Practical assignment, Digger

TU-22.1115 Design of Production Systems B

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Executive summary

Our product is a small, plastic children's toy consisting of three subassemblies and 12 different components. All plastic parts will be manufactured by injection molding in the production plant. The shafts and the tracks are bought from a supplier. The plastic parts are molded and quality checked. All parts are assembled and the final products are packaged for shipping.

The production requires an injection molding machine with tools, 150 m^2 factory space and regular factory supplies. Our production process is a combination of repetitive and batch type. The layout is a combination of a product and a process layout. The estimated lead time for our product is 18 days. In our current model we produce products at a constant rate with a make-to-stock strategy.

Our inventories are located in Poland and the maintenance of the inventories is outsourced. Our factory is also located in Poland, where the cost-level is the lowest of our alternatives Finland, Poland and Russia. Poland is also well located in the geographical center of our market area.

We have estimated that the demand will slowly increase in the following years, due to the nature of the product. With this estimated demand, production is profitable from the start.

The operating profit, illustrated in Table 1 Income statement, is increasing steadily until Y3. The operating profit will be between 71 333 € and 128 941 € for the whole period of Y0-Y5. Table 2 illustrates the balance of the production plant. In Table 3, the cash flow of the production plant is illustrated. The cash flow is negative the first year, due to the investments.

Table 1 Income statement

INCOME STATEMENT							
Estimated Sales		100000	110000	120000	130000	120000	110000
		Y0	Y1	Y2	Y3	Y4	Y5
Net sales	30 %	297 000 €	326 700 €	356 400 €	386 100 €	356 400 €	326 700 €
Cost of raw material		75 915 €	83 145 €	90 375 €	97 605 €	90 375 €	83 145 €
Employee expenses		88 102 €	88 807 €	89 517 €	90 234 €	90 955 €	91 683 €
Maintenance costs	4 %	4 400 €	4 400 €	4 400 €	4 400 €	4 400 €	4 400 €
Other costs		35 250 €	37 755 €	40 311 €	42 921 €	42 616 €	42 371 €
EBITDA		93 333 €	112 593 €	131 797 €	150 941 €	128 053 €	105 101 €
Depreciations	20 %	22 000 €	22 000 €	22 000 €	22 000 €	22 000 €	22 000 €
EBIT		71 333 €	90 593 €	109 797 €	128 941 €	106 053 €	83 101 €

Table 2 Balance sheet

BALACE SHEET			Y0	Y1	Y2	Y3	Y4	Y5
Fixed assets			110 000 €	88 000 €	70 400 €	56 320 €	95 056 €	76 045 €
Inventories	90	DOS	74 250 €	74 250 €	74 250 €	74 250 €	74 250 €	74 250 €
Accounts receivable	60	DOS	49 500 €	49 500 €	49 500 €	49 500 €	49 500 €	49 500 €
Other current assets			10 000 €	10 000 €	10 000 €	10 000 €	10 000 €	10 000 €
Cash & equivalents	10 %		29 700 €	32 670 €	35 640 €	38 610 €	35 640 €	32 670 €
TOTAL ASSETS			273 450 €	254 420 €	239 790 €	228 680 €	264 446 €	242 465 €

Table 3 Cash flow statement

CASH FLOW STATEMENT	Y0	Y1	Y2	Y3	Y4	Y5
Operating cash flow	93 333 €	112 593 €	131 797 €	150 941 €	128 053 €	105 101 €
Capex	110 000 €	2 000 €	2 000 €	2 000 €	50 000 €	2 000 €
NET CASH FLOW	-16 667 €	110 593 €	129 797 €	148 941 €	78 053 €	103 101 €

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1 Introduction

The product being manufactured is a traditional type of plastic toy, suitable for young children for outside play. As this product is designed for outside play, such as sandboxes, demand peaks around late spring and early summer are to be expected. On the other hand, as this product is meant for children, a demand peak around Christmas is also highly expected.

This product cannot be seen as a totally new and revolutionizing good, as these types of products have traditionally been used for many years, and similar products from 15 years back, such as plastic trucks, still exist in almost identical form. Due to this, the production system will not be expecting any booming increases in demand, but instead a quite steady demand on an annual level. This means that the production system does not have to be designed for sudden capacity raises, other than due to the different seasons. The production system does not for instance have to be expandable. The capacity will not either decrease very much, even after this particular product stops being new. In other words, equity should not be wasted on making the production system flexible.

Competition wise this product is not by any means unique. Several other manufacturers make similar products in the same price range. As this product is very affordable, even when manufactured in Finland, no significant competitive advantage can be gained for instance Asian competitors. It is even possible that consumers find a European product as superior to products manufactured outside Europe.

2 Analysis and design of the system

2.1 Impact of the product to the system

The product consists mainly of plastic parts that are made of HDPE. The other components are steel shafts and the rubber caterpillar tracks. The different components of the product can be grouped according to the material they are made of and in addition, according to the method they are manufactured by. All of the plastic components are manufactured by injection molding. The shafts are made out of rolled steel bars that are machined to its final shape. The caterpillar tracks are made out of rubber and also molded.

The Bill of material Figure 1 gives a good picture of the different parts as well as the subassemblies in our product. The Digger can be divided into three subassemblies; arm, body and wheelbase. Each of these consists of four components. The arm consists of the bucket, arm 1, arm 2, and arm base. The body consists of the chassis, bumper, cockpit and frame. The wheelbase consists of two shafts, two shaft connectors, four wheels and two rubber tracks.

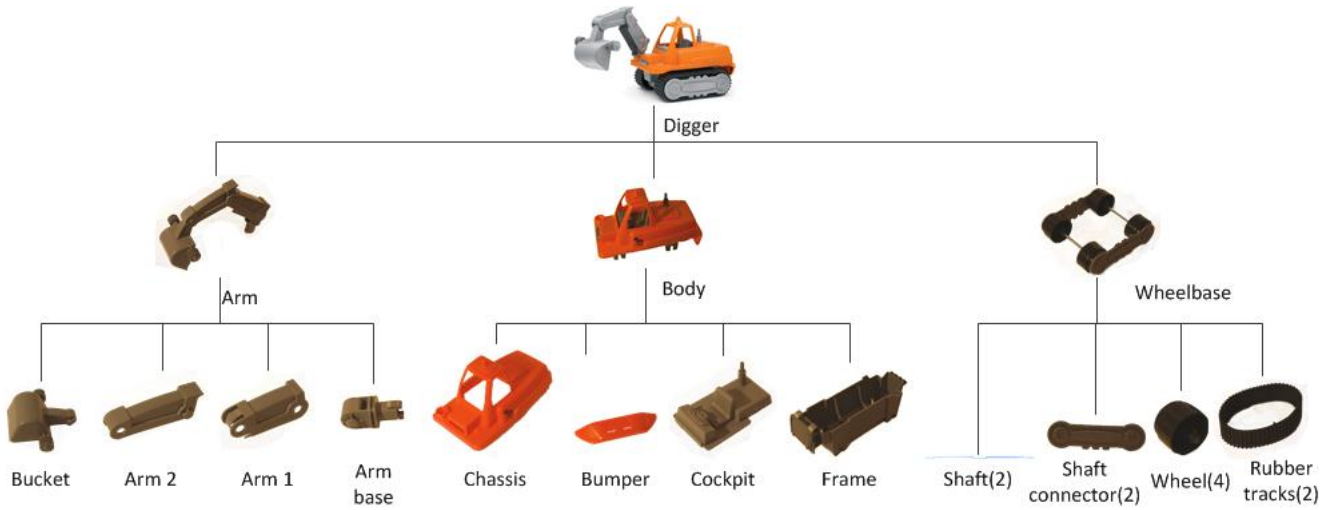

Figure 1 Bill of material

The product is assembled by different fittings, and no screws or tools are needed for the assembly. The assembling can also be done by hand. The wheels are pushed on to the steel shafts that are ringed, and the shafts are then combined with the base of the product. The rest of the connections are plastic to plastic, and are therefore very easy to establish, as plastic is an elastic material.

The different plastic parts can be grouped according to their color. The product consists of components of three different colors, namely grey, orange and black. The reason why the grouping according to colors should be taken into account is that it affects the set up time significantly. The set up time between molds of different color is significantly higher than between components of the same color. This is due to the fact that the injection molding machine has to be cleaned between color changes, to ensure that the colors do not get mixed in the components.[1]

As the majority of the components of the product are made out of HPDE plastic, these should definitely be made in-house. These components are manufactured by injection molding, and the initial investment needed is therefore the molding machine itself and in addition the molds for each part. The ringed shafts made out of rolled steel bars should be bought, since they are standard parts in many similar toys and purchasable in large quantities from manufacturers specialized in manufacturing only similar parts. The savings made from manufacturing them in-house would be quite insignificant, as the machinery needed to manufacture them at a reasonable pace is a large investment and also requires skill about metalwork etc. that is not needed in other parts of the manufacturing process. Similar facts apply for the caterpillar tracks. They are used in several similar items, and can be affordably bought from manufacturers specialized in manufacturing them. By only manufacturing the plastic parts that are made by the same method, our production system can focus on only one core competence, which is resource efficient injection molding.

The time needed for assembling the product was measured with the help of a stop watch time study. The results from this experiment can be seen in Table 1. The total amount of time needed for assembling one product, including boxing, was 66 seconds. This time would probably be a bit shorter with the learning curve, as the workers skills got better. This time estimate leaves room for removal of faulty products, movement of raw material etc.

Table 1 Results of stop watch time study

Assembly	**Time [s]**
Wheelbase	10
Frame	19
Boom	12
Final	10
Boxing	15
TOTAL	**66**

The amount of HDPE needed for one finished product is approximately 300 grams. For this amount of plastic approximately 6 grams of color is needed[1]. The HPDE material costs currently about 1460,00 € per ton, so the cost of HDPE plastic for one product is thereby 0,44 €[2]. The color of the plastic pellets costs approximately 10 € per kilogram, so the cost of the color for one product would be 0,06 €[1]. The shafts can be ordered from a subcontractor for approximately 0,05 €, so the total cost for the shafts is 0,1 € per product[3]. The rubber caterpillar track will also be outsourced, and their approximate cost is 0,01 € per unit. Two caterpillar tracks are needed for one product, so the cost of the caterpillar tracks is thereby 0,02 € per product[4]. Raw material costs can be seen in Table 2. The outsourced warehousing has been approximated to cost 5 % of the price per product. This has been taken into account in other costs. The total costs have then been calculated based on these figures and are presented in section 4.

Table 2 Cost of raw materials

Raw materials			105000	115000	125000	135000	125000	115000
HDPE	1 460 €	per ton	45 990 €	50 370 €	54 750 €	59 130 €	54 750 €	50 370 €
Color	10 €	per kg	6 300 €	6 900 €	7 500 €	8 100 €	7 500 €	6 900 €
Rubber	0,01 €	per pcs	2 100 €	2 300 €	2 500 €	2 700 €	2 500 €	2 300 €
Shafts	0,05 €	per pcs	10 500 €	11 500 €	12 500 €	13 500 €	12 500 €	11 500 €
Box	0,21 €	per m2	11 025 €	12 075 €	13 125 €	14 175 €	13 125 €	12 075 €
TOT			75 915 €	83 145 €	90 375 €	97 605 €	90 375 €	83 145 €

The labor cost for manufacturing has first been approximated according to the current salary levels in Finland. The labor costs for the workers are based on the national collective agreement of the plastic industry. The salary for an average plastic worker is according to the Finnish collective agreement for the plastic industry 2035,00 € per month. We have then approximated that with social and other costs, the total cost for one worker is 1,5 x 2035,00 €, which gives 3052,50 € per month[5]. This cost has then been scaled according to the national levels of the other possible locations, based on the European salary statistics[6]. The labor costs of a polish worker would thereby be approximately 1,5*2035€*6,85/30,12 per month[6]. In a year this would be only 8367,37 € per worker. But because of the lower level of skills in Poland, and different level of work ethics, more workers would be needed. Approximately 3 workers are needed; even the production system itself only requires two, the last worker can handle tasks such as moving pallets of raw material and products and helping the other workers. This gives some buffer for possible uncertainties. The cost of the superior of the production plant is approximately 63 000 €, which makes the total labor costs 86 102 € for Y0. This will be discussed further in chapter 2.5.

The total manufacturing costs would thereby be 203 667 € for Y0, meaning 2,04 € per product.

2.2 Overview of the production system

All of the plastic components of the product are manufactured with a hydraulic injection molding machine. The input in this machine is plastic HDPE pellets and color. The raw material is sucked into the machine from a pallet. The machine then melts the pellets and extrudes the molded plastic components to a container with wheels. The machine can produce all of the components, depending on the mold. The molded products are then moved to the assembly area where they are assembled to subassemblies which are temporarily stored close to the assembly area. The molded pieces are, during the assembly, quickly checked for quality related faults and defect products are tossed. Having assembled all the subassemblies, the worker then starts to put together the subassemblies to a finished product which is also boxed at the same time. A quality inspection is performed on the finished products. Stacked on euro pallets the finished products are then moved to the storage area where they await pick up. The pallets are then moved to trucks and moved to an inventory.

The injection molding machine is the largest singular investment needed. A new hydraulic injection molding machine costs approximately 50 000 €. The ten different molds that are needed cost approximately 5000,00 € per mold in Finland, so the total cost of all molds will thereby be 10 x 5000,00 €, which gives 50 000 €. Finnish molds are chosen due to superior quality.[1] The machine also needs some sort of tools, such as wrenches and cleaning supplies for maintenance and color removal. Other supplies are furniture, boxes with wheels for product transport, clothing, etc. estimated to cost 10000€. This means that the annual maintenance costs of 4 %, will be 4 400 €. The molds have been approximated to need replacement in Y4, which explains the peak in fixed assets in the balance sheet in section 4.

We have approximated that the rent of the production plant would be 3 € per m^2. Other costs are for instance electricity, which we have approximated to be 0,09 € per kWh[8]. The machine uses approximately 30 kW and with other electricity costs such as heating, we have approximated the total electricity costs to be 10 000 € per year. The safety costs of the production plant have been approximated to be 5000 € per year. The total other costs are thereby 35 250 € for Y0. We have estimated that the other costs, except for warehousing, will rise 5 % annually.

The Process flow chart, illustrated in Figure 2, shows all the process steps. The Raw materials consist of the plastic pellets, color, shafts and rubber tracks. Rubber tracks and shafts move straight to the visual inspection face of the parts at the assembling face. The other raw materials are mixed and move to the injection molding face. Inventory levels are monitored and if they reach a critical point a new order is placed with the subcontractor. After the injection molding the goods are stored in the inventory awaiting assembly. When all the parts for one subassembly are molded the parts go through a visual quality inspection as they are assembled. The assembled parts are stored in the unfinished goods inventory awaiting the other assemblies. When all the subassemblies have been assembled, they are taken from the inventory to be assembled to a finished product. When the final products are assembled, they are visually inspected for flaws and then packaged. From there the products are moved to the finished goods inventory to await pick up. When a customer order is received, an order is sent to the dispatch department to transport the product.

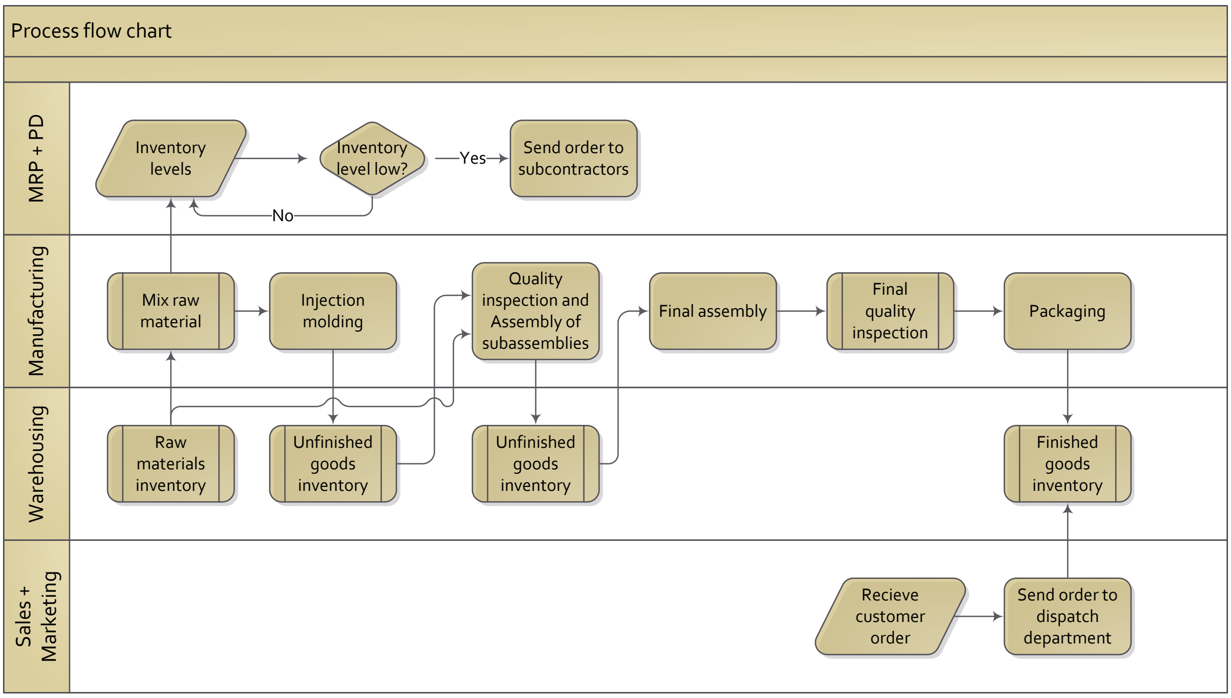

Figure 2 Process flow chart

2.3 Layout and material flows

The production process type of the production plant is not definite. Instead, a production plant of this type shows characteristics of several different types of production processes. According to Stevenson, the five different types of basic processes are job shop, batch, repetitive, continuous and project[7].

From the volume aspect, the production process would probably be something between a batch and repetitive process, since the amount is approximately 100 000 per year. This volume is really small compared to a crayon factory for instance, which can be seen as a typical repetitive production process, but somewhat larger than the volume of a bakery, which Stevenson suggests as a typical batch type of process[7].

All of the products manufactured in this plant are of the same type, with the exception of variation caused by the system. From this point of view, the production process leans more towards the repetitive process type.

This combination of relatively low production volume compared to crayons for instance, and the low variation of products is quite problematic, since the standardized output could utilize complex tools such as conveyor belts and highly automated machinery. The low production volume combined with the complex assembly process of the product however means that the investment return rate of the equipment would be extremely long. In addition, such automation also means higher maintenance costs and requires a more skilled operator, in case something goes wrong.

Since the assembly of the product is done by hand and is a very simple process that can be done in approximately one minute, the skill needed from the laborer is very low. The tools needed for the manufacturing are with the exception of the molding machine very simple. The assembly for instance, can be done without using any tools whatsoever. The tools used in the plant are mainly for maintenance purpose, and can therefore be of a very common type. Such tools are generally used in workshops.

The fuzzy production process type also means that the layout of the plant shows characteristics of different process layout types. Stevenson presents the following types of basic layouts: product layout, process layout, fixed position layout, combination layout and cellular layouts. [7]

The production layout type of our production plant is a combination type of layout that shows aspects mainly from the product layout, but also from the process layout. The material moves linearly according to the stage of the manufacturing of the product, illustrated in Figure 3, which is typical for a product type of layout. However, the small production volume means that the amount of workers that can be employed is very low. This means that workforce has to move around the factory to different tasks. Another factor that amplifies this effect is that the work tasks are very quick to complete, and employing more labor would increase the slack time for each worker. The use of only one molding machine for all of the ten injection molded parts, can also be seen as a process layout type of characteristic. The machine is able to produce all of the different plastic components, due to its very high production speed. There is therefore no need for several injection molding machines, even though this means that the assembly line is longer in idle while waiting for components. The reason for this is that injection molding machines cost from 40 000 € to 80 000 €, and we have approximated that ours would cost 50 000 €, as was discussed in section 2.2[1].

This layout requires two workers and one superior, even if we use three. One of the workers is purely an assembly worker, while the other one is partly a machine operator, and partly an assembly worker. The reason for this is that the injection molding machine can operate virtually unattended, and the machine operator therefore has much time to assemble components as well. A superior is needed to supervise the workers and take care of running matters, such as logistics, invoices and salaries. The skills demanded from the assembly worker are quite minimal. The assembly process is very simple, and no special skills are therefore needed, this means low labor costs for this worker. The injection molding machine operator needs somewhat more extensive skills, in case something goes wrong and the machine needs maintenance. The operation of the machine itself is very simple[1]. The superior of the factory could be an engineer with some grade of management skills.

The equipment needed for this layout consist of the injection molding machine itself, the tools required to maintain it, assembly tables, and wheeled carts for efficiently moving the components and subassemblies. Some sort of forklift or other lifting device is also needed for loading and unloading the trucks.

The materials needed in the layout consist of the raw materials, which are HPDE plastic pellets, machined shafts, rubber caterpillar tracks, color ingredients and packaging material. Other materials needed are for instance maintenance material such as lubricant for the injection molding machine.

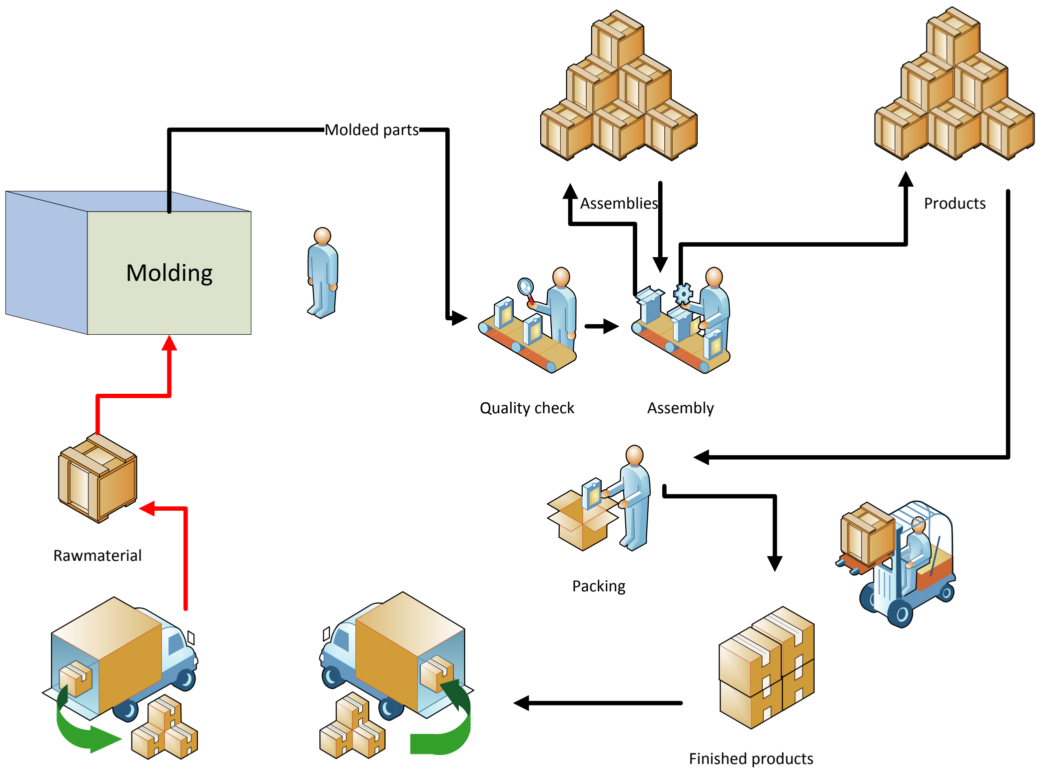

Figure 3 Material flow chart

The uneven speed of production caused by the very fast injection molding and in relation long assembly time creates an uneven production. This leads to large inventories due to waiting times. The production plant requires approximately 150m^2 of space. This can be seen as a restriction of the production system, even though the inventory costs of this type of product is relatively low. This is due to the fact that the product is relatively small in size wise and very light. The frequent moving of subassemblies and raw material increases the costs of warehousing equipment, such as wheeled boxes. The physical layout of the production plant is illustrated in Figure 4.

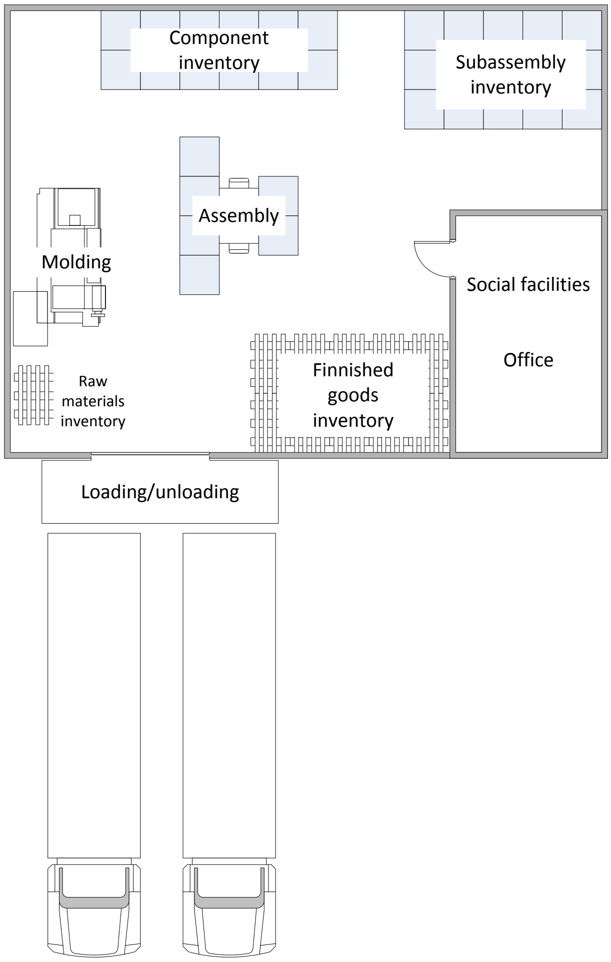

Figure 4 Layout of the production plant

The sequence of manufacturing has been determined with the help of the table in Appendix 1. The order of the production has been organized so that a single component is produced for a whole day at a time. If several different components were manufactured on the same day, many changeovers would be required, because of the need for different mold. This would mean that the set-up to production time for the molding machine ratio would be very high, i.e. the productivity of the machine very low. To save time in changeovers, all molding of components of the same color is done in a row. This saves time, as the machine does not have to be cleaned after every changeover. The estimated changeover time at color change is 4 h, when a changeover to the same color only takes 0,5 h. The estimated amount of assembly time available from the labor was 7 hours from the assembly worker, and 5 hours from the machine operator. This estimation is due to the fact that the injection molding machine can run virtually unsupervised.[1] To ensure a sufficient production rate, small components such as wheels and the bumper can be produced several at once, by using molds that have for instance four identical components. This naturally increases the cost of the mold, but due to the simplicity of these small components, the cost of the mold is similar to the more complex singular molds. The estimated lead time for one finished product is thereby 18 days. As can be seen from appendix 1, this work sequence leaves 3 days of buffer for maintenance, training and problems in the production.

2.4 Production management principles

The relatively large fluctuations in demand on a monthly level, would normally suggest using a chase strategy for the production, since this would decrease the fixed costs of the production system. In our case however, due to the very small, compact and light products, the inventory costs caused by storing the products are very low. Therefore, an even production rate is therefore probably better, as less costs are accumulated as the capacity does not have to be adjusted constantly by using overtime, subcontracting and layoffs etc. Our production system could however easily cope with fluctuations in demand, since the injection molding machine has some buffer time. Due to the simple assembly process, the assembly can easily be outsourced.

A chase demand would also not be suitable for the production system as the demand peaks in the summer and at Christmas times are quite severe, and would therefore result in a heavy peak in costs due to part time labor for instance. Our production system can now instead maintain a constant production rate and create a stock for the peaks.

The bottleneck of our production plant is the assembly, so extreme fluctuations in demand would need to be coped with by adding workforce by outsourcing or leasing workforce.

The production strategy of the plant is make-to-stock, since even the max capacity is not enough for seasonal peak, such as the Christmas season. The high expected variations in demand would make make-to-order very complicated and expensive. No significant benefits would be gained from assembly-to-order, since assembly is the bottleneck, and takes most of the production time. A Vendor Managed Inventory would not either be suitable for our production system, since we most probably have many customers, and the use of VMI would therefore be very complex and in addition require more workforce and the monitoring of our customers inventory levels. A VMI type of approach is probably more suitable for producers with only a few major customers.

The demand can be met with two full time workers and since we make-to-stock, no additional production triggers are needed. By using a safety buffer of 90 days we minimize the risk of running out of products. The inventory levels should however be monitored, to ensure that we do not run out stock. Since the production in the beginning of the year is purely based on the demand forecast, the production rate might also have to be adjusted according to the actual demand.

Since the production is steady and constant, raw material is also needed at a steady rate. Therefore, the raw material can be ordered in at in the same amounts at the same frequency. This is beneficial, because a raw material order sequence of this type is very economical, as the supplier does not have to prepare for sudden peaks. A VMI type of order would be more suitable for large demand fluctuations.

The raw material can be stored on pallets near the injection molding machine. This storage would also be near the door of the production plant, as can be seen in Figure 4. This minimizes moves and thereby eliminates waste. The raw material inventory does not need any actual controlling, since it is consumed in a steady pace. An eye should anyhow be kept on the inventory, just in case something is out of the ordinary, or in case the production rate changes.

The production plant has significant inventories of unfinished goods, since all of the same components are molded sequentially, to avoid too many changeovers in the production process. This inventory is however quite economical, since the products are, as mentioned earlier, light and compact. This inventory is kept in the production plant to ensure short moving distances, and thereby also lower inventory generated costs.

The finished products will partly be stored in the factory, namely the products that are finished and packaged and awaiting transport to further locations. As the production plant was decided to be located in Poland, see section 2.5 for details, the main inventory would also be kept in Poland. This is also a central location geographically for our market, which is the EU.

The customers of our production system are probably widely spread and different in size. The highly varying delivery quantities would make the logistic process laborious and complex, and would most probably require investments in logistics programs and also more workforce. The logistics and warehouse process should therefore be outsourced as an entity. This would mean that a subcontractor would pick up the finished goods from the production plant, transport them to their own facilities and store them there. When a consumer order is received, the subcontractor is contacted to deliver a certain amount of products to a certain location. This way, the production plant could focus on its key competence, and not waste capital and labor on auxiliary functions. No significant source for this cost was found, so the expenses caused by the outsourced warehousing were approximated to be 5 % of the revenues.

2.5 Location

Our possible locations for production are Russia, Finland and Poland. Russia is excluded as the location for our production mainly because our primary market is Europe. Neither is Russia a part of the EU, which means that customs duties would have to be paid when importing the products to Europe. In addition, things like uncertainty because of extortion rackets also affect our choice of location. No variation in product quality between different locations is expected, since the impact of human labor is fairly small, and it is the machines that really are the significant factors in product quality. Quality controls are also executed to ensure that the product quality is according to standard.

Excluding Russia means that our choice of location is between Finland and Poland. From these two options, choosing Poland is not difficult. The Labor cost in Poland is slightly more expensive than in Russia, but the employee costs in Finland are approximately threefold compared to Poland. We have chosen to have a Finnish supervisor regardless of the location, which makes the total labor costs in Finland and Poland more even. We have estimated that having the production in Poland requires one more worker than in Finland because of the inefficiency of Polish workers, which means that a total of three employees and one supervisor are needed. Even with one more worker, the labor cost in Poland is only 88 000 € compared to 136 000 € in Finland[6].

Exporting from Poland to other European countries is not a problem, since Poland is part of the EU, and thus there are no customs duties when exporting to other EU-countries. Electricity costs and storage costs are not an issue either, as relatively little storage space is needed for our products. Electricity costs in Finland and in Poland are about the same. This means that the only significant cost affecting the choice of location is the labor cost. As our primary market is Europe, Poland is centrally situated, and thus minimizes transportation costs.

3 Future scenarios

In our case outsourcing subassemblies is not an option worth considering, since the subassemblies are not very time consuming and do not require any expertise. Outsourcing the subassemblies would be a complete waste of time and money considering the transport needed and the resources spent leaving you with an unfinished product. You could consider outsourcing the whole assembly process. That would increase the efficiency significantly since the assembly stage of the production is the most time consuming stage, therefore the “bottleneck” (see Appendix 1).

The design of the product itself could be improved in various ways. Merging some of the existing parts together, for example the chassis and bumper could be merged into one mold, leads to fewer molds and saves time due to less mold changes and lower assembly times. Merging of the frame and cockpit should also be considered. Another option would be to simplify the colors by making a one-colored product. This leads to shorter changeover times and cheaper raw material costs, however considering that the product is a toy, consumers mainly base their choice of product on appearance and not on the functionality. Since Plasto is a company that produces many different products, their approach has been to make some of the parts standardized so that they can be used for several products. For example the wheels, cockpit, the shats and the frame of our product are also used in other products.

If the demand would start to fluctuate and become unpredictable, we would have to consider other options for our production. In the case of an increase we would be able to employ part time workers to work with assembly of the product. Employing a fourth worker would result in a lead time of 13 days for 9000 products. If the demand however were to decrease we would have to consider additional options, starting the production of a new product side by side with the old product for an efficient use of machine hours. Another option would be to outsource the molding itself and only focus on the assembly part of the production.

If the annual volume of demand would be at a much lower level, the production in its previously planned way would not be possible. If the demand volume would be around 20 % of the current forecast, it would not be profitable to make large investments. For example investing in a molding machine worth over 50 000 would not pay off. This is due to the fact that our revenue would also be at a level of 20 % of the previously planned revenue. To be able to make a profit out of this business with such a low demand volume, the income the producer gets for each product would have to be a lot higher. This means that the price of the end product in the retailer end would go up.

In the case that we would receive only a fifth of the current demand, even if we would have only one worker and no superior, our operating income would be 15 000 € negative. Producing the product according to the current model is not a possibility with such a low demand.

If we would have existing production for some similar products and would easily be able to increase our capacity, for instance by hiring more part-time of full-time workers, production could be profitable. This requires that we do not have to make any large investments in new machines.

In the current setting our factory and all our workers are situated in Poland. If the primary market for this product would be the Nordic countries, it would probably be profitable to move at least part of the warehousing to Finland. The facility rent in Finland is approximately double compared to Poland. By having a warehouse in Finland, the products could be delivered a lot faster to the retailers, and thus minimize obsolescence. Since the company's headquarter is in Finland, setting up new facilities and expanding business in Finland is easier than in for example Poland. This is due to different work cultures, attitudes and similar issues.

If the products would require customization, investments into machinery for this purpose would have to be made. Alternatively, depending on the type of customization, the work could also be made by hand. Possible customizations could be changing the colors of some, or all parts of the product, or adding a logo on the product. Bigger changes to the product, for example changes due to stricter legislation in some country, and are potentially very costly. Such legislation could include that children would not be able to take the product apart, i.e. make the product safer for children's play. Generally, making changes to a small portion of the production is costly. To do customizations profitably, changes would have to be implemented in a larger scale and for a large part of the total production.

We have assumed that the retail price of the product is 9,90 euros according to Lekmer's online store [9]. On top of the factory price which is thirty percent of the retail price, value added tax is added. The value added tax depends on what country the product is sold in but assuming it is sold in Finland the value added tax is 23% of the retail price i.e. 2,277 euro.
The factory price of the product is 30% of the retail price, meaning 2,97 €. We have estimated that the Wholesaler margin is 30% of the factory price and the Wholesaler logistics, and that the Retailer margin is 30% of the Factory price + Wholesaler logistics and margin + Retailer logistics= 1,759€. The logistic costs are estimated to be about 0,85 € between the factory and wholesaler and the wholesaler and the retailer. The cost structure of the final product is illustrated in Figure 5.

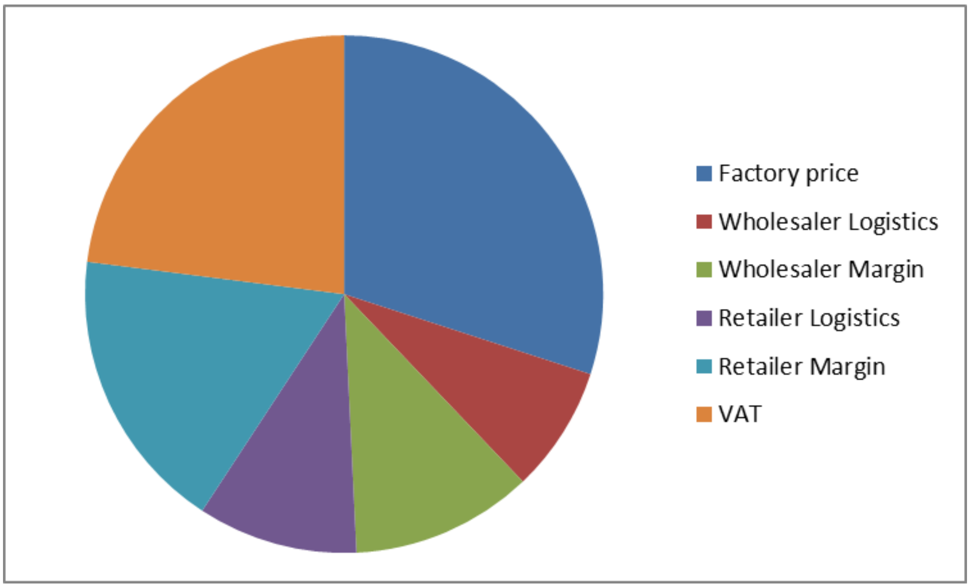

Figure 5 Pie chart of the components of the final price

4 Conclusions and recommendations

Our production system is a hybrid form of batch and repetitive type of production processes. The layout type is products, but it also shows characteristics of a process type of layout. The production system will be located in Poland, because of the great savings in labor costs. The reason for this is that the bottleneck of our production system is the assembly work; hence making the costs accumulated by the salaries of the assembly workers the largest cost, especially in a high income country such as Finland. Poland is also a great location when considering the geographic location of our market, which is the EU.

The production system will maintain a constant production rate, to save in costs that would otherwise be accumulated by worker layoff costs, part time workers etc. In addition, the warehousing costs are also low due to the low volume and mass of the product.

A production plant located in Poland creates risk in the form of crime such as burglary, fraud and extortion. These have been tackled by adding safety service that produces a significant annual expense in the form of other costs, as can be seen in Table 3. The safety service could include for instance surveillance cameras and security guards. These costs were however small compared to the savings from the low labor costs.

Table 3: Income statement

INCOME STATEMENT							
Estimated Sales		100000	110000	120000	130000	120000	110000
		Y0	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**
Net sales	30 %	297 000 €	326 700 €	356 400 €	386 100 €	356 400 €	326 700 €
Cost of raw material		75 915 €	83 145 €	90 375 €	97 605 €	90 375 €	83 145 €
Employee expenses		88 102 €	88 807 €	89 517 €	90 234 €	90 955 €	91 683 €
Maintenance costs	4 %	4 400 €	4 400 €	4 400 €	4 400 €	4 400 €	4 400 €
Other costs		35 250 €	37 755 €	40 311 €	42 921 €	42 616 €	42 371 €
EBITDA		93 333 €	112 593 €	131 797 €	150 941 €	128 053 €	105 101 €
Depreciations	20 %	22 000 €	22 000 €	22 000 €	22 000 €	22 000 €	22 000 €
EBIT		71 333 €	90 593 €	109 797 €	128 941 €	106 053 €	83 101 €

As the income statement in Table 3 illustrates, the production plant will have a relatively stable, slightly increasing EBIT until Y3, after which the newness of the product will start ware off, decreasing the sales. Table 4 shows the balance sheet of the production plant. Fixed assets are relatively stable, and only affected by the depreciation and investment occurring in Y4. We have approximated the prepaid assets etc., which create the other current assets, to be 10 000 €. This will keep the total assets relatively stable.

Table 4 Balance sheet

BALACE SHEET			Y0	Y1	Y2	Y3	Y4	Y5
Fixed assets			110 000 €	88 000 €	70 400 €	56 320 €	95 056 €	76 045 €
Inventories	90	DOS	74 250 €	74 250 €	74 250 €	74 250 €	74 250 €	74 250 €
Accounts receivable	60	DOS	49 500 €	49 500 €	49 500 €	49 500 €	49 500 €	49 500 €
Other current assets			10 000 €	10 000 €	10 000 €	10 000 €	10 000 €	10 000 €
Cash & equivalents	10 %		29 700 €	32 670 €	35 640 €	38 610 €	35 640 €	32 670 €
TOTAL ASSETS			273 450 €	254 420 €	239 790 €	228 680 €	264 446 €	242 465 €

The cash flow statement illustrated in Table 5 shows the operating cash flow, which has been approximated to be equal to EBITDA. The Capex consist of small investments in tools, renewal of clothes, and the new injection molds etc.

Table 5 Cash flow statement

Cash flow statement	Y0	Y1	Y2	Y3	Y4	Y5
Operating cash flow	93 333 €	112 593 €	131 797 €	150 941 €	128 053 €	105 101 €
Capex	110 000 €	2 000 €	2 000 €	2 000 €	50 000 €	2 000 €
NET CASH FLOW	-16 667 €	110 593 €	129 797 €	148 941 €	78 053 €	103 101 €

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Appendix 1 Work sequence

Mold color																					
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10	Day 11	Day 12	Day 13	Day 14	Day 15	Day 16	Day 17	Day 18	Day 19	Day 20	Day 21
Part molded	Arm 1	Arm 2	Bucket	Arm base	Frame	Cock pit	Shaft con.	Bumper	Chassis	Wheels	Wheels										
Molding	7,5	7,5	7,5	7,5	7,5	7,5	7,5	3,75	7,5	4	3,5										
Changeover	0,5	0,5	0,5	0,5	0,5	0,5	0,5	4	0,5	4	4										
Molds produced	9000	9000	9000	9000	9000	9000	9000	4500	9000	4800	4200										
Parts per mold	1	1	1	1	1	1	2	2	1	4	4										
Parts produced	9000	9000	9000	9000	9000	9000	18000	9000	9000	19200	16800										
					Assembly of arm starts																
Assembly time					12	12	6														
Arms assembled					3600	3600	1800														
Arms assembled sum					3600	7200	9000														
							Assembly of body starts														
Assembly time							6	8,5	12	8,5	8,5	4									
Bodies assembled							1136,842	1610,526	2273,684	1610,526	1610,526	757,8947									
Bodies assembled sum							1136,842	2747,368	5021,053	6631,579	8242,105	9000									
												Assembly of wheelbase starts									
Assembly time												10	14	1							
Wheelbase assembled												3600	5040	360							
Wheelbase assembled sum												3600	8640	9000							
														Assembly of product starts							
Assembly time														13	12						
Products assembled														4680	4320						
Products assembled sum														4680	9000						
															Boxing of product starts						
Boxing time															2	14	14	7,5			
Products boxed															480	3360	3360	1800			
Products boxed sum															480	3840	7200	9000			
Total assembly time available																					
Worker 1	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Worker 2	5	5	5	5	5	5	5	1,5	5	1,5	1,5	5,5	5,5	5,5	5,5	5,5	5,5	5,5	5,5	5,5	5,5
Machine not running												1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5
Total assembly time	12	12	12	12	12	12	12	8,5	12	8,5	8,5	14	14	14	14	14	14	14	14	14	14