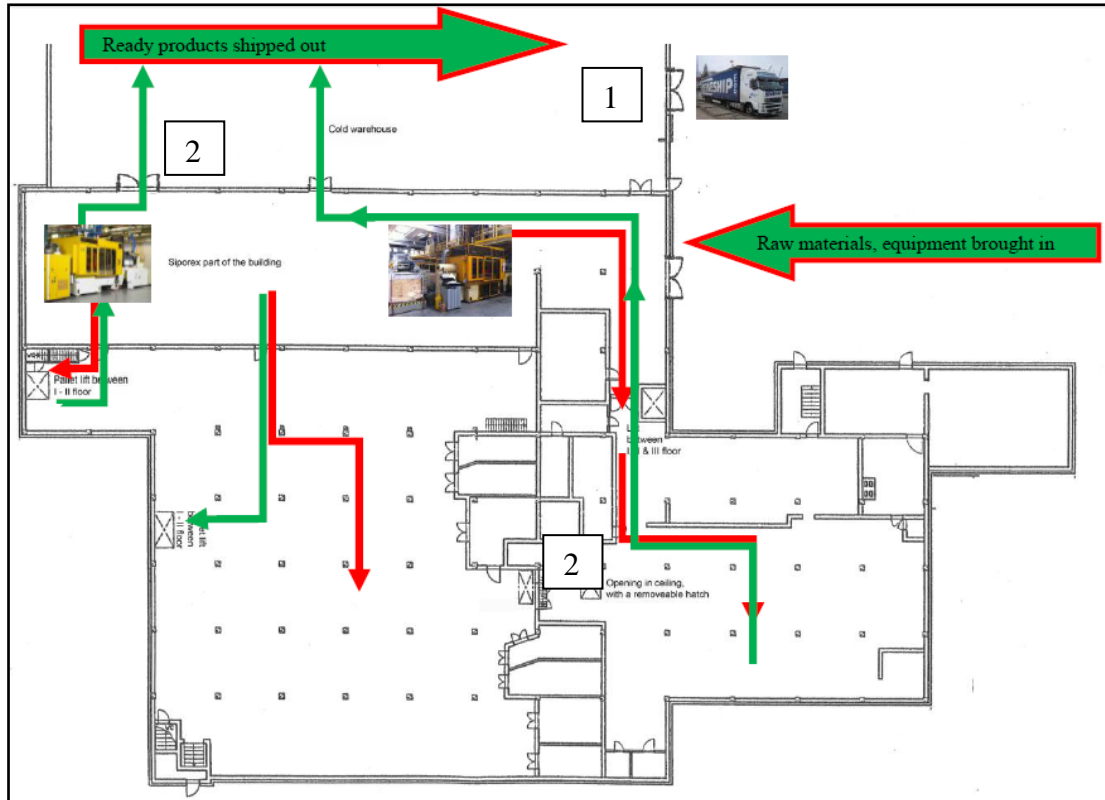


Figure 19 Factory layout

New doors must be made or existing door made wider to locations (1) and (2) described in figure 19. This is due to more space being needed to transport goods to the warehouse facilities, elevators from where ready goods are transported other storeys warehousing facilities or to lorries arriving at the factory collecting goods.

9 FINANCIAL CALCULATIONS

9.1 Raw materials

9.1.1 Bottle grade PET

The average price of bottle grade PET raw material has varied between 950€/tn to over 1700 €/tn between 02/2002 and 12/2010. Due to the variance, profitability estimations for longer time periods are difficult and challenging to make. See figure 21 below for a graph on the resin price and its volatility.

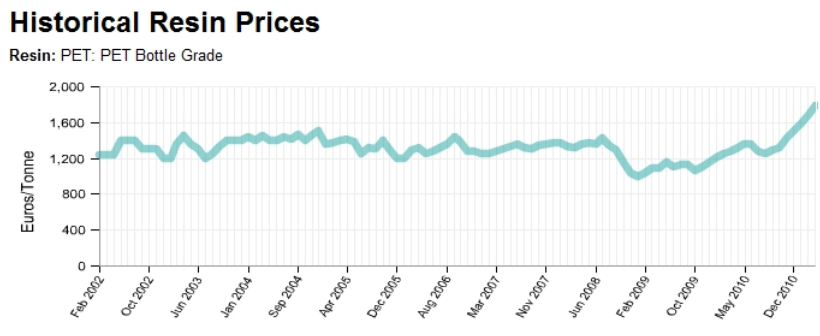


Figure 20 PET Bottle grade raw material historical prices 2002 - 2010 source www.europlasticnews.com

Calculations in this thesis have been made using a bottle grade PET raw material price of 1350 €/ton as an average. The price has been estimated using information supplied by European plastic news website (EPN). It is above the average reference price calculated using high and low prices from the abovementioned time periods described in figure 20 (Between February 2002 – March 2011 = 1282,50 €/tn)

9.1.2 Additives and colour

Depending on the grade or brand of PET used for production, various additives are used. They can be used for example to give the preform the desired colour, enhance the PET's viscosity (with chain extenders), or to use solid-stating accelerators to improve the outlook or characteristics of the PET.

Table 14.2 Chain extenders used to couple PET chains via reactive extension of end groups

Compound	Tradename	Manufacturer	Addition rate (wt%)
Pyromellitic dianhydride	PMDA	Nippon Shokubai Alco Chemical	0.05–2% and preferably around 0.15%–0.25% ^a
Trimellitic anhydride Phenylenebisoxazoline	TMA PBO	– Mikuni (Japan)	– 0.4–1.5, and preferably 0.4–0.6
Carbonyl bis(1-caprolactam)	Allinco CBC	DSM	–
Diepoxide bisphenol A-diglycidyl ether	Epon 1009 ^b	Shell	0.6
Diepoxide bisphenol A-diglycidyl ether	Epon 828 ^b	Shell	0.6
Tetraepoxide tetraglycidyl-di-aminodiphenylmethane resins (TGDDM)	MY721	Ciba SC	0.4–0.6
Triphenylphosphite	TPP	Various	0.2–0.8

^aNote: Excess can lead to undesirable molecular branching and cross-linking. Chain branching can severely hamper the crystallization capability of PET and this may lead to a loss in performance properties.

^bBisphenol A diglycidyl ether – prepared by a condensation reaction between epichlorohydrin and bisphenol A.

Figure 21 Chain extender dosage. Source: Additives for the Modification of Poly(Ethylene Terephthalate) to Produce Engineering-Grade Polymers by J Scheirs.

Some manufacturers of bottle-grade PET already have added these aforementioned additives in or have eliminated these steps. As the additives are not in the general scope of this thesis, they are not discussed further. The dosage of additives/colour is estimated to be 0.25 – 5 %. Cost estimations for additives/colour are done in the following way:

- 25 % of the 0.5 l bottle preforms were assumed to be a coloured
- 10% of the 1.5 l bottle preforms were assumed to be coloured
- These assumptions are based on surveying Oy Hartwall Abs product portfolio as a general example (<http://www.hartwall.fi/en/drinks/products/>)

As the additives and colour are estimated to be dosed at relatively small amounts, an estimated cost of 5 €for additives and 15 €for colour is used for ½ l and 15 €and 45 € is used respectively for 1.5 l bottles.

9.2 Preform price (Product price without investments)

Two preform sizes are used as examples for thesis calculations. At the present, 0.5 l preforms weighing 24 g and 1.5 l preforms weighing 41.5 g are commonly used by the beverage industry. As discussed in chapter 9.1.1, bottle grade PET is estimated to cost 1350 €/ton FOB destination.

See figure 22 for examples on dosages of chain extenders are used. Chain extenders (or coupling agents) can serve to reverse the MW damage caused by hydrolysis of polyesters or can modify the rheology of the polymer to increase its melt strength [66]. In general, modification additives are administered into the master batch at a dose of couple of percent, or even fraction of an percent, as is the case of solid-stating accelerators

Some manufacturers of bottle-grade PET

already have added these aforementioned additives in or have eliminated these steps. As

the additives are not in the general scope of this thesis, they are not discussed further.

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1 ton of bottle grade PET raw material can produce:

0.5 l preforms → 1000 kg /0.024 kg = 41666 preforms

1.5 l preforms → 1000 kg/0.0415 kg = 24096 preforms.

It is assumed that the transparent preforms will include some additives and the coloured preforms will require both the additives and colour. Thus 4 different Product (preform) prices will be calculated using the formula below:

(PET raw material price+ additives+ colour (if the preform is coloured) /amount of preforms produced)

⇒ 0.5 l Transparent preform price:(1350 €+5 €)/41666 preforms = 0,0325 €

⇒ 0.5 l Coloured preform price:(1350 €+5 €+15 €)/41666 preforms = 0,0329 €

⇒ 1.5 l Transparent preform price:(1350 €+15 €)/24096 preforms= 0,0566 €

⇒ 1.5 l Coloured preform price: 1350 €+15 €+45 €24096 preforms = 0,0585 €

According to the expert source working in the beverage industry, the average price (In October 2012) for 0.5 l preforms is 4.5 ¢ (0,045 €) and 1.5 l preform 6.45 ¢ (0,0645 €) each. See table 6 below for a comparison on product costs without investments

Preform size	Product cost without investments	Sales price	Difference	Margin %
0.5 l Transparent	0,033 €	0,0450 €	0,0125 €	27,78 %
0.5 l Colour	0,033 €	0,0450 €	0,0121 €	26,89 %
1.5l Transparent	0,057 €	0,0645 €	0,0079 €	12,25 %
1.5l Colour	0,059 €	0,0645 €	0,0060 €	9,30 %

Table 6 Product cost without investments

As it is clear from table 6, the manufacture of 1.5 l preforms is much less profitable than 0.5 l preforms. However, 70 % of the drinks on the market in 2010 were bottled into 1.5 l preforms/bottles. According to the expert source in the beverage market the price for coloured preforms is slightly higher than transparent preforms (about 1 - 2 €1000 pcs)

9.3 Production capacity restrictions

According to the offer received from Husky, the total preform production capacity of the HYPET 225 and HYPET 300 machines are according to figure 23 below;

Config.	Yearly Hours	Efficiency	Annual Preform Production
	Hours		
1	8400	95%	112,109,268
2			164,160,000

Figure 22 Production capacity of HYPET 225 & 300 [53]

Theoretically, it can be assumed that the 225-ton machine could produce 81 million 0.5 l preforms and the rest of its production capacity could be used in addition to the 300-ton machines capacity to manufacture 189 million 1.5 l – 2 l preforms. These figures are comparable to the domestic preform market of year 2010. These figures are well under the annual full capacity figure given by Husky in their preform systems brochure. (Hypet 225/0.5 l mould with 48 cavities 163 million pcs or 1.5 l 154.4 million pcs with 48 cavities. Hypet 300/0.5 l with 72 cavity mould 236.6 million pcs or 224.4 million pcs of 1.5 l with 72 cavity mould. [54]

9.4 Background on cost calculations for plastics production

The original heating and electricity consumption figures to use for calculations were based on the environmental permit of Hämeen Lanka [36], on a vast array of production machines. These consumption figures are however not applicable to the preform production machinery electricity consumption. Table 7 below lists the main electrical appliances and an estimated calculation on their usage on a working year of 350 days. The 15 days left over from a full year, are considered to be service breaks and public holidays when the factory is closed. This is also the maximum estimated production efficiency figure (95%, 8400 hours → 350 days) given by the offer received from Husky.

The total electricity consumption was based on the following facts and estimations:

- The factory has 3 elevators
- 2 of the 3 floors will be illuminated for 16h/day/working week. Electrical lighting is estimated using a 5W/m² illumination need over a 3000 m² floor area
- 2 electrical forklift trucks will be used to transport the goods for 3 hours per day
- 1-2 Injection moulding machines will be used for production purposes, their utilisation depending solely on the current order book. Their yearly consumption has been calculated using both Injection moulding machines

Electricity consumption for the injection moulding machines was calculated from the offer received from Husky [53], with a daily consumption of 9 MWh for the 225 ton

machine. To estimate the consumption for the 300-ton machine, the electrical consumption of the 225-ton machine was divided by its clamping force and multiplied by 300:

$$\text{HyPET 225: } 9 \text{ MWh} \times 24\text{h} \times 350 \text{ days} = 75600 \text{ MWh}$$

HyPET 330: $9 \text{ MWh}/225\text{t} = 0,04\text{Mwh/h}$. $0,04 \text{ MWh} \times 300 = 12 \text{ MWh}$. The 300-ton injection moulding machine consumption is 12 MWh $\rightarrow 12 \text{ MWh} \times 24\text{h} \times 350 \text{ days} = 100800 \text{ MWh}$

Electricity consumption calculated with this information adds up to almost 400 MWh as seen in table 7. By using the information on electrical pricing for industrial use from the Statistics Finland web-site [49], an annual estimate can be calculated:

$$\text{Electricity price for annual industrial use: } 10,71\text{¢ /kWh} \times 400,00 \text{ MWh} \rightarrow 0,107 \text{ €} \times 400\,000 \text{ KWh} \rightarrow 42\,800 \text{ €} \approx 43\,000 \text{ €}$$

To allow for some price and other possible power consumption fluctuations, a sum of 46 000 € is used for running the factory at full production capacity on 2 machines.

Equipment	Daily usage/h	Days/year	Amount	Yearly consumption	Unit
3 Elevators	3	350	3 pcs	12,6	MWh
Lighting	16	350	2 floors	168	MWh
Forklifts	3	350	2 pcs	42	MWh
IM Machine 225 ton	24	350	1 pc	75,6	MWh
IM Machine 300 ton	24	350	1 pc	100,8	MWh
Total consumption				399,0	MWh
			10,71 ¢/Kwh	45 666,74 €	

Table 7 Estimated electricity costs for preform production, using a 225-ton and 300-ton injection moulding machines

9.5 Heating expenses

As described in chapter 2.6, the site is equipped with a large oil burner which used 208,3 tons of heavy oil a year for heating the factory. The main factory building has an area of 3714 m², spread out over 3 floors (approximately 1200m²/floor). The proposed preform production requires only 20 % of the factory facility area and needs heating. This can be done by using the existing oil burner, but heating will be primarily handled by using cooling water of the injection moulding machines. The warm cooling water will be fed into the heating batteries and then back into the cooling system of the mould in the Injection moulding machine. The need for heating oil is calculated by:

(208, 3 tonnes / 300 days) [35] X 350 days (current working year planned with plastics production) = 241,016 tonnes.

By using the information on heavy oil pricing for industrial use from the Statistics Finland web-site [60], a yearly estimate can be calculated:

241,016 tonnes of oil/100 X 20 % = 48, 2 tonnes oil consumption/year. At this consumption, the yearly cost would be at:

$$48,2t \times 1000kg \times 0,612 \text{ €/kg [60]} = 29500,35 \text{ €}$$

To account for fluctuations, a figure of 30 000 € is used for calculations. An assumption has been made that 50 % of the heating capacity is sufficient until a 50 % market of proposed preform production is reached. This is due to that necessary working- and storage space for ready products and raw materials would be substantially smaller, and can be separated from the cold part of the factory by using Styrofoam or other padding.

9.6 Insurance

An insurance covering possible fire hazards and production stops has been estimated to cost 100000 €/yr. A 1% annual rise in the fee has been estimated for in the calculations.

9.7 Overhaul of premises

The factory needs to be tidied up, the production and warehousing area to be re-painted and insulated for noise- and heat insulation, and two doors need to be remade (see chapter 8 Factory layout). An estimated sum of 100 000 € has been earmarked for this. In the calculations an overhaul of the factory premises is set to happen every 10 years after the primary overhaul.

9.8 Maintenance of production machines and site equipment

Maintenance of production machinery, elevators and fork lift trucks depend on production load, so annual cost estimations are related directly to production capacity. An estimated 10 (20% production load) - 50 000 €(95%) is needed for the maintenance

9.9 Employee wages

Production has been planned to run in 3 shifts (07-15, 15-23 & 23-07 (unmanned)). The unmanned shift will be monitored remotely, using alarm triggers and web access from the foreman's home. Weekend shifts are not accounted for in these calculations, they are more expensive to run and the production equipment needs downtime. If incoming orders increase, weekend shifts are possible. This would require the machines to be serviced at a more frequent basis thus and increasing service and overhaul costs.

Each production cell is manned by one or two workers. The cell consists of an Injection moulding machine and packing of the preforms into boxes, manually or by a robot arm. The workers responsibilities also cover primary quality control of the products and transferring the saleable products into the warehouse.

The production personnel's wages are based on figures from the Finnish Plastics and chemistry industries (Muovituoteteollisuus ja kemian tuoteteollisuus) collective bargaining agreement (in force until 31.1.2013) [47] and an article in Taloussanomat [48].

An average wage was calculated based on these hourly wages (10,91 €/h and 13,64 €/h)
→ $(10,91 \text{ €} + 13,64 \text{ €}) / 2 = 12,28 \text{ €/h}$. Thus the wage on the production floor is 12,28 €/h.

The production is monitored by a shop floor manager, whose working time normally is set so that his/her working hours overlap on both shifts to ensure proper communication to both shifts and can carry out possible troubleshooting duties during the daytime and

(The shops floor managers working hours could be for example 9 – 17) The shop floor managers wages are set at 15, 96 €/h. The rest of the wages are described in table 8.

In the beginning, or when the order base will cover a market share of 20 – 30 %, 3 people will work on the shop floor and the floor manager will run administration duties, covering as a back-up for shop-floor duties. If the order base will increase to over 50 %, more workers may be employed to relieve then manager from dual duties.

Employees:	Amount	Wage	Monthly salary	Social sec.payments etc.	Yearly salary costs
Shift workers	3	12,28 €/h	1 951,73 €	2 400,62 €	86 422,32 €
Shop floor manager	1	15,96 €/h	2 537,24 €	3 120,81 €	37 449,72 €
Office: sales, marketing & billing	1	17,55 €/h	2 790,97 €	3 432,89 €	41 194,68 €
Managing and warehousing director	1	17,55 €/h	2 790,97 €	3 432,89 €	41 194,68 €
Total	7				206 261,40 €

Table 8 Wage calculations for factory running under 50 % production capacity

Employees:	Amount	Wage	Monthly salary	Including social sec.payments etc.	Annual salary	Yearly salary costs
Shift workers	4	12,28 €/h	1 951,73 €	2 400,62 €	28 807,44 €	115 229,76 €
Shop floor manager	1	15,96 €/h	2 537,24 €	3 120,81 €	37 449,72 €	37 449,72 €
Office: sales, marketing etc.	2	17,55 €/h	2 790,97 €	3 432,89 €	41 194,68 €	82 389,36 €
Warehousing : manager	1	12,28 €/h	1 951,73 €	2 400,62 €	28 807,44 €	28 807,44 €
Managing director	1	20,00 €/h	3 178,71 €	3 909,81 €	46 917,72 €	46 917,72 €
Total	12					310 794,00 €

Table 9 Annual wage costs of the workers if the market share rises over 50 % of possible factory production capacity

9.10 Production equipment

Based on planned market share acquisition, two injection moulding machines are needed to produce the preforms. Husky equipment was chosen because it is the market leader in preform technology and their offer was used to base the calculations on. The machines are characterised by the clamping force that they can provide. The clamping force, indicates the amount of force that the clamping unit can apply to the mould to keep it securely closed during the injection of the molten plastic [57]

The machines are the Husky HYPET 225, which has a clamping force of 225 tonnes and the HYPET 300 machine with 300 tonnes. The reason for the larger machine is its can provide a larger production capacity if necessary with separately purchased 72 cavity moulds for 0.5 both and 1.5 l preforms.

- a. The 225-ton Injection moulding machine mainly produces 0.33, 0.5 l, 0.95 and 1.5 l bottle preforms. It has a 48 cavity 24g preform mould for 0.5 l CSD bottles.

- b. The 300-ton machine would mainly produce 1.5 or/and 2.0 l bottles. The supplied 48 cavity 41.5 g preform mould is for the production of 1.5 l CSD bottles.

9.11 Investment loan

A 3 000 000 € loan is needed to cover the purchase of the equipment described in Table 10 below. The purchase of the injection moulding machines is funded by a loan from Export Development Canada (EDC) as Husky is a Canadian company. Husky sells the order they receive to EDC, and EDC in turn charges the end customer, whilst offering extended payment terms and competitively-priced financing.

The 400 000 € loan which is left over can be obtained from a domestic bank, or by financing by the counterparts of the company. This is discussed further in chapters 10.1 & 10.2. The estimate of the total machine package price has been made by using an offer for a HYPET-225 machine received from HUSKY Injection Molding Systems UK Ltd. [53]

Amount	Description	Price
1	225-ton Husky HYPET Injection moulding machine	
1	300-ton Husky HYPET Injection moulding machine	
	Both machines are equipped with hoppers, robot arms etc. The delivery is on a "turnkey"-basis	Total 2 600 000 €
2-3	Electric forklift trucks, bought used, for example from DKS.fi	Total 15000 €
1	Cost of acquiring factory	250 000 €
	Cost of investments covered by 3000000 € loan	2865000 € thus leaving 135000 € for possibly unexpected costs

Table 10 the contents of the whole investment loan

The loan has been planned to be taken for a time period of 9 years, to ensure the possibility of a reasonable payback timetable and market liquidity of the company during the simulated 10-year time period. Interest rate for the loan has been set at 6.5 %. The Payback for the loan starts during the 2nd year of operation of the 10-year period. See Table 11 for the detailed payback scheme of the loan.

Loan payment no.	1	2	3	4	5	6	7	8	9
Payment date	30.11.2014	30.11.2015	30.11.2016	30.11.2017	30.11.2018	30.11.2019	30.11.2020	30.11.2021	30.11.2022
Interest rate	6.5 %	6.5 %	6.5 %	6.5 %	6.5 %	6.5 %	6.5 %	6.5 %	6.5 %
Principal payment	255 714,1 €	272 335,5 €	290 037,3 €	308 889,8 €	328 967,6 €	350 350,5 €	373 123,3 €	397 376,3 €	423 205,7 €
Interest	195 000,0 €	178 378,6 €	160 676,8 €	141 824,4 €	121 746,5 €	100 363,6 €	77 590,8 €	53 337,8 €	27 508,4 €
Loan balance	2 744 285,9 €	2 471 950,38 €	2 181 913,05 €	1 873 023,3 €	1 544 055,71 €	1 193 705,23 €	820 581,97 €	423 205,7 €	0 €

Table 11 Loan payback scheme

9.12 Factory building ownership alternatives

The price for the whole factory building has been set at 250 000 € by the owner Danspin. They are also offering to lease it at a monthly cost of 3100 € without heating.
 $3100 \text{ €month} \times 12 \text{ months a year} \times 10 \text{ years} = 372\,000 \text{ €}$

Based on this calculation, the factory would be paid in full in a time period of less than 7 years, compared to renting it. The building is in good shape, and as the payback time for the production equipment has been set at 9 years, it is worthwhile to buy the factory estate. The premises could be later sold to a real estate asset management company such as Aberdeen asset management, and stay on as a tenant.

9.13 Real-life market share and profitability estimations

A conservative and lifelike estimation of the possible domestic market was made to give a view of the operations over the simulated 10+1 year time period. This is described in table 12 on the following page. The percentage factor is based on estimations on bottled drinks in 2010, and in what size preforms were needed for bottling them.

As an example, 20 % of the 0,5 l preforms made in 2010 would add up to: 81 million preforms (Table 4) $\rightarrow 81\,000\,000 \times 20 \% \approx 16,2 \text{ million preforms}$.

Their raw material cost would be:

$81 \text{ million pcs (total amount of 0,5 l preforms needed/year)} \times 0,024\text{kg (preform weight)} \times 1,35 \text{ €/kg (PET raw material price per kilo)} \times 20 \% \text{ (market share)} = 524880 \text{ €}$

The possible market share has been calculated from 20 % increasing up to 35 % during the 1st 4 years, this is vital to ensure that all costs can be covered for and that the operations stay even slightly positive. Year 11 is shown to describe the 1st loan-free year with a market share of 55 %.

The market share corresponds to sales in the Finnish market. A full domestic market share is hardly possible, but more sales could be possible by trying to gain some export market share. Prices for the preforms and raw material cost calculations in this thesis

3. The loan is paid normally, ending in 2022. The 1st year (2013) figures differ compared to years 2014-22 as the loan has been already drawn, and the payback of it begins in year 2014
4. The price of raw-materials must not rise above 1350 €/tn

Break-even: Expenses	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Market share	18,00 %	30,60 %	30,65 %	30,70 %	30,70 %	30,80 %	30,80 %	30,90 %	31,50 %	32,00 %	13,80 %
0,5 l PET granules	472 392 €	803 066 €	804 379 €	805 691 €	805 691 €	808 315 €	808 315 €	810 940 €	826 686 €	839 808 €	362 167 €
0,5 l additives	1 312 €	2 231 €	2 234 €	2 238 €	2 238 €	2 245 €	2 245 €	2 253 €	2 296 €	2 333 €	1 006 €
0,5 l Colour additives	1 750 €	2 974 €	2 979 €	2 984 €	2 984 €	2 994 €	2 994 €	3 004 €	3 062 €	3 110 €	1 341 €
1,5 l PET granules	1 905 971 €	3 240 150 €	3 245 444 €	3 250 739 €	3 250 739 €	3 261 327 €	3 261 327 €	3 271 916 €	3 335 448 €	3 388 392 €	1 461 244 €
1,5 l additives	19 060 €	32 402 €	32 455 €	32 508 €	32 508 €	32 614 €	32 614 €	32 720 €	33 355 €	33 884 €	14 613 €
1,5 l Colour additives	8 471 €	14 401 €	14 424 €	14 448 €	14 448 €	14 495 €	14 495 €	14 542 €	14 824 €	15 060 €	6 495 €
Electricity	8 280 €	14 076 €	14 099 €	14 122 €	14 122 €	14 168 €	14 168 €	14 214 €	14 490 €	14 720 €	6 348 €
Heating oil	15 000 €	15 000 €	15 000 €	15 000 €	15 000 €	15 000 €	15 000 €	15 000 €	30 000 €	30 000 €	30 000 €
Insurance	100 000 €	101 000 €	102 010 €	103 030 €	104 060 €	105 101 €	106 152 €	107 214 €	108 286 €	109 369 €	110 462 €
Overhaul of premises	100 000 €									100 000 €	
Maintenance of mach.	9 000 €	15 300 €	15 325 €	15 350 €	15 350 €	15 400 €	15 400 €	15 450 €	15 750 €	16 000 €	6 900 €
Wages	206 261 €	206 261 €	206 261 €	206 261 €	206 261 €	206 261 €	206 261 €	206 261 €	206 261 €	206 261 €	206 261 €
Production machinery											
Loan payment no.		1	2	3	4	5	6	7	8	9	
Loan payment date		30.11.2014	30.11.2015	30.11.2016	30.11.2017	30.11.2018	30.11.2019	30.11.2020	30.11.2021	30.11.2022	Loan paid
Interest rate		6,5 %	6,5 %	6,5 %	6,5 %	6,5 %	6,5 %	6,5 %	6,5 %	6,5 %	
Principal payment		255 714 €	272 336 €	290 037 €	308 890 €	328 968 €	350 350 €	373 123 €	397 376 €	423 206 €	
Interest at 6,5 % rate		195 000 €	178 379 €	160 677 €	141 824 €	121 747 €	100 364 €	77 591 €	53 338 €	27 508 €	
Loan balance	3 000 000 €	2 744 286 €	2 471 950 €	2 181 913 €	1 873 023 €	1 544 056 €	1 193 705 €	820 582 €	423 206 €		
Total Expenditure	2 847 497 €	4 845 568 €	4 853 232 €	4 860 907 €	4 861 937 €	4 876 287 €	4 877 338 €	4 891 709 €	4 987 635 €	5 055 264 €	2 183 383 €
Income	18,00 %	30,60 %	30,65 %	30,70 %	30,70 %	30,80 %	30,80 %	30,90 %	31,50 %	32,00 %	13,80 %
0,5 l Preforms sold (pcs)	14580000	24786000	24826500	24867000	24867000	24948000	24948000	25029000	25515000	25920000	11178000
1,5 l Preforms sold (pcs)	34020000	57834000	57928500	58023000	58023000	58212000	58212000	58401000	59535000	60480000	26082000
Amount of sold preforms	48600000	82620000	82755000	82890000	82890000	83160000	83160000	83430000	85050000	86400000	37260000
0,5 l	656 100 €	1 115 370 €	1 117 193 €	1 119 015 €	1 119 015 €	1 122 660 €	1 122 660 €	1 126 305 €	1 148 175 €	1 166 400 €	503 010 €
1,5 l	2 194 290 €	3 730 293 €	3 736 388 €	3 742 484 €	3 742 484 €	3 754 674 €	3 754 674 €	3 766 865 €	3 840 008 €	3 900 960 €	1 682 289 €
Total	2 850 390 €	4 845 663 €	4 853 581 €	4 861 499 €	4 861 499 €	4 877 334 €	4 877 334 €	4 893 170 €	4 988 183 €	5 067 360 €	2 185 299 €
Profit/Loss before taxes	2 893 €	95 €	349 €	592 €	-439 €	1 047 €	-4 €	1 461 €	547 €	12 096 €	1 916 €
Gross margin	0,10 %	0,00 %	0,01 %	0,01 %	-0,01 %	0,02 %	0,00 %	0,03 %	0,01 %	0,24 %	0,09 %

Table 13 Break-even figures

9.15 Wage subsidy support

If certain conditions are met, the local TE-Office can offer funding to cover for salary costs if an unemployed jobseeker is recruited. The funding covers only the training period of the jobseeker. The pay subsidy is mainly used to employ persons who have been unemployed for a long time; disabled, young people aged less than 25 and jobless persons threatened by long-term unemployment or exclusion from the labour market. [29]

The subsidy grant is for a fixed term, normally up to 10 months. In a case of an apprenticeship, subsidy payment can be longer term. In this factory case, apprenticeships are expected to be 24 months long. Extra subsidies or payment of external training can be granted to cover for costs arising from the training. For the employment of a Work Planning Officer, or a person who is difficult to employ or disabled, a pay subsidy can be granted for a maximum of 24 months at a time.

The aim is to employ person(s) to become permanent employees, subsidy offered by the TE-office being partly a training time to rehabilitate the jobseeker back to work and getting accustomed to their possible new work chores. The normal minimum wage subsidy is 670 €/month. An additional subsidy is paid to jobseekers that are difficult to employ (for example for rehabilitation or unemployment has lasted over 500 days). The additional subsidy part is between 60-90 % of the basic subsidy.

To receive additional subsidies to employ a person, the subsidy must be used to improve the competence and vocational skills of the employee through training or otherwise.

In these cases the different subsidies would be:

- The normal subsidy is 670 €/month
- With the additional part the subsidy would be 1072 €/month (670 €+670 X 0.6)
- For jobseekers who are difficult to employ, the subsidy would be 1273 €/month (670 €+ 670 €X 0,9) [67]

In the factory case, possible wage subsidies could be used. Table 14 displays possible subsidy compensation related to single person annual wage expenses.

Employee	Amount	Normal annual salary costs	With normal subsidy	With extra subsidy	Subsidy for difficult to employ
Shift workers	1	28 807,44 €	25 568,68 €	20 744,68 €	18 332,68 €
Shop floor manager	1	37 449,72 €	35 651,34 €	30 827,34 €	28 415,34 €
Office: sales, marketing etc.	1	41 194,68 €	40 020,46 €	35 196,46 €	32 784,46 €
Warehousing : manager	1	28 807,44 €	25 568,68 €	20 744,68 €	18 332,68 €
Managing director	1	46 917,72 €	46 697,34 €	41 873,34 €	39 461,34 €

Table 14 Personnel wages with possible subsidy compensations

The scenario is assumed with the following;

- 2 of the shop floor workers are on apprenticeship/persons that are difficult to employ/on rehabilitation. Wage costs are subsidised for the first 2 years of company existence by the TE-Office.
- If the market share increases to 50 % more personnel will be employed, both to the shop and the office to take care of administration/sales and billing. A total of four people will be employed using wage subsidy grants, all for a period of 2 years. The aim is of course to employ these people as permanent workers for the company later on.

9.16 Exit strategy

As stated in chapter 9.14, an annual market share of approximately 32 % must be reached to ensure a sufficient cash flow to pay for expenses such as loan costs which cannot be decreased by downsizing production or by other means. If operations fail, the injection moulding machines and the possible raw material stock are the most valuable assets. As an example, a year's worth of Bottle grade PET raw material and their additives can cost over 4,28 MEUR. (Based on the 32 % market share in Table 13) There are numerous companies making food containers in the near Baltic countries and Sweden as well, so selling the raw materials should not be a major problem.

The HyPET injection moulding machines are specially made for preform production, and are sold quite often used by companies such as Top machine brokers, Elite machinery systems and Plastemart. The building has been empty already for a long time period, so it could pose a bigger problem in liquidating it. However, as mentioned in paragraph 2.1, the factory has been completely emptied during October 2012 so selling it onwards should be an easier task with it being empty. In addition to this, new fibre optic cabling is being dug into the ground past the factory site by Elenia, offering a new world of possibilities being done in the site. As an example, a data centre similar to Google's site in Hamina could be ideal to be built into the building as it is very robust and secure.

10 FINANCIAL PARAMETERS:

Several calculations were made to provide information to define if starting up a preform production plant is profitable. Comparisons were made using ROI, EBIT and TIE as figures of financial performance.

10.1 Return on investment (ROI)

The most common measure to see if a made investment is profitable is Return On Investment (ROI). As the cash flow for the company is uneven, the ROI is calculated using the following formula:

Exact formula for uneven cash-flow:

$$ROI = 100\% * (-S + F_1 + F_2 + \dots + F_n + R) / (I * N)$$

Figure 23: Calculation of ROI with uneven cash flow. Source Henry Clay Ericsson's lecture notes

I = initial investment, in monetary units (In this case, 3 000 000 €)

N = economic lifespan of the investment, in years (The calculations have been done on for 10 years, so 10 years will be used)

F = annual net cash inflow (+) or outflow (-), in monetary units

The investment starts producing on the first day of year 1.

S = start-up cost, in monetary units (Set to 200 000 € Two overhauls are done to the factory during this timeframe, the 1st in 2013 and the 2nd during year 2022)

R = salvage value (rest value) of the investment after n years, in monetary units (This is set to 500 000 € as the calculations have been made for a 10+1 year period only). The value is based on research of used machines from companies mentioned in chapter 9.16.

Cash inflows	3 167 100 €	5 542 425 €	5 542 425 €	5 542 425 €	6 334 200 €	6 334 200 €	6 334 200 €	7 125 975 €	7 917 750 €	8 709 525 €
Cash outflows	3 117 078 €	5 431 169 €	5 432 179 €	5 433 199 €	6 099 686 €	6 100 726 €	6 101 777 €	6 768 295 €	7 542 356 €	8 208 895 €
Net cash flow	50 022 €	111 256 €	110 246 €	109 226 €	234 514 €	233 474 €	232 423 €	357 680 €	375 394 €	500 630 €
Cumulative cash flow	50 022 €	161 277 €	271 523 €	380 749 €	615 263 €	848 737 €	1 081 159 €	1 438 839 €	1 814 233 €	2 314 863 €
ROI										8,72 %

Figure 24 ROI Calculation

Year	Investment	Net cash flow	Notes
1	3 000 000 €	-150 022 €	100000 € for overhaul of factory
2		111 256 €	
3		110 246 €	
4		109 226 €	
5		234 514 €	
6		233 474 €	
7		232 423 €	
8		357 680 €	
9		375 394 €	
10		600 630 €	100000 € for overhaul of factory
Total		2 214 820 €	Salvage value 500 000 €

Figure 25 ROI Calculation values

The ROI Calculation is carried out as follows:

$$100\% \times (-200\,000\text{ €} + 50\,022\text{ €} + 111\,256\text{ €} + 110\,246\text{ €} + 109\,226\text{ €} + 234\,514\text{ €} + 233\,474\text{ €} + 232\,423\text{ €} + 357\,680\text{ €} + 375\,394\text{ €} + 500\,630\text{ €} + 500\,000\text{ €}) / (3\,000\,000\text{ €} \times 10) = 8.72\%$$

Using these values, a ROI of 8.72 % was achieved. This value is not even close to a normally required value minimum value of 25 % for ROI.

It is to be noted that:

- During year 2013 no loan payment instalments are paid. The 1st loan payment is paid during year 2014. The estimated market share is for year 2013 is 20 %
- In 2018 half (50%) of the 3 000 000 €loan should be paid and the market share is estimated to be 40 % if all goes well.
- During year 2022 the last instalment of the loan will be paid. Market share has been estimated to be 55 % at this time.

10.1.1 ROI Estimation for 20 year time period

If a constant market share of 50 % could be maintained, a ROI of approximately of 14 – 19 % could be estimated for a time period of 20 years. This of course would require that the fluctuating raw material price must not exceed the calculated PET raw material price of 1350 €/tn, or other possible cheaper raw material alternatives could be utilised. Also improvements in preform design, such as described in the chapter 15 Discussion would be an advantage.

10.2 EBIT

EBIT stands for Earnings before Interest and Taxes. Accountants like to use the term Net Operating Income for this income statement item, but finance people usually refer to it as EBIT (pronounced as it is spelled - E, B, I, T). Either way, on an income statement, it is the amount of income that a company has after subtracting operating expenses from sales (hence the term net operating income). Another way of looking at it is that this is the income that the company has before subtracting interest and taxes (hence, EBIT). [58]

The EBIT for the 10+1 year period is displayed in the table 16 below. As it can be seen, the EBIT value reaches 270 000 € on an estimated 35 % market share, during year 4

(2016). When the market share rises over 40 %, the EBIT is over the 0.4 MEUR mark.
When the loan is fully paid, the EBIT rises close to a 1 MEUR (950 250 € in 2023)

	Year: 2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Market share	20 %	35 %	35 %	35 %	40 %	40 %	40 %	45 %	50 %	55 %	55 %
Interest at 6.5 % rate		195 000 €	178 379 €	160 677 €	141 824 €	121 747 €	100 364 €	77 591 €	53 338 €	27 508 €	
Profit/Loss before taxes	50 022 €	111 256 €	110 246 €	109 226 €	234 514 €	233 474 €	232 423 €	357 680 €	375 394 €	500 630 €	950 250 €
EBIT	50 022 €	306 256 €	288 624 €	269 903 €	376 339 €	355 220 €	332 786 €	435 271 €	428 732 €	528 138 €	950 250 €

Table 15 EBIT 2013-2023

10.3 Debt/equity ratio

Debt-equity ratio is used to measure a company's financial leverage by dividing its total liabilities by its equity. It indicates what proportion of equity and debt the company is using to finance its assets. In this case, the liabilities are the loans totalling 3 MEUR loan for financing the investment of production machinery and other equipment described in chapter 9.11 on the Investment loan. The equity calculations are done using the following assumptions:

- The factory value is set at 350 000€ The purchasing cost is 250 000 and an overhaul costing of 100 000 € is needed (See Chapter 9.7 Overhaul of premises) and other possible repair work of damages due to the factory being unused. The value of the factory site is estimated to rise at an average cost-of-living index based increase of 2 %/year, partly due to its almost uninhabited location.
- The production equipment's value is estimated to depreciate at a 4% yearly rate. This is based on an assumption that the Injection moulding machines will have an life time expectancy of 20 years
- The 2 fork lift trucks which are bought used at a value of 15000 € are estimated to have a lifetime expectancy of 10 years, thus a yearly depreciation of 10 %

As an example, the Debt equity ratio during year 2017 is:

$$1\,873\,023.3 \text{ € (Loan Balance)} / 2\,596\,994 \text{ € (Present value of equity)} = 0.7212 \rightarrow 72 \%$$

$$\text{Or during year 2021: } 423\,205.7 \text{ €} / 2\,292\,151 \text{ €} = 18.46 \%$$

The Debt/Equity ratio goes to zero after year 2022 as the loan has been paid in full.

10.4 Return on Assets (ROA)

Return on assets indicates how profitable the factory would be in relation to its assets. In this case, the assets are the building, production machinery and the fork lift trucks.

ROA is calculated by: $\text{Net Income} / \text{Total assets}$.

For example, for the second operative year (2014) it would be:

$$83\,998 \text{ €} / 2\,866\,500 \text{ €} = 2,93 \%$$

After the investment loan is paid in full (2023) The ROA rises up to a quite satisfactory level of over 33 % $\rightarrow 717\,439 \text{ €} / 2\,160\,443 \text{ €} = 33,21 \%$.

The ROA indicators for fiscal years 2013 – 2023 are calculated in Table 17 below

	Year 2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Loan balance	3 000 000 €	2 744 286 €	2 471 950 €	2 181 913 €	1 873 023 €	1 544 056 €	1 193 705 €	820 582 €	423 206 €	0 €	0 €
Assets											
Real estate	350 000 €	357 000 €	364 140 €	371 423 €	378 851 €	386 428 €	394 157 €	402 040 €	410 081 €	418 282 €	426 648 €
Fork lift trucks	15 000 €	13 500 €	12 150 €	10 935 €	9 842 €	8 857 €	7 972 €	7 174 €	6 457 €	5 811 €	5 230 €
Production machinery	2 600 000 €	2 496 000 €	2 396 160 €	2 300 314 €	2 208 301 €	2 119 969 €	2 035 170 €	1 953 763 €	1 875 613 €	1 800 588 €	1 728 565 €
Total	2 965 000 €	2 866 500 €	2 772 450 €	2 682 671 €	2 596 994 €	2 515 255 €	2 437 299 €	2 362 978 €	2 292 151 €	2 224 682 €	2 160 443 €
ROA	1,27 %	2,93 %	3,00 %	3,07 %	6,82 %	7,01 %	7,20 %	11,43 %	12,36 %	16,99 %	33,21 %
Debt-Equity ratio	101,18 %	95,74 %	89,16 %	81,23 %	72,12 %	61,39 %	48,98 %	34,73 %	18,46 %	0,00 %	0,00 %
Total	3 167 100 €	5 542 424 €	5 542 425 €	5 542 425 €	6 334 200 €	6 334 200 €	6 334 200 €	7 125 974 €	7 917 750 €	8 709 525 €	8 709 525 €
Profit/Loss before taxes	50 022 €	111 256 €	110 246 €	109 226 €	234 514 €	233 474 €	232 423 €	357 680 €	375 394 €	500 630 €	950 250 €
2013-17 Income Statement	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Taxable income	50 022 €	111 256 €	110 246 €	110 246 €	234 514 €	233 474 €	232 423 €	357 680 €	375 394 €	500 630 €	950 250 €
Taxes (24,5%)	12 255 €	27 258 €	27 010 €	27 010 €	57 456 €	56 798 €	56 342 €	87 668 €	91 971 €	122 654 €	232 811 €
Net income	37 766 €	83 998 €	83 236 €	83 236 €	177 058 €	176 676 €	176 081 €	270 012 €	283 423 €	377 975 €	717 439 €
2018-23 Income Statement	2018	2019	2020	2021	2022	2023					
Taxable income	233 474 €	232 423 €	357 680 €	375 394 €	500 630 €	950 250 €					
Taxes (24,5%)	57 201 €	56 944 €	87 632 €	91 971 €	122 654 €	232 811 €					
Net income	176 273 €	175 479 €	270 048 €	283 422 €	377 975 €	717 439 €					

Table 16 ROA and Debt/Equity ratio calculations

11 OWNERSHIP OF THE FACTORY

11.1 Holding company

A separate holding limited liability company called Padas preform will be formed to run the operations. Its share capital will be 600 000 € The ownership is the following:

- 20 % of shares owned by the Padasjoki municipality
- 20 % of shares by the executive staff and employees
- 60 % owned by the entrepreneur him/herself
- A special issue of shares could be arranged towards the public. See table 18 on a possible scenario on share price and economic indicators related to the market share estimation and progress of the company.

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Market share	20 %	35 %	35 %	35 %	40 %	40 %	40 %	45 %	50 %	55 %	55 %
Share equity	600000 €	600000 €	600000 €	600000 €	600000 €	600000 €	600000 €	600000 €	600000 €	600000 €	600 000 €
Number of shares	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000
Share price	3,00 €	3,00 €	3,00 €	3,00 €	3,00 €	3,00 €	3,00 €	3,00 €	3,00 €	3,00 €	3,00 €
EPS	0,25 €	0,56 €	0,55 €	0,55 €	1,17 €	1,17 €	1,16 €	1,79 €	1,88 €	2,50 €	4,75 €
PE	11,99 €	5,39 €	5,44 €	5,49 €	2,56 €	2,57 €	2,58 €	1,68 €	1,60 €	1,20 €	0,63 €
Selling price per share	1,25 €	2,78 €	2,76 €	2,73 €	5,86 €	5,84 €	5,81 €	8,94 €	9,38 €	12,52 €	23,76 €
Total share equity	250108 €	556279 €	551229 €	546129 €	1172571 €	1167368 €	1162113 €	1788399 €	1876969 €	2503148 €	4751 250 €

Table 17 Shareholder scenario with present market share growth assumptions

11.2 Collaborative preform production with beverage producers

There are five main domestic beverage producers; Finn Spring, Olvi, Vip Juicemaker, Hartwall & Sinebrychoff. Olvi, Hartwall & Sinebrychoff already collaborate in the form of Palpa, Suomen Palautuspakkaus Oy PALPA. It administers and develops deposit-based systems for beverage containers in Finland.

A questionnaire was made and sent by email to the leading Finnish beverage and beer producers. It can be found from the appendix section of this thesis under the heading “Questionnaire regarding preform procurements in Finland”. According to the feedback received on the questionnaire, the following assumptions could be made;

1. The vendors would consider/would be interested in buying preforms from a finnish supplier. This would of course be done on a assumption that the formed company is financially healthy and would possibly also have export sales.
2. The domestic preform producer could charge between 1 – 5 % more on preforms compared to foreign competitors , depending on benefits such as applicability and shorter lead times versus the current suppliers.
3. No domestic competitors in preform production exist at this moment
4. Co-ownership of a domestic production plant could be considered.

11.3 Co-ownership of the preform production plant

As stated in chapter 11.2, the companies already have collaboration in the form of Palpa. They possess joint know-how in recycling of bottles in co-operation with the retail trade (shops) and breweries, the beverage producers could own the production plant where their preforms are made. Several benefits would arise from a co-venture:

- A decrease in logistics costs in warehousing and shorter transportation time and distances
- Shorter lead times

- More efficient production planning
- Decreased inventory levels at bottling plants due to elimination of the need of extra shop floor inventory space and utilisation of JIT production principles
- Possibility to employ domestic workforce and increase local know-how
- A considerable decrease in the Carbon footprint emission of the end product

12 EMPLOYEE AVAILABILITY

Local workforce is preferred to motivate the employees and to keep the distance and travelling time to work short. The possibility of receiving employment funding (wage subsidies) by using local inhabitants as employees is an advantage.

The unemployment rate in the Padasjoki municipality is 9.6 %. The Lahti area, which had a considerable industry in the plastics field earlier, has a higher unemployment rate of 13.5%. [51].

According to a final report by Unto Tervo and Timo Malén from the Lahti region Salpaus vocational college between 23.02.2009 – 28.02.2010, the availability of work force in Southern Finland is sufficient. The questionnaire regarding the region was answered by representatives of over 20 companies (25% of total amount of companies working in the plastics and rubber industry sector) and 20 % of these companies represented the Injection moulding industry sector in the southern region of Finland, to which Padasjoki belongs to in this report.

These companies ranged from the size of 1-4 employees and up to over 250 employees. The injection moulding industrial quarter represented almost 30 % of the total work force in companies which took part in the questionnaire [53]. This also means that knowledge and experience exists in the region on plastics manufacture and the operation of for example, an injection moulding machines.

4.3 Vastanneiden yritysten henkilöstömäärä valtakunnallisesti

Vastanneiden yritysten henkilöstön koon mukainen jakautuminen valtakunnallisesti.

Henkilöstömäärät	Ruiskuvälu	Kalvo	Putki	Komposiitti	Lämpömuovaus	Kumi	Muut	Kaikki yhteensä
1-4	4		1	1			2	8
5-9	4		2		1	3	2	12
10-19	4	2	1	1	2		4	14
20-49	4	2	3	3	3	2	4	21
50-249	10	4	3	4		2	5	28
250+	1	1	1	2		2		7
Kaikki yhteensä	27	9	11	11	6	9	17	90

Figure 26 Companies which took part in Salpaus'es questionnaire related to their workforce size and their industrial field. Ruiskuvälu = injection moulding. Picture source Loppuraportti_julkinen, received by email from Timo Malén during August 2010.

There are quite a few educational establishments giving training in the plastics field in the vicinity of the factory area.

According to Tervos and Maléns report [52], the following schools and educational establishments offer training in the field of plastics:

Hyria Education (Hyvinkää-Riihimäki)	Salpaus vocational college
Lahti University of Applied Sciences	Jämsä College
Pirkanmaa Vocational Institute	Vammalan ammattikoulu

Table 18 schools and educational establishments offering training in the field of plastics in the Häme municipality

Based on Tervos and Maléns research, the grounds for running the preform factory with personnel possessing a suitable work experience or gaining suitable further/education should not be a problem.

13 USE OF THE END PRODUCT

The preform is the manufactured end product for this thesis. The following steps are not covered in detail as they are not in the scope of this work. However, to clarify how they are used in beverage production a brief explanation of the process is explained.

The ready preforms are transported to the beverage manufacturer usually by road or by railways. When the order reaches its destination, the preforms are loaded onto the beverage production line for further processing before bottling. The neck part of the pre-

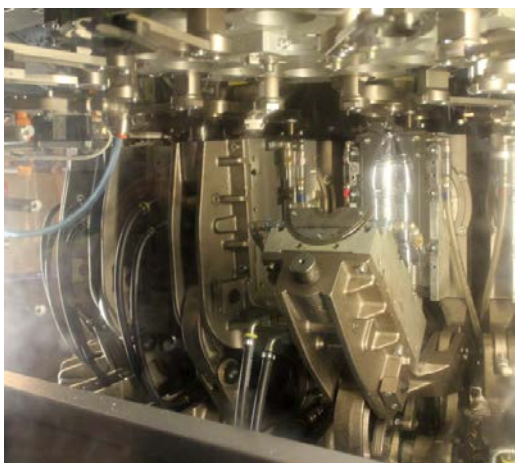
form is already at its final shape and size, it is not processed further. Being the strongest part of the preform, the neck is used to transport the preform into the filling machine.



Picture 11 Preforms being transported into filling machine Picture Paul Fletcher 2011

Before the bottle is filled, it must be processed to its final shape. To achieve this, the preform is heated up to approximately 90°C to prepare it for being blown into its final shape. This is normally done with an infra-red heating source. At this stage it is critical that the neck finish is protected in the oven, as the incorrect positioning of heat shields could result in distortion of the neck finish which in turn will affect handling on any air conveyor system on route to the filling and closure application after filling. [42]

After the heating, the preform is conveyed into the mould which will define the final form and possible outside decoration of the blown bottle. In the mould the preform is stretched using a metal rod to reach its final height. Then the mould is closed. Low pressure air at ca. 7–8 bar is applied at the same time in order to form a balloon inside the mould and then finally high pressure air of up to 40 bars is applied to stretch the material sideways into the final shape of the bottle mould [42].



Picture 12 Bottle filling mould Picture source Paul Fletcher

Once heated, the preform is transferred by the neck to the bottle mould. The preform is then initially stretched with a metal rod to elongate the preform lengthwise so the tip of the preform is located into the centre of the base section of the mould. Low pressure air at ca. 7–8 bar is applied at the same time in order to form a balloon inside the mould and then fi-

nally high pressure air of up to 40 bars is applied to stretch the material sideways into the final shape of the bottle mould. These two operations must be done sequentially in order to get maximum biaxial orientation of the polymer chains. See figure 12 for a graphical description of the process.



Picture 13 Single bottle filling moulds Picture source Paul Fletcher

When the preform has been blown into its final shape as a full-sized and shaped bottle, it is ready to be filled with the whatever drink is planned for use.

14 CONCLUSION

Plastic goods manufacture has been an important income source to the Finnish industry. Large scale production such as of mobile phone covers has been moved out of Finland by the sales of Perlos's [17] and Eimo's [18] factories. After Eimo's factory in Lahti and Hollola were closed down, 1200 plastics workers became redundant [19].

At the same time new fields of plastics production and research and development have emerged, and traditional plastic product manufacturers such as Orthex, has acquired new companies and markets thus simultaneously improved their turnover from 12.3 MEUR (2009) to 13.6 MEUR (2010) and financial profit from 1.8 to 2.2 MEUR [21].

Surgical products, such as PLA-based implants manufactured by such companies as Bioretec, Commed or Onbone's wood composite material, manufactured from wood chips and biodegradable plastic [22] offer a huge potential for the future, but are also naturally potential targets for corporate buy-outs. However, Finland offers excellent know-how and resources such as clean air, water and clean room facilities, which makes

the immediate transfer of production and/or production facilities of these goods less necessary to countries with lower manufacturing costs and labour.

Preform manufacture is not rocket science. The product design itself is easy to copy, and just by doing a search of manufacturers on the internet will return tens or hundreds of companies offering end products with advantageous prices from India and China just as two examples producers. However, the Padasjoki region offers an excellent logistical taxonomy to all of the domestic beverage producers and transport hubs such as harbours and railway stations. There is plenty of qualified personnel in the area, and the municipality is willing to help with re-employment of unemployed people.

14.1 Is it profitable or not ?

As seen in tables 12 and 13, a market share of approximately 30-35 % must be reached during the second fiscal year at least to help the company survive. This is not an easy task. In addition to this, long-term contracts with Finnish beverage producers would ensure the survival of the company. Another substantial factor in the profitability is the raw material price. The price of Bottle grade PET as well as PET fluctuates violently following the oil price. This is partly why new materials are being researched which would not be so dependent on oil and simultaneously be more environmentally friendly. The ROI was calculated to be 8.72 % during the 1st 10 year time period, this indicates that the investment would not be profitable. A Ballpark ROI estimation for a time period of 20 years shows considerably improved values for the ROI value, but the calculations are based on pure assumptions which are discussed in chapter 10.1.1. The production of preforms can be profitable, but it involves huge risks related to raw material price fluctuation. This can of course be buffered by using the empty space as a warehouse and fill it with surplus stock of raw materials. In addition to this, some export share would be welcome, and somewhat necessary. Also investing into alcoholic drink preform production and preform-based test tubes could be profitable in the future.

Based on the calculated figures for the first 10 years, it is not profitable for a private company to produce preforms in Finland.

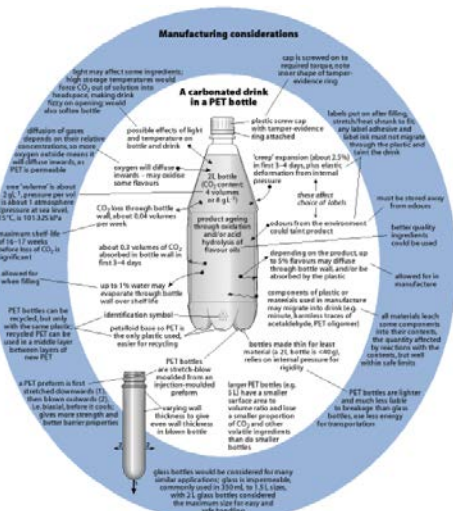
15 DISCUSSION

15.1 Cutting production costs

As discussed in chapter 9 financial calculations, the raw material pricing and the overall share of the raw material compared to the total manufacturing price plays the key role in keeping or making this kind of a production plant profitable. The price of PET is tied to the oil price, so other ways in eliminating production costs apart from buying large amounts of raw material into stock should be, and in some cases have been found.

15.2 Light weighing

To decrease production costs, the trend is to make the preforms lighter in weight. The average weight of 0.5 l preforms has decreased from 26 to 21,5 grams and 1½ l preforms from 43 to 41,5 grams. As picture 14 explains in detail, there are numerous



factors which affect the preform and the blown bottle characteristics. The aim of light-weighting is to reduce manufacturing costs without reducing the bottle performance and consumer appeal. This is achieved by for example: 1. Make the neck part of the bottle lighter (thinner, shorter) 2. Change the bottle base design (See Ecobase below) 3. New bottle body concepts. As an example of light weighing,

Picture 14 Preform design objectives. Source: Presentation from Next steps in PET bottle light weighting conference, UK 2007 by Edward Kosior Nextek Ltd

Husky has developed a preform design which

they call Ecobase.

The company claims that the shape modification of the preform will facilitate a yearly saving of 2.5 % of raw materials. This has been achieved by decreasing the wall thickness of the preform base. This does not impact the bottle's mechanical integrity. [53].



Mineral water	Carbonated soft drink
500 ml—up to 0.3 grams	600 ml—up to 0.5 grams
1.0 liter—up to 0.6 grams	1.5 liter—up to 1.1 grams
1.5 liter—up to 0.8 grams	2.0 liter—up to 1.2 grams

Actual savings depend on original preform weight and dimensions

Case study

Application: 1.5 liter, (sparkling water)

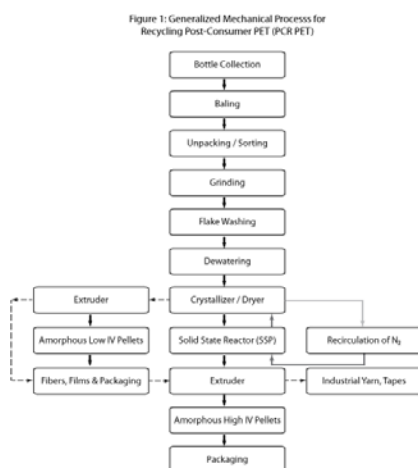
Weight savings: 0.6 grams after base light-weighting

Cavitation	96-cavity
Weight savings	0.6 grams
Cycle time	9.0 seconds
Annual resin savings	190 tonnes (209 tons)

Picture 15 Ecobase preform on the left. Potential weight savings and case study application on the right side. Picture sources HYPET Preform system brochure

15.3 RPET

RPET or rPET is the abbreviation for recycled PET. See figure 25 below on how it is manufactured. In addition to pellets which are used for making bottle preforms, other end-products such as fibers, films and other packaging products are made. Environmental



activists together with governments and brand owners such as Coca Cola have created a pressure for raw material producers to manufacture rPET and increase their efforts into existing and new and improved recycling technologies. Surprisingly enough, the good quality of the rPET and increased demand in China, the Americas and Europe has increased the material price (1400 €/ton) [55] close to virgin PET (1500 €/ton) [56].

Figure 27 Flow chart on RPET manufacturing process. Source: <http://www.bepet.com/article-on-recycling.htm>

In addition to decreasing the CO² emission footprint, the re-use of for PET material via recycling helps save the environment from littering. At the present, the largest problems with using RPET for preform manufacture, is its high price and lack of availability. Another big problem are the possible impurities and material defects that can exist in the flake material or pellets used for manufacturing preforms. Some producers of the RPET raw material don't sort the raw material according to the materials crystallinity, or the container-type, for example by not separating washing liquid containers from for example food stuff containers or beverage bottles, thus making a possible that the pre-

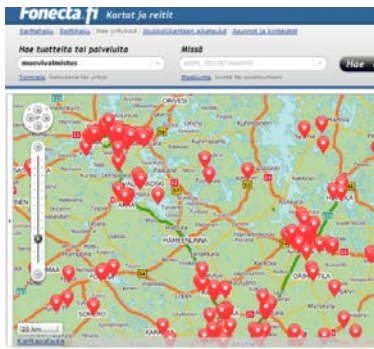
form and the blown bottle will appear as smeared or it is actually contaminated from other chemicals used for producing the containers.



Picture 16 Contaminated RPET preform source: Large scale demonstration of the viability of Recycled PET (rPET) in Retail Packaging Coca-Cola Enterprises Ltd 2006

15.4 Buffer stocking of raw materials

To be able to maintain operations at a profitable level, raw materials should be bought for a ½ -1 year time period in advance if the raw material price decreases considerably. A dry atmosphere is vital for PET or almost any plastic granules and a constant state of temperature in the warehouse facilities are necessary. The factory estate is so large, that the top (3rd) or second floor could be kept as plain warehouse for the raw materials. This would also make it easier to maintain a constant temperature and humidity.



There are other plastics companies in the area and the unnecessary 2nd and 3rd floor space could be used as a storage room facility or wholesales unit for local manufacturers in need of for example PET granules. The building is constructed in such a manner that a constant temperature and low humidity level should be easy to sustain. To improve the warehousing facilities, heating using renewable energy such as solar panels or a heat pump could be used.

Picture 17 Location of companies/factories making plastic products in the vicinity of the factory.
Picture source: Fonecta finder search.

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Appendices

Appendix 1. Site survey report

visit to Padasjoki 5.10.2010

Present on trip

Paul Fletcher final thesis student

Henry Clay Ericsson Thesis supervisor

Tuomas Häme Janitor, Hämeen Lanka

Heikki Jaakkola Director of Padasjoki municipality

Background

We left for the trip from Ruskeasuo at 11.00 heading towards Padasjoki. The purpose of the trip was to survey the Hämeen Lanka premises and to conduct a meeting with the municipal director Mr Jaakkola later on in the afternoon.

Survey of premises

We arrived at the site in good time before the agreed meeting time with Mr Häme , and surveyed the building from the outside. Several things were discovered immediately:

- The building is in good condition from the outside, even the clock was on time
- Warehouse space is large, later on we found out that it was over 2000 m², a 1/3 of the actual factory space. The warehouse has been built from Siporex and has a tin roof
- The yard is overgrown, no visible communal water pipes

At 13.30 Mr Häme arrived and told us briefly about the history of Hämeen Lanka.

The factory was founded in 1948 by his grandfather to make carpet rags from wool, which was imported from the United Kingdom and New Zealand. The factory employed 120 people at its heyday. Hämeen Lanka's competitor Danspin bought the factory in 2007, and early during that year production was moved to Estonia. The

factory closed its operations in October 2007, at that time 33 people were employed, out of which a personnel of 15 worked in the office only.

Notes about premises

When we went into the factory the following things were discovered:

- The factory is on 3 floors, interconnected with elevators.
- Most of the production machinery is still there. Removing it is/will be a slow, time-consuming task and expensive.
- In general the condition inside was good, no humidity related damages
- The heating is via a 1300 MW oil burner located in the cellar. Every floor has batteries for heating, so getting a constant level of heat would not be a problem.
- As each floor is relatively (under 3 metres ?) and the floor is very robust (thick concrete) the best things to produce there would be something not so big in size but very heavy as the floor can take a lot of weight.
- The factory lacks proper drainage systems and water pipe infrastructure. The nearest water pipes are at Padasjoki centre, approximately 8 kilometres away.
- Water is drawn from the local lake via a pump station. The distance to the lake is about 500m. The dirty water from the factory is lead back to the lake via a concrete-encased cleaning station. The cleaning of the grey water (as a example metal colours from the mat rags) is done biologically.

Appendix 2. Interview with Mr. Heikki Jaakkola, Municipal manager, Padasjoki municipality

When and where

06.10.2010 15.30 - 17.00 at the Padasjoki municipal office

Present:

Mr. Heikki Jaakkola	Municipal manager, Padasjoki municipality
Henry Clay Ericsson	Thesis supervisor
Paul Fletcher	Student Arcada, Interviewer

Please tell us about the employment situation in Padasjoki. If we would require employees for a site such as the Hämeen Lanka plant, what is the availability?

The unemployment rate in Padasjoki is approximately 10 %. In the Padasjoki town centre area there are approximately 150 unemployed people.

The availability of workforce for normal tasks is good, unless the job requires special skills such as CAD drawing skills as an example. People with such skills are mostly employed, for example in Lahti or Vääksey.

There used to be a trade school department in Padasjoki which gave education for students to become service personnel for factories. All further education studies are now arranged in Lahti by Päijät-Häme training center.

On our way back from surveying the Hämeen Lanka premises we got a hint that there would be space available at the old Aspocomp PCB-factory site. This might suit our needs better. What is the situation of this site?

PP Recycling are working in part of the premises which is called Greentech center due to its involvement in recycling. PP Recycling Ltd is a company which specializes in the treatment and recycling of hazardous waste solutions, such as waste which was generated from the Aspocomp factory.

Now that the Aspocomp plant has closed down, PP Recycling has a problem of acquiring suitable materials for treatment, having to bring the material over long distances, making their work less profitable.

At the moment the company is under company reorganization, and we will have to wait and see if the company will be declared bankrupt or the operations will carry on or not. The site does have empty space for hire, but situation with PP Recycling has to be solved first.

Opposite the Greentech center in the premises of Padasmaila, there is also some space available to be rented. Padasmaila is the manufacturer of the world famous Montreal ice hockey sticks. The ownership situation in Montreal has also changed; the company is no longer Finnish. It is owned by the American sports company Warrior.

The biggest problem with the Hämeen Lanka site is the lack of proper sanitation facilities and water pipes connected to the communal water works. Is there any kind of plans to improve this situation?

About 5 years ago the municipality made a questionnaire to the people living round the Kaukela area about improving the water works infrastructure.

The result was that people do not want communal water piping, as almost everyone has their own wells and water can be drawn from the lakes in the vicinity such as the Kaukila and Miestämä lakes.

The nearest municipal running water is in Arrakoski, several kilometers away from the Hämeen Lanka Premises

If needed there is possibility to extend the infrastructure. During the last few years the municipality has drawn water pipes in the south direction of Padasjoki, into the Nyystölä and Maakeski direction.

If new jobs would be created into the Hämeen Lanka premises, how could the municipality help the start-up of the company?

The municipality has a fund (Padasjoen kehitysräho Oy) from where risk- or finalization funding can be granted by using convertible bonds. Such funding with a 10-year payback time has been offered to Montreal and Aspcomp.

The municipal board will decide if the project is profitable and offer funding accordingly.

Also the municipality has space for rent at the industrial estate. The price is advantageous, normally it is around 5 €/m² for special cases this can also be negotiated to be lower, down to 3 €/m².

Considering the town planning aspect, if the company would become operational on the municipal industrial estate, and the town planning would require changes, these can be negotiable.

Start-up support for new companies is supported mainly by LAKES, which is located in The Lahti science and industrial park (Lahti Regional Development Company). The Padasjoki contact person there is Mr. Tuomo Jalkanen)

Did the current owner of Hämeen Lanka contact the municipality for co-operation of keeping the site operational before its close-down? What kinds of matters were discussed and what happened?

Of course we had meetings about the possibilities of the factory carrying on their operations. The operations at the site were decreased at the beginning of 2007, when Danspin moved part of the production and machinery to Estonia.

The negotiations related to the closure were not fruitful, as the demands made by Danspin exceeded what the municipality could offer. Negotiations were mainly held about improving the drainage and supporting the factory operations financially. The results of the negotiations were not positive, and the factory was closed down in October 2007.

What kinds of future improvements have been planned/are being carried out in the municipality?

The broadband connection cabling is being upgraded to optical fiber at the moment by Sonera. Optical fiber will improve the broadband internet connection speeds up to 100 Mb/second at least in the center of Padasjoki town center.

On the municipal side extensive research into renewable natural resources is in the long-term environmental planning. At the moment VAPO has a peat-burning plant on the local industrial estate, and wind power plants are being built in the vicinity of the Padasjoki Marina.

Acknowledgements

The interview finished at 17.00. I wish to express my thanks to Mr Jaakkola for his time and Mr Henry Clay Ericsson for his time, driving and discussions.

Appendix 4 Questionnaire regarding preform procurements in Finland

THE QUESTIONS

1. Would your company be willing to buy/collaborate on preform issues from a production facility in Finland ?

Yes/No/Maybe (If your answer is of a negative manner, some kind of short description would be appreciated).

2. Would your company possibly buy their preforms from a Finnish factory if their prices would be a) 2-3 % b) 5 % c) 7-8 %

higher than your present suppliers such as Putoksnis, Rexam etc This price would include the same terms as offered by your present suppliers such as Putoksnis etc.

The benefits of a local supplier would be of course local production smaller transportation costs, shorter lead- and delivery times, a smaller carbon footprint and even a possible buffer warehouse at the factory. The imaginary factory would be located X km from your X factory.

3. I have spent quite a lot of time on ground research concerning possible manufacturers of preforms in Finland. As far as I know there are no suppliers of these in Finland hence Preformia which has been closed down and Pernod-Ricard Finland/Graham Packaging Company Oy (ExRyttylän Muovi) Graham Packaging, which makes packaging only for Altia . If any suppliers come to you mind, please let me know.

4. Do you at your company have such a vision that a preform production plant in Finland could exist, which would be jointly-owned by for example the five largest beverage manufacturers in Finland ? Each manufacturer would own a share, and even some research work could be carried out together ? For example the production plant could cover for the manufacture of bulk-preforms. It seems to me there are some preform/blown bottle types which are uniform undependant of the supplier or cork thread. Similar co-operation already exists in the form of PALPA (<http://www.palpa.fi/beverage-containers>)

If the answer to this question is negative, a short explanation why would be very much appreciated.

Thank you for your possible feedback in advance.