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**DEVELOPMENT OF THE HEAVY PUNCHING BAG PRODUCT  
DESIGN AND PRODUCTION PROCESS**

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<p>The current work is created to review new product development practices and to implement them into real life case of the heavy punching bag design development. Although the punching bags market in Finland has high competence environment, the author of the work has found the opportunity that possibly will help the newly developed product to take a niche in the existing market.</p> <p>The production process development has been worked out as well and included into the current work to complete the author's idea of creating the heavy bag design and its production process. The work was planned in the way to provide information and documentation on the heavy bag and its production process designs. The work also treats several problems and their solutions on the matter of the product specifications and production methods.</p> <p>The topic of the work was covered in the way to balance the theoretical framework and results of practical activities. It was important to keep that balance as the development processes have a wide range of concerns and by following guidelines from the experts in product and process development the work was directed to fully satisfy the author's goals.</p>		
<b>Key words</b> New product development, punching bag, process planning		

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## **1 INTRODUCTION**

### **Author's background**

Before I went to Centria University of Applied Sciences I had studied a college programme by the name of "Computer Systems, Complexes and Networks". Back then while participating in course about manufacturing methods of computer printed boards I became really interested about manufacturing itself as well as studying disciplines that teach about doing something tangible or that help to create it in a more optimal and beneficial way.

Later in 2008 when I have started my studies of "Industrial Management", I was very curious about learning how all these big and small companies organize their production, marketing, logistics and other crucial business processes. I was interested in their strategies and methods of running their businesses as daily routine and that times when business falls under stress of recessions or other unfavorable economic impacts. I was particularly keen to learn about production processes in general as well as manufacturing and quality control specific methods and practices being used nowadays. During the studies it became obvious to me that it would not be possible to run production without processes that support it. Thus I realized the importance of logistics and marketing processes: from acquiring material suppliers and purchasing to the actual sales.

By the third year it had come to me that management of the company processes is like a clockwork, everything should be running smoothly and any problems have to be solved adequately fast and according to circumstances. Neglecting the importance of some processes or activities may affect business well-being quite dramatically.

To my mind that interest in production and its supportive (in the view of manufacturing) processes have lead me to that interesting idea of developing of a new product as it requires almost a full range of knowledge and skills that I have acquired studying "Industrial Management".

### **Work background and aims**

Initially the idea of developing my own product design for a punching bag came to me when I got interested in starting entrepreneurial business in Finland at the end of 2012. I

was attracted to the idea of making punching bags that have more versatile features compared to existing products on the market in Finland. Back then I had made little research about possible competitors on the market and particularly the variety of their product offers and prices.

As a result of that research I ended up with the opinion that if a product of great quality and with a relatively lower or similar price is brought to the market, it will be able to have success among target customer groups.

The aim of the study is to develop the initial idea of such product to the state that allows it to be launched to the market in a matter of short time. To achieve that aim core development of the product shall be made that includes product design leading to research on required and accessible materials. Thus more precise study of the punching bag designs and technology of industrial sewing will be made and reported in the final product design. After the core product design is ready and it is possible to observe the product material requirements, production process is worked out. Based on the product design and material specifications it is possible to make a research on the production equipment that will satisfy the needs of production process of the product. Results of the research on equipment and comparison of equipment specifications will be reported. The most beneficial set of equipment will be chosen and the reasoning behind the decision will finalize that part.

The production process study also includes full description of manufacturing operations and techniques applied to newly developed design in each step of punching bag manufacturing. It is worth to mention that the production process is intended to be made manually i.e. with no automated operations, thus the description will be made basing on that assumption. The quality control of the production process will be designed as well to ensure that the crucial goal of launching the product on the market is achievable.

The economic analysis will provide the information about the market of heavy punching bags in the Finland. The discussion about the proper business entity for the heavy bag production is included into the analysis chapter. The analysis will also define the product advantages that the business has to focus on as it is important to determine the competitiveness level of the product to launch it properly.

## **2 PRODUCT DESIGN**

Punching bag is specially designed sport equipment for the purpose of martial arts, boxing or aerobic trainings (Franco 2012). The design of a punching bag allows it to withstand continuous and powerful series of hits and blows from the person who is doing exercise while keeping his or her hands and feet pretty much safe. However it is strongly recommended to use special wraps to protect the skin during trainings (Silverman 2011).

The main purpose of using a punching bag in trainings is to develop power of the strikes, however it also can be used to improve kicking, free strikes and other martial arts and self-defense techniques (Franco 2012). Types of design of a punching bag vary to satisfy requirements and needs of different exercises and training styles (Silverman 2011).

### **The heavy bag**

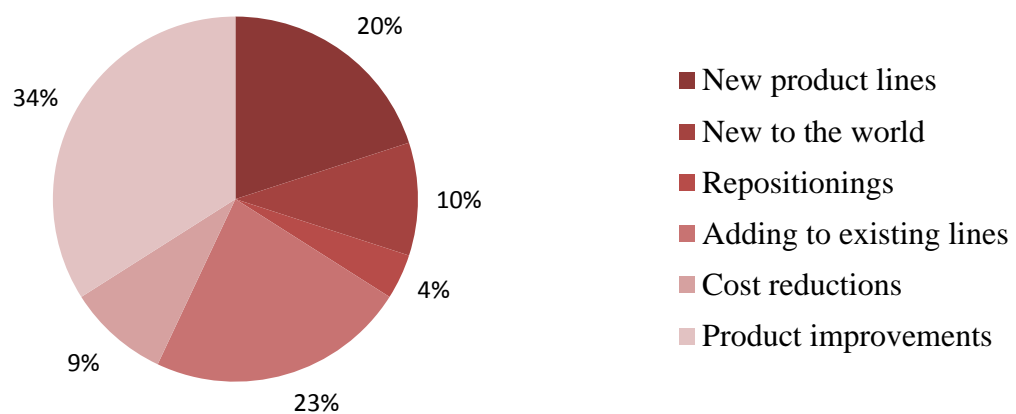
Heavy bag is the most common type of a punching bag that has cylindrical shape. Weight of the heavy bag usually varies from 15 kg to 60 kg and basically it is set according to the dimensions of the bag. Height of a heavy bag is between 60 cm and 140 cm. The heavy bag is made of heavy textile materials such as leather, vinyl or canvas that cover middle layer of foam jacket or other kind of material that helps to soften the effect of powerful strikes on the limbs. Heavy bags usually are filled with cloth material, sawdust and sand. It has to be hanged on chains connected to the ceiling or to the metal construction on the wall. (Silverman 2011)

Heavy bags are used to train strike power. They are also used to strengthen fists and legs of a person to make them used to intensive and powerful strikes (Silverman 2011). Because of this purposes heavy bags must be very durable while seams have to be of the best quality. The design of an implement has to be done in the way that it is balanced and swings as less as possible during trainings (Franco 2012).

## 2.1 New product development

New product development is a complicated process that is normally run by companies or R&D of universities. This process is resource-demanding and requires a treatment of marketing, engineering and financial specialists (Trott 2005). Before moving to the new product development process it is necessary to review what is “new product” and what does it mean in modern business environment.

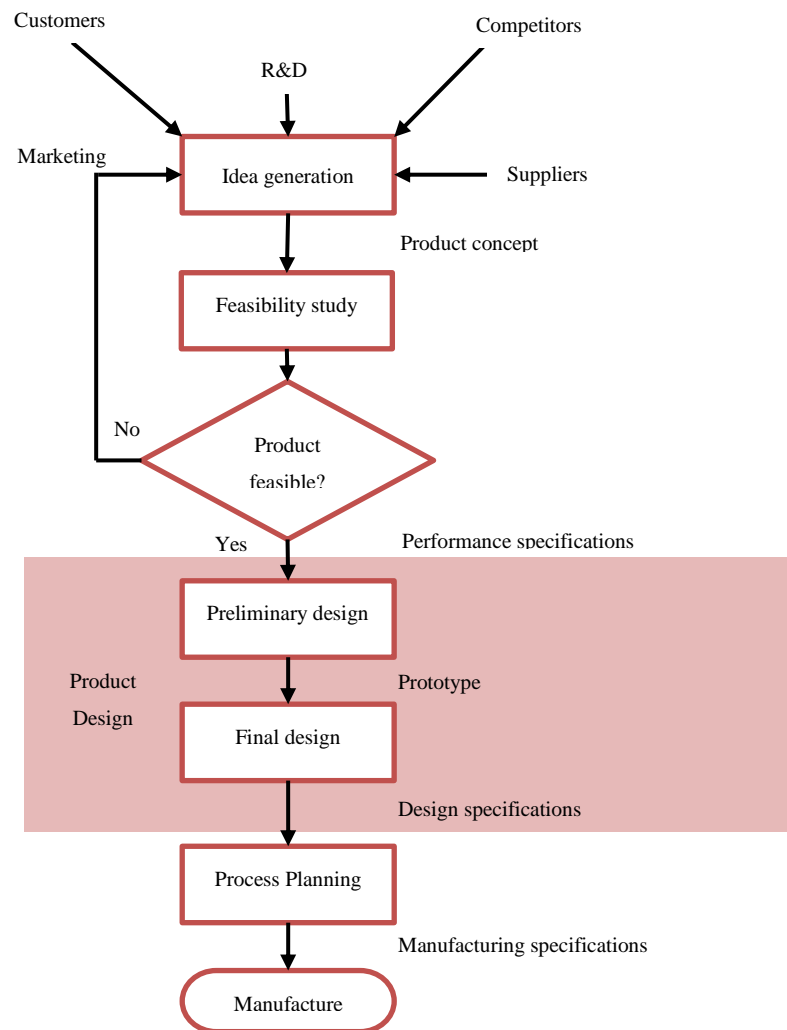
When one refer to a new product meaning it is the most common consideration that a new product is a result of new technology implementation. However new technology is just one of many triggers that could start the process. As it is seen on the graph 1 there are six groups of new products that companies develop for the market. Obviously repositioning and widening the product lines are not caused by new technologies, at the same time they are the matter of marketing problem solving in most cases. Even a minor change of the existing product turns it to a new product as long as this change meets the customer needs. After all meeting the customer needs and satisfying the demand are more important for a business than scientific or technological value of the product. (Trott 2005, 293 – 294)



GRAPH 1. The average new product portfolio (adapted from Trott 2005, 396)

The graph 1 shows that the biggest part of new products entering the market belongs to the improved products. That means companies tend to put their existing products into improvement process. In other words companies run new product development process to substitute their old products to satisfy customers’ needs. In that case the cost of the process might be relatively lower comparing to other new product groups, i.e. new product lines meaning that the product is totally new to the company.

Although customer needs are very important in the new product development, the process itself can be triggered by other sources beside customers. The graph 2 represents flow of the new product development process where the product concept is worked out after a request or initiative of various key sources. All those triggers open a possibility to generate an idea of a new product that can satisfy requirements set by the source and if the product concept seems to be feasible – the product design and manufacturing process are worked out.



GRAPH 2. The Sequential Design Process (Adapted from Russell & Taylor 1995, 212)

This chapter will cover mostly the product design steps: preliminary design and final design of the product with the design specifications as a result. From the viewpoint of technologists whose responsibility is to develop production process of the new product, the most important outcome of product design steps is design specifications including materials specifications. One of the biggest problems of sequential design process (shown



on graph 2) is that there are many of such viewpoints, i.e. customers, marketers, engineers and production workers but it is solved by arranging a design team to work together and to share their views.

## **2.2 Heavy bag design**

The author has fulfilled a preliminary study of the heavy bags market in Finland and the results of the study show that companies offer heavy bags of various sizes filled or unfilled. Heavy bags that are sold to customers being filled are usually stuffed with cloth, wooden sawdust and sand. That kind of filling is the most popular worldwide because of its cheapness and easy accessibility. However wooden sawdust and sand filling has several disadvantages.

Punching bag is a very durable product if it is of high quality and it might be used from several years to a decade. When a heavy bag is filled with wooden sawdust or sand, the material becomes caked as the smaller fractions move to the bottom of the heavy bag if it is in use and hanging vertically or to the side of the heavy bag if it is stored horizontally. In that case the solution is to flip the heavy bag upside down that hardly will help to restore original performance of the filling. Another possibility is to work out the process of filling the punching bag, however it is a complicated and time consuming process. (Demeeres 2011)

### **Product concept**

The main idea of the current study is to develop a design of the heavy punching bag that is filled with a crumb rubber. The design must be simple and scalable. The scalability of the design allows using it as a base design for products with changed specifications. The specifications change may be done in respect to height and weight to work out a product line of several heavy bags different in size and weight.

The outer layer or cover of the heavy bag is made of vinyl or artificial leather. The cover material should be durable to withstand the force of strikes. To soften strikes impact and to make trainings more comfortable polyurethane foam or similar material is placed under the

cover. Seams of the heavy bag are sewed with durable threads using sewing technology that insures joints to be strong and lasting.

The heavy bag should be filled with a high quality crumb rubber that is free of metal pieces and fabric fluff. The fractions size of crumb rubber is about 2-5 mm. The crumb rubber filling has superior quality as a filling for the heavy punching bag comparing to sawdust. The crumb rubber is less affected by caking process thus the performance of the filling remains unchanged much longer. Another advantage of the product is the durability which is ensured by the reliability of the double seams that are made by thick thread. It is important to notice that all of the materials that are used in the heavy bag are coming from Finnish suppliers and the product itself is being made in Finland that gives it the value of true Finnish product.

## **2.3 Final design of the product**

That part of the thesis report represents the results of the new product development and contains information and specifications of the developed heavy punching bag.

### **2.3.1 Functional design**

The goal of the heavy punching bag is to provide a training surface that is comfortable and safe for the user. Before the first training session the product has to be mounted to the ceiling by chains that are hitched to four fastener rings. The product doesn't need to be taken off after each training session and can be left in mounted state. The design of the fasteners allows them to hold the product's weight during intensive trainings and to keep the heavy bag balanced.

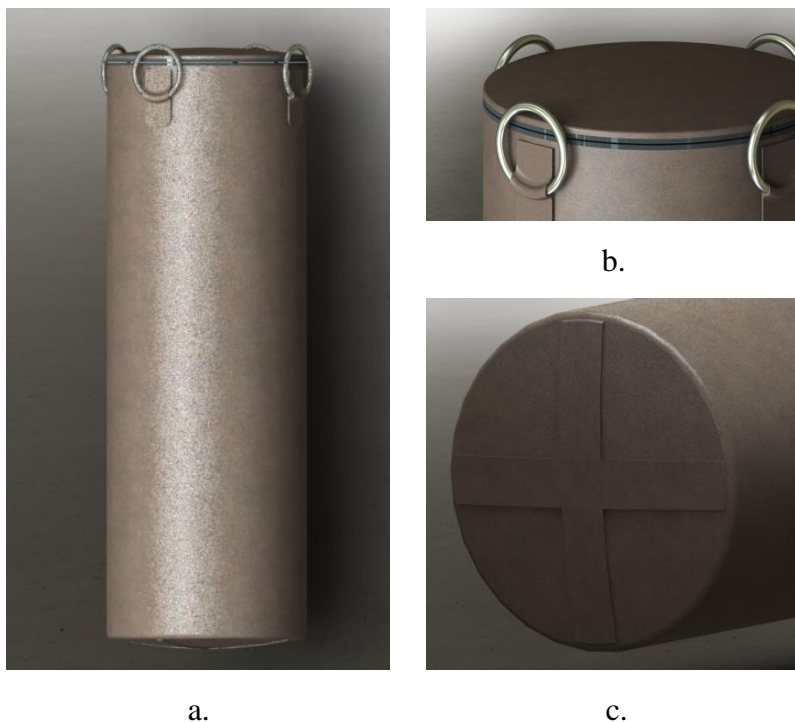
If the heavy bag is mounted, the user can proceed to the training. The design of the product and its purpose doesn't specify the training style. The user can build his or her training with different combinations of strikes and kicks varying in applied force. The surface of the product has soft but elastic design that allows the users to feel the impact and its force.

Although softness of the surface reduces the chance of getting limb injuries, the user has to wear at least hand wraps during his or her trainings.

### 2.3.2 Form design

The heavy bag form design has rather classic appearance of a punching bag. The general view of the product was created by the author with Solidworks and can be seen on the graph 3. The height of the product is about one meter and the diameter is 0,35 meter. The cover surface of the heavy bag is made of artificial leather and has black or brown texture color. The zipper on the heavy bag cover has black color. The heavy bag has one most visible seam on its side made with black thick thread.

The bottom of the product has prominent surface that is showed on the graph 3c. Two fastening strips are sewed to the bottom and cover of the heavy bag and intersect each other forming a cross. The top of the heavy bag is zipped to the heavy bag. There are also four fastener rings sewed with patches to the heavy bag showed on the graph 3b. The rings are polished and have natural color of steel.



GRAPH 3. The heavy bag form design (a. General view, b. Top, c. Bottom)

### 2.3.3 Production design

Production design determines product specifications for manufacturing purposes (Trott 2005, 222). The idea of the production design is that all of the product's dimensions and parameters are defined and can't be changed during the production process. However during the development of the heavy bag a problem was faced that interferes with that idea.

The cause of the problem is the uncertainty in bulk density of the supplied crumb rubber. The author of the actual work has studied technical specifications of crumb rubber produced by different manufacturers and each of them has close but varying bulk density and some of them even don't specify it. It worth to say, the parameter is crucial for the manufacturing process of the heavy bag. If the product has been assembled and filled with crumb rubber, it may appear that the weight of the heavy bag doesn't match the value in design. Table 1 shows how the bulk density affects the weight of the heavy bag. In that case the product has height of 1 meter and diameter of 35 centimeters by the design. Moreover the designed weight of the heavy bag is 30 kilograms. As it is seen on the table 1, specifications set by the design can be realized only if the bulk density of the filling equals to  $400 \text{ kg/m}^2$  or about it.

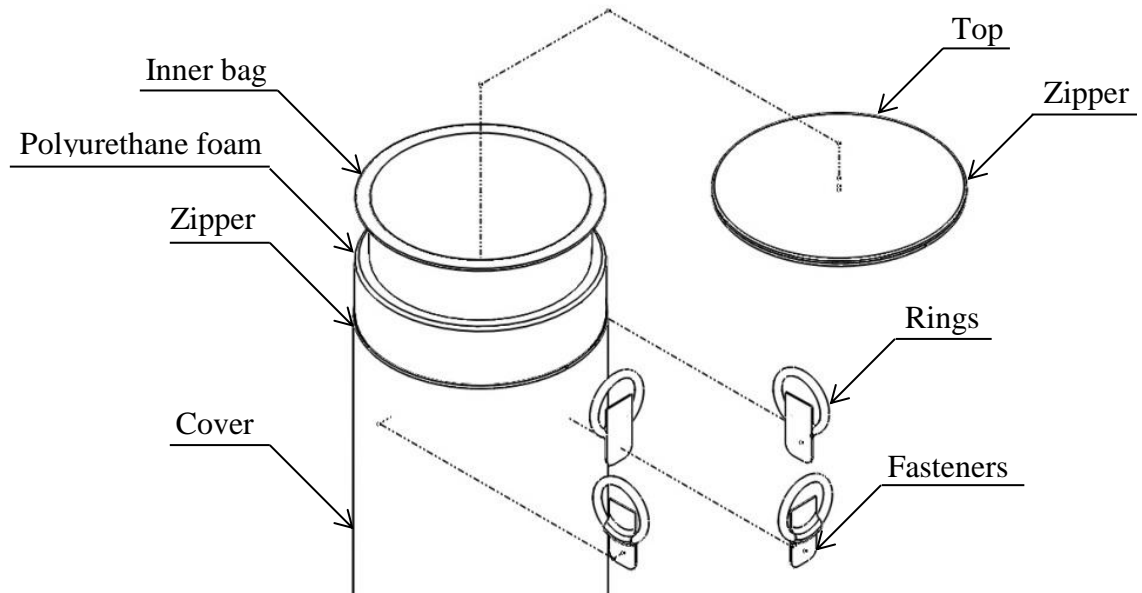
TABLE 1. Relation between bulk density and weight of the heavy bag filling

$p_b, \text{kg/m}^2$	400	410	420	430	440	450	460	470	480	490	500
Weight, kg	29,0	29,7	30,5	31,2	31,9	32,7	33,4	34,1	34,8	35,6	36,3

The problem described above can be handled during the development process when building a prototype of the heavy bag. When filling the prototype it can be seen whether the dimensions of the heavy bag fit the bulk density of the crumb rubber or not. If the prototype is heavier than designed, the diameter has to be increased, otherwise it should be decreased.

The heavy bag is an assembly of components that are mainly sewed together. These components can be seen on the graph 4. It shows nine parts of the product, however there are two more components missing on the graph. These two components are: the bottom that is sewed to the cover at the beginning of the assembling and the filling of the heavy

bag that is filled at the last step of the assembling. The drawing of the product that shows the general look and the heavy bag dimensions was designed as well to clarify the product design (see APPENDIX 1).



GRAPH 4. Components of the heavy bag

### **Product assembly**

The assembling process steps are represented on the graph 5. The assembling process starts with the sewing the fasteners with the steel rings to the cover of the heavy bag. The cover, top and bottom of the heavy bag are made of artificial leather. They are cut from the leather roll in the very beginning of the manufacturing process. The bottom is strengthened by the leather strips and sewed to the cover. The diameter of the bottom and the top leather cuts is 35 centimeters. The stripes are 5 centimeters wide. Heavy bag cover is 1 meter high. Zippers are sewed to the cover and to the top of the heavy bag.

The polyurethane (PU) foam is placed between the cover of the heavy bag and its filling to soften the strikes during trainings. The thickness of the layer is 20 millimeters. It becomes sealed inside the heavy bag when the inner bag is set and sewed to the cover.

The inner bag is made of polypropylene (PP) material which has such beneficial properties as being durable, dense and inexpensive. The inner bag is design to hold the filling of the

heavy bag and keep it from going between cover and PU foam. Sewing the inner bag to the cover of the heavy bag is the last step of assembling before the filling it with crumb rubber. After the last stage the product is ready to be filled with crumb rubber.



GRAPH 5. The product assembling steps

As it can be seen on the graph 5 the assembling process includes six steps. At the first step leather fasteners with rings are sewed to the rectangular leather cut. The zipper is sewed to the leather cut as well. The bottom is strengthened by the leather stripes also during the first step.

The second step requires the sides of the leather cut to be sewed to each other. By performing that operation the leather cut becomes a cylinder – the cover that looks more like the heavy bag. The strengthened bottom is sewed to the cover. Great attention should be paid to the quality of the seams as they are the main seams of the product and they will be exposed to the full tension of the product's weight.

During the third step the PU foam is inserted into the heavy bag. It is good to check if the PU foam layer is set tightly to the cover to prevent any bends of the PU foam. After the softening layer has been set, the fourth step of assembling is performed. During that step the inner PP bag is inserted into the product and sewed to the cover. The seams of the inner bag are located closely to the zipper seams.

At the fifth step the zipper is sewed to the round cut of the leather thus forming the top of the heavy bag. At the next the heavy bag is filled with crumb rubber and the top is zipped

to it. The process of filling should be done accurately as such components of the heavy bag as inner bag or PU foam can bend during the process that can cause the deformation of the form or weight of the product.

#### 2.4 Required raw materials, their accessibility and cost

The product components that have been described in the previous section require raw materials or components produced by third party. Depending on the production capacity or business strategy it might be wiser to order a production of some of the required components from specialized companies. By what means the components will be available for the production process is reasoned in the next chapter.

Before planning the production process of the heavy bag markets of raw materials have been studied for every component of the product. The results of the study are shown in the table 2 that lists all of the raw materials required for the heavy bag production. Most of the suppliers are Finnish online stores. However the details about the crumb rubber have been inquired from the Finnish company Nowaste Ltd. that is located in Tampere, Finland.

TABLE 2. Required raw materials and their prices (including VAT)

#	Supplier	Brand	Material	Component	Description	Price, €
1	Sisustusmuovikum	Polux	Artificial leather	cover; bottom; top; fasteners	Comes in rolls (1,45m wide).	18,9 per meter
2	Recticel Oy		Polyurethane foam	softening sublayer	Comes in rolls (1m wide)	4,7 per meter
3	Slojd-detaljer	Gütermann	Thread	seams		4,2 per 500m
4	Nowaste Oy		Crumb rubber	filling		327 per ton
5	K-Rauta		Tarpaulin	inner bag	3m wide and 5m long	5,9 per item

Knowing the product and materials specifications such as dimensions of each component and bulk density and weight of the filling it is possible to calculate the amount of materials that has to be used to produce single heavy bag. The materials cost per one item may be determined based on that values. These values and costs are shown in the table 3 that represents the total cost of materials spent on a single product.

TABLE 3. Amount of material use and cost for production of single heavy bag

Material name	Material amount	Cost
Artificial leather	1.48 m <sup>2</sup>	28,04 €
Polyurethane foam	1.10 m <sup>2</sup>	5,17 €
Tarpaulin	1.27 m <sup>2</sup>	0,49 €
Crumb rubber	29.02 kg	9,49 €
Total:		43,55 €

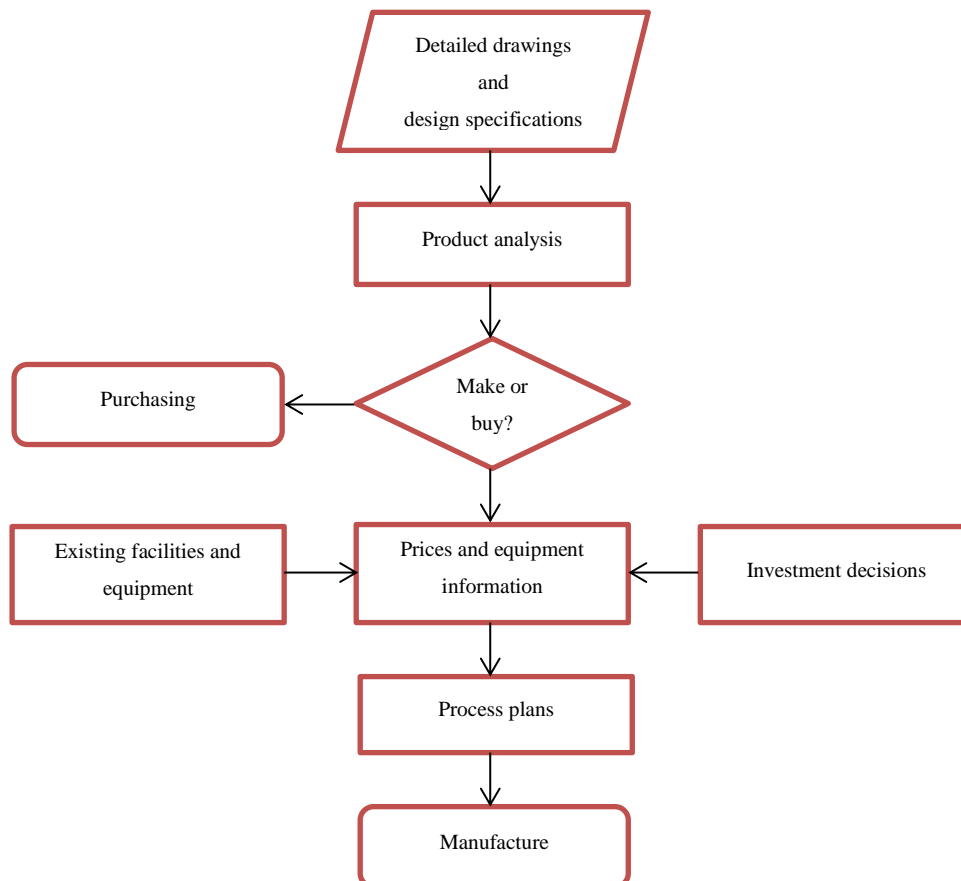
Thus product specifications and requirements for the production process have been defined. The production design of the heavy bag is crucial for the next stage of the thesis report that will cover the production process development. However it is worth to mention the problem that affected the product development stage.

The first and the main problem that made the development process more complicated was related to materials acquisition. The waiting time for the materials inquiries replies was longer than the actual development activities in most cases. Moreover some of the inquiries have not been replied at all. That fact made the development process longer as the lack of information brings the delays into the process.



### 3 PRODUCTION PROCESS

The final design of the product has been created and outputs the product design discussed in the previous chapter. Drawings and design specifications that have been worked out earlier contain all necessary information that is required to plan a production process of the heavy bags. As it can be seen on the graph 6 these documents are required to start the process planning. However before stepping into process planning and taking any decisions it is necessary to analyze the product specifications to communicate how the product is to be made (Russell & Taylor 1995, 277). The documents that are worked out during the analysis help to draw up in what way the product will be assembled and what tools and equipment should be used.



GRAPH 6. Process planning (Adapted from Russell & Taylor 1995, 278)

### **3.1 Process planning**

The first and most important decisions that should be made during the process planning are concerned purchasing product parts or even the whole product that will be manufactured by other company (Russell & Taylor 1995, 283). As one of the aims of the thesis is to develop the product and its production process the decision at that step will be made only about the possibility to use outsourcing of manufacturing. The reason of talking about the outsourcing is it could be beneficial for the quality of the product in the matter of manufacturing process as outsourcing manufacturers that specialize on the industrial sewing might have higher experience and products quality than it will be available at the launch of the independent production.

#### **3.1.1 Process selection**

Process planning should not be considered as a complicated activity that builds up the whole production process from the ground up. Choosing the process and process planning itself have to be distinguished from each other. Process planning or engineering design of the process is directly related to the planning of production operations, meaning that process planning is all about tactical solutions for production process. From the other hand choosing the process is a matter of strategic solutions that determine the production technologies to be used. (Aquilano, Chase & Jacobs 1998, 118)

Richard Chase, Nicholas Aquilano and Robert Jacobs define following process basic categories.

#### **Conversion processes**

That process type is used to change the properties of materials. An example of such process is processing of iron ore into rolled steel. (Aquilano, Chase & Jacobs 1998, 118)

#### **Fabrication processes**

That process type is applied to change the shape of materials according to product design i.e. machining metal sheet to produce parts for a wing of a plane. (Aquilano, Chase & Jacobs 1998, 118)

### **Assembly processes**

That process type is used when several components of the final product have to be combined, i.e. attaching doors to a car or packing tube of toothpaste into a box. (Aquilano, Chase & Jacobs 1998, 118)

The overview of the process categories helps to decide what process category will be used in the production of the heavy bag. However it doesn't have to be just one category of process and the production process can consist of several different process categories. Just as in the production of the heavy bag two categories of process are required.

To produce the heavy bag such materials like leather, PU foam and tarpaulin have to be processed according to product specifications. Later on all of the product components should be assembled into the final product. Thus during the production process of the heavy bag fabrication and assembly processes will be used.

### **3.1.2 Process flow structure**

According to Richard Chase, Nicholas Aquilano and Robert Jacobs process flow structure defines the type of material flow at the production site using one or more process categories that were described before. Usually the following process flow types are used at the production.

#### **Job shop**

The job shop production delivers wide range of products in small batches. That process flow type often requires various sets and order of the production operations. Job shop process flow is commonly used at the print shops or companies that produce custom design furniture. (Aquilano, Chase & Jacobs 1998, 119)

#### **Batch**

A production that uses batch process flow delivers its products following recurrent orders that come from customers or from a warehouse of the company. Such process flow is usually selected if the company has more or less stable product range and each of the

products is periodically produced in batches. The most part of the company's products requires same manufacturing scheme to produce. (Russell & Taylor 1995, 285)

### **Assembly line**

The assembly line produces specific separate parts that are automatically being moved between operations. The material movement is performed in the way that it has controllable speed and order to satisfy the productivity. However an assembly line that includes other processes is called flow line. (Aquilano, Chase & Jacobs 1998, 119)

### **Continuous flow**

A continuous flow production is organized in the same way as an assembly line production and its processes are running in specific order, but the difference between these two process types is that the continuous flow is nonstop. Continuous flow productions are commonly highly automated to evade costly production interactions. (Russell & Taylor 1995, 287)

The aim of the thesis is to develop the production process that would fit current economic environment of the sport equipment market in Finland. Another important parameter that affects the choice of the process flow is the initial expenditures for launching the production. During the development process of the heavy bag and its production process development the expenditures and especially investments have to be as low as possible. Based on these circumstances the actual choice has to be made in a favor of the process flow that will satisfy the process requirements of the product and producer's aims for the future development.

The product scalability is one of the requirements that were set before the going into the product development process. The heavy bag design that was created and described in the chapter 1 satisfies that requirement as such specifications of the product as weight, diameter and height can be changed avoiding the need to change the production process. This fact allows assuming that the current product can serve as a base for future development of product line of heavy bags that will satisfy different customers' needs.

The production process of heavy bags will deliver standardized product range supplying periodic customers' orders that come from new customers or regular customers in batches.

These requirements for the process flow can be satisfied with the batch production process flow.

### **3.1.3 Product flow design**

Product flow design is intended for development and definition of operations, their sequence and requirements in the production process. Raw materials, work-in-process materials and assembly units are passing through these operations as they are being manufactured. There are several common tools used to describe operations order and flow direction that are: operation process charts, process flowcharts, assembly charts and drawings. The first step of the product flow design is creation of flow and operations schemes using one or more tools mentioned above. (Aquilano, Chase & Jacobs 1998, 124)

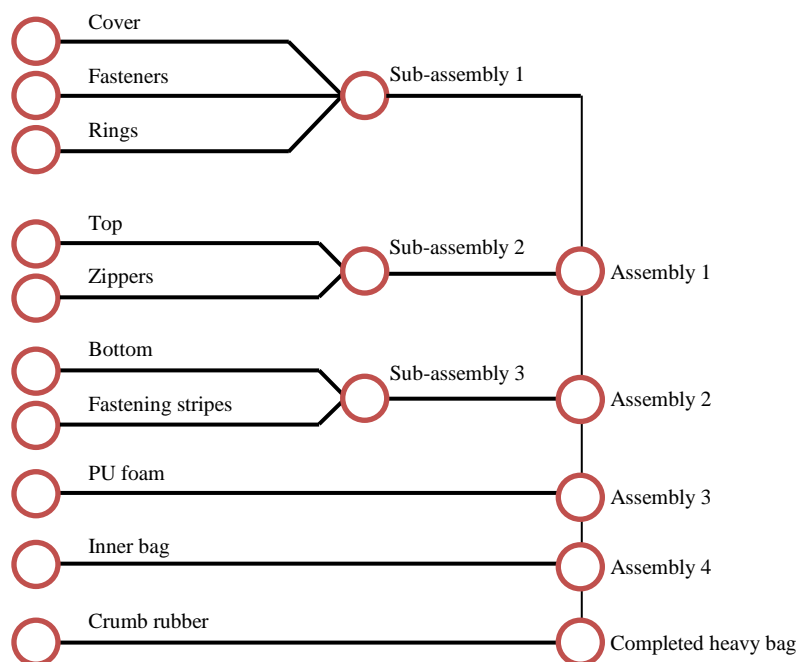
To create product flow design it is required to define the design tools and what they are used for. The assembly diagram is a detailed drawing of all product parts which are placed separately in the diagram (Aquilano, Chase & Jacobs 1998, 124). Assembly chart is a schematic diagram that is used to reveal the relationships of each part and subassembly to their parent assemblies as well as the assembly sequence (Russell & Taylor 1995, 278). The operation process chart describes the flow routes of the parts and components along the operations of the production process. It contains information about equipment, tools and operations that are required to manufacture particular part (Aquilano, Chase & Jacobs 1998, 124).

Process flowcharts are used to show the broader overview on the production process. Several standard symbols are used to designate such processes as operations, inspections, transportation, delay and storage. Moreover the process flowchart can be used to analyze the efficiency of the product flow as it includes both productive (operations) and nonproductive activities (delay, inspection). Thought-out design of the process flowchart allows reducing delays and storage time that improves product flow organization and makes it balanced. (Russell & Taylor 1995, 278; Aquilano, Chase & Jacobs 1998, 125)

### 3.2 The heavy bag production process

Previously in the process selection conclusions it was found out that the production process of the heavy bag has to have batch process flow structure. It was also defined that two categories of processes should be used in the production. These processes are fabrication and assembly processes. After the selection of the process flow structure it is possible to start designing the actual production process of the heavy punching bag.

The result of the analyzing of the product design, its materials and processes that are required to produce the heavy bag provides the information for the further development of the production process. Graph 7 represents the assembly chart of the product providing the connections between product parts and assembly operations. The product parts are assembled in such sequence that will make the sub-assemblies to be ready for the next assembly step.



GRAPH 7. Assembly chart for the heavy bag (Adapted from Russell & Taylor 1995, 280)

The operation process chart that is shown in the table 4 defines each operation during the production process of the heavy bag. The chart describes the operations and provides information about the equipment and tools that are used in each operation. As it can be seen from the operation process chart the heavy bag production requires 13 operations to

be performed starting from the raw material processing and ending up with filling the final assembly with a crumb rubber.

TABLE 4. The operation process chart of the heavy bag production (Adapted from Russell & Taylor 1995, 282)

№	Description	Machine	Dept.	Time	Tools
10	Drawing cover, top, bottom and fasteners patterns on the leather			20	Templates, chalk
15	Cutting out the cover, top, bottom and fasteners work pieces from the leather by the pattern			45	Snap-off unity knife
20	Sewing on the leather fasteners with rings to the cover	Sewing machine		20	Gütermann thread
30	Sewing the cover to form a cylinder	Sewing machine		10	Gütermann thread
40	Sewing on the fastening stripes to the bottom	Sewing machine		10	Gütermann thread
45	Sewing on the bottom to the cover	Sewing machine		30	Gütermann thread
50	Sewing on the zippers to the top and to the cover	Sewing machine		60	Gütermann thread
60	Cutting the PU foam layer from the PU foam roll with appropriate length			5	Snap-off unity knife, ruler
65	Inserting the PU foam into the cover assembly			10	
70	Drawing inner bag pattern on the tarpaulin			10	Template, chalk
75	Cutting out the inner bag work piece from the tarpaulin			15	Snap-off unity knife
80	Sewing the inner bag from the work piece	Sewing machine		15	Gütermann thread
90	Inserting and sewing on the inner bag to the cover	Sewing machine		20	Gütermann thread
100	Filling the heavy bag assembly with the crumb rubber			90	Electronic weights

Considering the fact that the heavy bag production is launched by a small company or private entrepreneur (that case will be discussed more precisely in the chapter 4) the production capacity can be relatively low as well as the area of the production site. Thus it is easy to design the process flowcharts for the product parts. As an example of the process

flowchart for the heavy bag production process the one was designed for the cover of the heavy bag (see APPENDIX 2). This particular process flowchart shows that the work-in-progress materials are supposed to be stored at the production site before or after fabrication or assembly processes. Such solution for keeping the stock of the work-in-progress material can be allowed for as long as the production is considered to deliver low quantities of the product. In case of higher sales or larger order quantities the process has to be improved and work-in-progress material stocks have to be relocated.

It is also important to supply the manufacturing stage with the product and parts with drawings that show the specifications and sequence of the product and its parts manufacturing. As the cover of the heavy bag appears to be the most complicated and time-taking part to manufacture, it is wise to consider it as the best example to use for such drawings. The operation that has number 10 in the operation process flowchart requires the pattern to draw the template on the leather work piece. Thus the pattern for the cutting out operation was designed (see APPENDIX 3).

During the designing process of that pattern it was important to consider the dimensions of the leather work piece. The layout of the parts was planned in the most efficient way to lower the amount of scrap from the cutting operation. The dimensions of the drawn parts differ from the dimensions of the product because according to sewing technology the pattern have to be created with seams allowances of 20 mm (Gardiner 2007).

The production equipment and tools that are required for the manufacturing operations should satisfy the material properties. It is relatively easy to acquire such manufacturing tools as snap-of unity knife, chalk or marker for the leather patterns processing. Cutting operations also require a work table which surface dimension allows comfortable processing of wide and long work pieces. However it is more difficult to select the right sewing machine. The leather processing operations need industrial sewing machine that is designed to sew leather material.



## **4 ECONOMICAL ANALYSIS**

In the previous chapters the product and the production process have been developed. However the development process relies on the preliminary market studies and such important matters as product advantages and competitiveness have not been defined fully. This chapter will mainly be focused on these matters as well as discussion about choosing a small business enterprise as an owner of the heavy bag production. It is worth to mention that the current work has been done to assist the author in the matter of product and process definition for the goal of launching a real life production. That fact greatly affects the discussion about the enterprise size that the production has been developed for.

### **3.1 Enterprise size**

According to definition that was suggested by Sara Carter and Dylan Jones-Evans, within the economic approach, small enterprises are those enterprises that fall under the following criteria: independent; managed in a personalized manner; relatively small share of the market. The actual production process has been developed for an enterprise that certainly would have such profile.

The independence of the small enterprise means that it doesn't belong to a larger enterprise (Carter S. & Jones-Evans D. 2006, 8). As the goal of the author is to launch a start-up business, this criteria is fully applicable to the current case. The business will be set up as an independent company or private entrepreneurship and will not belong to any larger enterprises.

Private entrepreneurship or a small company does not require complicated management structure as the amount of activities and the number of personnel are relatively low comparing to medium or large enterprises. Thus such company also satisfies the second criterion of management structure. Personalized manner management refers to the simple management structure (Carter S. & Jones-Evans D. 2006, 8).

By the third criterion the small business will be price “taker” rather than price “maker” (Carter S. & Jones-Evans D. 2006, 8). Such statement is true for the start-up business as its product will have to compete within the market with the companies that present on the market. Moreover that fact already had been considered at the stage of product development to balance the quality and the production cost of the heavy bag.

### **3.2 Product competitiveness**

The product competitiveness is crucial for the small enterprises as such enterprises face high level of uncertainty on their market because of the limited number of customers, independence and their personalized nature (Carter S. & Jones-Evans D. 2006, 8). This it is important to define the product’s advantages to determine the competitiveness of the product that will be launched.

The first advantage of the product is its price margin. The actual cost of materials is about 43 – 50 euros and the market prices for the product of the same materials quality (however these products have different filling) are in average 150-200 euro. That fact allows for assuming the possibility of efficient price policy competence on the market. Such possibility is beneficial at the stage of market entry.

The second advantage of the product is the crumb rubber filling that has been already discussed earlier in the product development chapter. Additionally it is important that the crumb rubber is a product of recycling process. Due to the growing appreciation from the government and customers for the materials recycling, crumb rubber adds a good competence level for the product. Although the crumb rubber is produced out of car tires, the material safety is ensured by the study work of United States Environmental Protection Agency (United States Environmental Protection Agency 2009).

## 5 CONCLUSIONS

The accomplished study was aimed to implement the theoretical framework of the product and process development activities into the practical development process of the heavy bag design and its production process. In real life situations such activities require rather high amount of labor resources as well as thorough treatment of wide range of such matters as marketing, financing and engineering. Due to that fact the study was limited to fit the actual interest of the author to develop the product design and the production process of that product that could be implemented into business start-up.

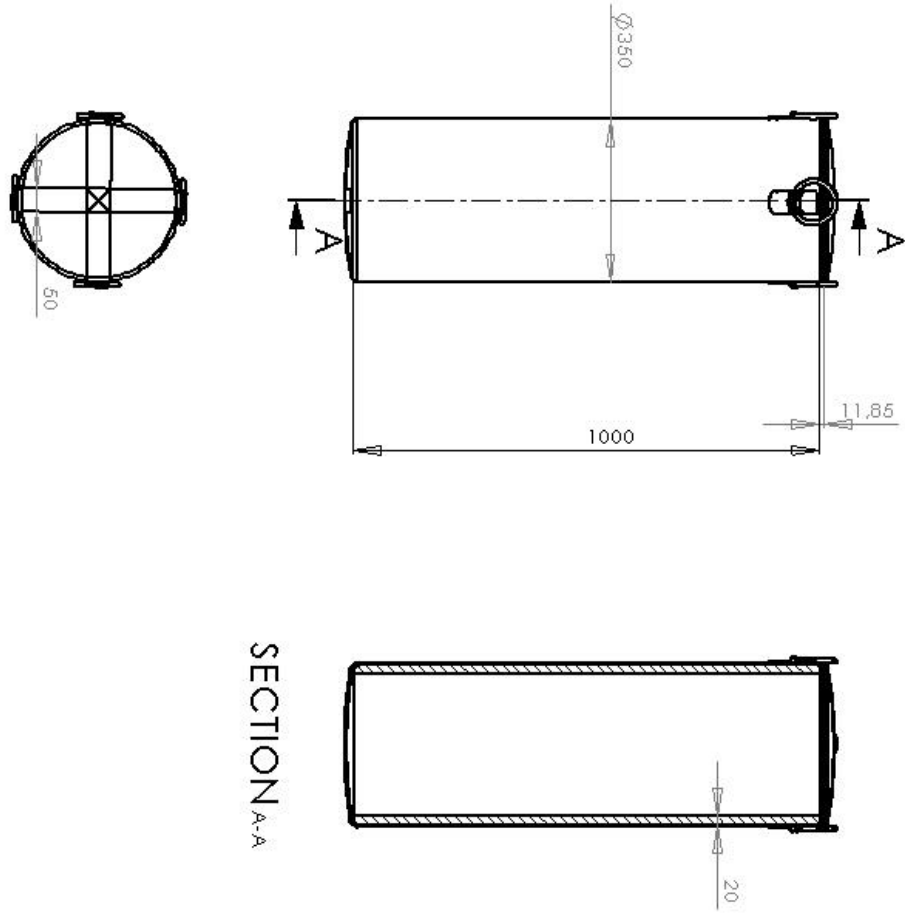
The result of the product development process is a set of technical documentation and structured product description supported by the reasoning about the materials selection. The development activities helped the author to approach the product design of the heavy bag in a systematic way that has resulted in the detailed overview of the product concept, functional design and production design. The form design that was created with computer aided design software Solidworks served as a base for production design of the product.

Production process development activities comprise a comprehensive look at the production operations and processes that are required to manufacture the product. The designed technical documentation helps to identify each operation in the production process and the production process in whole. The information that is brought by that documentation can be used later on during the production layout and jobs design processes. However these processes will be launched at the time when there will be detailed information concerning financing and production placement.

Moreover, the result of the limited economic analysis showed the most proper business entity solution that satisfies the production requirements and capacity. The product advantages were also clearly described in that section to define the competence of the designed product and to show it as a product of potential entrant for the existing market of heavy bags.

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Process flowchart of the cover processing (Adapted from Russell & Taylor 1995, 283)

Step	Operation type	Description of process	Time	Dist.
1	● → □ D ▽	Unload leather rolls	30	
2	○ → □ D ▽	Move to storage		
3	○ → □ D ▽	Wait until needed		
4	○ → □ D ▽	Move to cutting table		
5	● → □ D ▽	Draw the pattern	10	
6	● → □ D ▽	Cut the work piece	20	
7	○ → □ D ▽	Wait until needed		
8	○ → □ D ▽	Move to the sewing machine		
9	● → □ D ▽	Sew the work piece to form a cylinder	30	
10	○ → □ D ▽	Wait until needed		
11	● → □ D ▽	Sewing on the bottom to the cover	20	
12	● → □ D ▽	Sewing on the zippers to the top and to the cover	30	
13	○ → □ D ▽	Wait until needed		
14	● → □ D ▽	Inserting the PU foam into the cover assembly	10	
15	● → □ D ▽	Inserting and sewing on the inner bag to the cover	30	
16	○ → □ D ▽	Moving to the inspection place		
17	○ → □ D ▽	Quality check of seams	15	
18	○ → □ D ▽	Moving to the filling place		
19	● → □ D ▽	Filling the heavy bag assembly with the crumb rubber	60	
20	○ → □ D ▽	Moving to the inspection place		
21	○ → □ D ▽	Quality check, weight	20	
22	○ → □ D ▽	Moving to storage place		

