SIMOLDES - The Impact of Additive Manufacturing: 3D Printing Technology

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Abstract

Title: SIMOLDES - The Impact of Additive Manufacturing: 3D Printing Technology

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This case study provides an overview of the automobile industry, Simoldes and the emergence of additive manufacturing technology, also known as 3D printing. The goal of this master's degree dissertation is to conduct a strategic analysis of Simoldes taking into account the implications of incorporating additive manufacturing technology into the company´s value chain. Understanding what advantages additive manufacturing can bring to Simoldes strategy is fundamental. Different management approaches regarding this technology are provided at the end of the case. Should Simoldes not adopt this technology, or should they proactively incorporate additive manufacturing into its manufacturing process? This is the main subject to the discussed on this master's dissertation thesis.

In the teaching notes section, there is a set of questions with a proposed resolution. From this analysis, it is possible to see several benefits that additive manufacturing can bring to Simoldes. Efficiencies in time and costs are the main potential advantages. Incorporation of this technology into Simoldes manufacturing processes is the recommended outcome of this case study.

Key words: Innovation, Additive manufacturing, 3D Printing, Simoldes.

Título: SIMOLDES – O Impacto da Fabricação Aditiva : Tecnologia de Impressão 3D

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Este caso de estudo mostra uma visão geral da indústria automóvel, da empresa Simoldes e do surgimento da tecnologia de fabricação aditiva, também conhecida como a impressão 3D . O objetivo desta dissertação de mestrado é a da realização de uma análise estratégica da empresa Simoldes tendo em conta as implicações da incorporação da tecnologia de fabricação aditiva na sua cadeia de valor. Entender as vantagens que esta tecnologia pode trazer para a Simoldes é um dos aspectos fundamentais. Diferentes abordagens em relação a esta tecnologia são fornecidos no final do caso. Deverá a Simoldes não adotar essa tecnologia , ou deverá incorporar de forma proactiva a fabricação aditiva nos seus processos de produção ? Este é o principal aspecto a ser discutido nesta dissertação de mestrado.

Na secção de notas de ensino , há um conjunto de perguntas com uma proposta de resolução. A partir desta análise , é possível observar vários benefícios que a fabricação aditiva pode trazer para a Simoldes. Ganhos de eficiência no tempo e nos custos são as principais e potenciais vantagens. A incorporação desta tecnologia em processos de fabricação Simoldes é o resultado recomendado deste caso de estudo.

Palavras-chave: Inovação , Fabricação Aditiva, Impressoras 3D, Simoldes.

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1. Introduction

In 1984, Charkes W. Hull created the first working 3D printer (three-dimensional printing). At that stage, these machines were very expensive and did not have viable commercial applications. Engineers and designers have now being using these machines for more than a decade. Developing quick and cheap prototypes before embarking in expensive manufacturing processes have been the main benefits. Nowadays, due to the latest technology advances, 3D printers have become less expensive and capable of working with a wider range of materials. These devices are already manufacturing final products ([1]), as diverse as, car components, jewelry, shoes, pharmaceuticals, and even food.

This case is focused on how advances in three-dimensional printing can affect automobile manufacturing industry and its upstream industries. Simoldes, a Portuguese based multinational group will be the focus of this case. How its managers should react regarding these new technology advances will be the main issue to be addressed.

2. Industry overview and competitive environment

2.1 Automobile sector overview

The automobile industry is considered a key sector for all major country in the world. It comprises two different types of manufacturers: the automobile manufacturers and their suppliers. In order to assemble a vehicle, companies use wide variety of materials. These products include components made of steel, iron, aluminum, glass, plastics, textiles, rubber and many others*.* Estimates state that each direct automobile job creates another five indirect jobs ([2]), highlighting the importance of the suppliers in this industry.

[1] http://www.economist.com/node/18114221
[2] http://www.oica.net

Figure 1 – Number of cars sold worldwide from 1990 to 2014

	Million units/Year
1990-1999	39
2000-2009	51
2011	61
2012	65
2013	69
2014	72

***Source**: © Statista 2014*

Taking into account the statistics and estimations for the number of cars sold, it can be stated that automobile industry is with a growing trend. This fact can also be related with the increased need of cars in developing countries.

Companies like Simoldes depend directly from the number of cars sold. Their growing trend will have a direct impact in this company revenue.

This industry is also one of the largest innovators. In 2012, Volkswagen was the company in the world that invested more in R&D, around 9.5 billion of euros, 5% of their revenues[3]. This fact reflects an increase interest in new technologies and products that can bring efficiencies to this industry.

2.2 Auto components sector

This sector comprises companies that supply directly or indirectly the automobile industry. The direct suppliers are the ones that sell final components directly to the car manufacturers. The indirect suppliers are the companies that develop the tools, normally molds, which are required by the direct suppliers to make the final component.

The components industry in Portugal tripled in size over the past 15 years. To remain competitive Portuguese companies had to reach rigorous international standards. Simoldes

[3]http://annualreport2012.volkswagenag.com/managementreport/valueenhancingfactors/researchanddevelopment/keyrdfigures.html

given the limited size of their home market, focus their sales in international markets. It is the leading Portuguese supplier of molds and components of big car manufacturers, with a turnover around 400 million of euros.

Figure 2 - Recent Auto Component industry evolution in Portugal

	Turnover (€ million)	*Portuguese Home market (€ million)*	*Exports (€ million)*	*Exports (% of turnover)*
2008	*6,236*	*1,519*	*4,717*	*76%*
2009	*5,188*	*1,255*	*3,933*	*76%*
2010	*6,585*	*1,365*	*5,220*	*79%*
2011	*7,533*	*1,549*	*5,984*	*79%*
2012	*7,102*	*1,388*	*5,714*	*80,5%*

Other Key Figures	*2012*
Nº Companies	177
Portuguese Owned	49%

Source: *AFIA- Associação de Fabricantes de Indústria Automóvel, June 2013*

Figure 2 show that the components industry turnover is increasing, exporting 80 % of its output. It is possible to state that exports are the source of growth in this sector. This proves that Portugal is one of the countries chosen to be the supplier of components to the worldwide automobile industry. Highlighting, the importance of companies like Simoldes in the Portuguese Economy.

Portugal is well recognized as mold-making and component producer. Some years ago, the rising of China´s economy, with their low-income jobs and costs, caused crisis in this Portuguese sector. However, nowadays, big manufacturing car companies returned to Portugal to purchase the required parts ([4]). The reason behind this development was the price/quality ratio offered by the Portuguese companies. In order to create products with similar quality as in Portuguese companies, the prices in China lose their cost advantage. For this reason, is possible to predict an increase in revenues for European companies in this sector ([5]).

[4] Portuguese association for the mold industry: http://www.cefamol.pt/cefamol/en/Cefamol_IndustriaMoldes
[5] Interview with Julio Grilo, engineer at Simoldes Plastic Division

There are several auto component companies in Portugal, however, due to the dimension of Simoldes, it is possible to state that in Portugal there is only one company that can be considered as its key direct competitor, Ibermoldes. Their revenues are over 80 million of euros, also selling molds and components to the major car manufacturing companies ([6]).

Therefore, when looking at competition, we have to take into account the major international players (Figure 3).

Figure 3 - Simoldes main competitors

Company	*Head Quarters*	*Revenues (€ Billion)*
Johnsoncontrols	US	43
Magna	Canada	35
Faurecia	France	18
Antolin	Spain	1.6

*([7]) **Souce:** Simoldes Plásticos*

All the companies included in the above table are responsible for only the production of the final component. However, they produce a big range of components, not being specialized only in plastic, as the case of Simoldes components. These firms do not have a division for the production of the molds required. They outsource this part of the process. Being Simoldes Tool division one of the suppliers chosen by these big component companies.

3. Company overview

3.1 Simoldes Group

Simoldes was founded in 1959. It started as a small plant located in Oliveira de Azeméis, in the north of Portugal, and it remains totally owned by a Portuguese family. This company supplies plastic injection molds and also manufactures plastic components, mainly for the

[6] A cluster of competences- http://www.afceaportugal.pt/2013/eventos/Grupo_IBEROMOLDES.pdf
[7] Information provided in Simoldes Interview

automobile industry, which represents 90% of its revenues. Current revenues are in the order of 400 million euros with more than 4,000 employees employed in the firm.

From 1959 till the 1980´s, Simoldes only produced molds for injection companies. In 1981, the group decided to vertically integrate downstream by investing in plastic injection plants. The objective was to supply directly component assemblers developing a direct relationship with this auto car companies.

The group is divided in two different business areas: Simoldes Tool Division and Simoldes Plastic division, which together comprise a total of 16 different companies (Figure 4). At present, the group has manufacturing plants in Portugal, Brazil, France and Poland. Portuguese market only accounts for a symbolic portion of the revenues, 2 million of euros. Therefore, their focus is in international markets. This group has a strong recognition in the automobile industry with brands like Porsche, Toyota, Citroen, Peugeot, Volkswagen, and Skoda listed among its clients.

Figure 4 - Simoldes group of companies - 2014

Simoldes Tool Division	***Simoldes Plastic Division***
Simoldes Aços, SA	
MDA, SA	*Plastaze*
IMA, SA	*Inplas*
Simoldes Aços Brasil	*Simoldes Plásticos*
Mecamolde, SA	*Simoldes Plásticos Polska*
IGM, SA	*Simoldes Plásticos Brazil*
Ulmolde, SA	*Simoldes Plásticos France*
ACS –Advanved costumer service	*Simoldes Plásticos Indústria*
ACS Germany	*CSC- Costumer service center*
ACS Argentina	*CSC France*
ACS France	*CSC Deutschland*
ACS Turquie	*CSC Spain*
ACS Iberia	

Source: *http://www.simoldes.com*

Simoldes Tool Division

This division of the group is responsible for the manufacturing of injection molds for the plastic components. These molds are a complex set of parts that that when assembled form this type of tool. Their function is to allow the injection of thermoplastic ([8]) polymers into the mold, where it cools down and hardens in the form of the mold´s cavity. (Exhibit 1)

This division is specialized in the production of molds for large plastic components and it exports to more than 30 countries. Revenues in Europe are over 90 million euros. As mold makers Simoldes is the leading group in Europe.

ACS Advanced Costumer Service

In the most important markets, Simoldes Tool division has created local offices where advanced services are available to their major clients. Technicians and engineers mostly compose these departments. The main objective is to provide commercial and technical support to their customers. After sale services, such as, modifications, repairs and maintenance are rapidly provided after the mold arrives to the client.

Simoldes Plastic Division:

Simoldes Plastic division is a group of seven companies. The main stream of revenues comes from this division. Only in Europe, it accounts for over 290 million euros in revenues ([9]). These companies are responsible for the injection of the plastic into the mold, producing the final components that are sent to assemblers. (Exhibit 2).

They have a department for the development of the final component, using CAD and special programs ([10]). Having more than 30 years of expertise, they are able to develop products that make the mold making process easier. These specifications of the final component are then used by the tool division to create the mold required. This department, due to its know

[8] Thermoplastic is a polymer which becomes pliable or moldable above a specific temperature and returns to a solid state upon cooling

[9] Interview with Julio Grilo, engineer at Simoldes Plastic Division

[10] CAD programs: *Computer-aided design (CA*D) is the use of computer systems as a tool for the creation, modification, analysis, or optimization of a design. CAD software is used to improve the productivity of the designer, increase quality, and to create a database for manufacturing. The CAD output is normally in the form of electronic file for printing, machining, or other manufacturing operations.

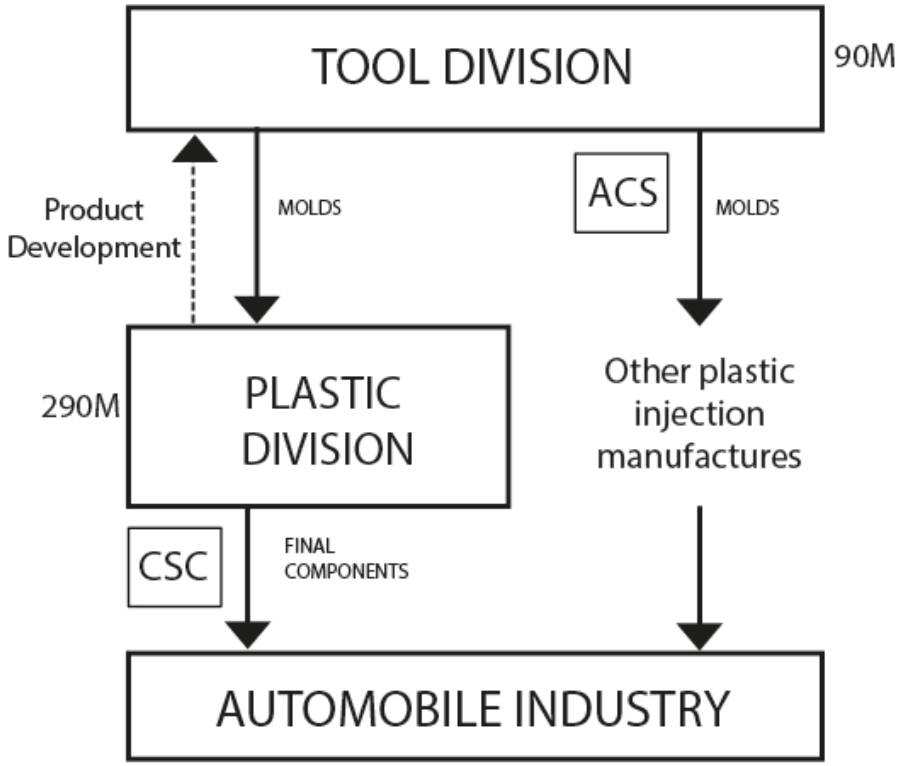
how, is capable of detecting problems and potential efficiencies that are going to be explored in the mold-making process. This fact creates one of the major sources of competitive advantages of Simoldes as a group. Companies in Simoldes Tool Division produce 90% of the molds used by this plastic division.

CSC - Costumer Service Center

This department is also distributed across different strategic locations. The goal is to provide assistance to Simoldes Plastic division main costumers namely auto manufacturers. Engineers and technicians constitute these offices where product development and after sales assistance are provided. These special departments work as a complement to the manufacturing facilities of Simoldes Plastics.

3.2 Linkages between its two key divisions

Figure 5 – Connections between both divisions



The differentiation from their main competitors comes from the integration between mold production and the injection of the plastic within the same group. Normally, mold-making

companies are small, specialized, and work for a small number of clients. On the other hand, plastic injection companies have a larger dimension. Normally multinational companies that are located closed to their costumers.

The integration between these two divisions in Simoldes group brings several advantages that constitute a source of differentiation versus its competitors. With this integration, Simoldes can guarantee the injection right after the production of the mold. The process reaching the final plastic product is much faster when compared with the normal process. Production of the mold in one company, then moving it to a plastic injection company and finally manufacture of the final component. Having these two divisions, Simoldes can be faster and provide immediate assistance if any adjustment is required in the mold. These specialized tools require constant adjustments in order to reach the final desired component form. Another advantage is that Simoldes can observe directly their own molds functioning in production. This fact allows them to see and study the causes of problems and deformities in the final plastic manufactured good. Most of these problems in the final product occur due to malfunctioning´s of the mold, and the characteristics of the plastic material used. Having product-developing teams working along with the mold making division leads to an integration that results in learning economies that are crucial for all the process. As a result of this interaction, Simoldes is able to conceive molds with a superior quality, which results in efficiencies in the injection. Higher final components quality is the positive result of this interaction.

3.3 The internationalization process of the Group

When compared to Portuguese companies in the auto component sector, Simoldes degree of internationalization is very high. The main revenues come from international markets and so a global presence is required in order to continually grow their sales. Currently, and taking into account the two divisions, they have manufacturing facilities in Poland, Brazil, and France. Regarding the costumers service they are present is many other countries, as indicated in the Figure 4.

Normally, when this group decides to enter in a new market they take into account several factors. Being close to their main costumers is one of the most important elements. This fact

allows them to decrease the transportation costs and speed the supply chain. With the “just in time” practices applied in the automobile industry, companies are expecting to receive components in a way that allows them to hold the minimum inventory possible.

Another important fact is the barriers to entry in a given one country. In Brazil, for example, they where obliged to build a manufacturing plant there. The reason behind this fact is the amount of taxes charged on imported products as well as the need to comply with constant local requirements.

The local availability of skilled workforce is also a very important consideration, due to the complexity of the products manufactured, mainly in the Tool division. It is required to have skilled employees with experience and academic training. As a result, low-income countries are not the natural targets in this internationalization process.

When Simoldes decides to enter a market, they prefer to start from scratch. Normally, they built their own manufacturing plants rather than purchasing existing companies. They consider that one of their major sources of competitive advantage rests on their manufacturing processes, and so, they build plants in a homogeneous way all over the world. Since they are serving global costumers, product quality has to be the same in the different geographical areas.

Simoldes has plans to continue their internationalization process. Spain, Russia, and the Czech Republic may be the next steps. However, they are dependent on their clients in order to open new facilities in these countries.

Despite of “start from scratch approach”, Simoldes, in countries where the risk of building new facilities is too high, has another form of pursuing its international goals: technical licensing. They have two different licensing types. In the first one, they develop the project, being responsible for the installation of the manufacturing process in given company. Simoldes receives a fee for this service not being accountable for the final manufactured product. On second type, it is a similar process, however, Simoldes receive a royalty for each product produced by that company. The difference is that Simoldes has responsibility over the product and the manufacturing process.

4. Disruptive technology in the market – 3D Printing: Additive Manufacturing (AM)

"*Size is not an issue! It's budget. You could print an aircraft carrier if you had the budget.*"
Stated by Jeff Hanson

4.1 The evolution of 3D printing technology

Three-dimensional printing or additive manufacturing, consists in developing a three dimensional solid object from a digital file/program. The creation of this object is accomplished using additive processes. This additive process consists in laying down successive layers of an input material until the entire object is created ([11]).

Three dimension printing technology started being developed in 1980s. Chuck Hull invented a first commercial 3 Dimensional Printer. Through his company 3D Systems, he introduced this technology in the market. This machine used a technique that relied on a laser that solidified an ultraviolet sensitive polymer material everywhere this laser touched ([12]).

In the industrial world, this technology has been used for decades. Manufacturers used these printers to create prototypes for traditional manufacturing and for research proposes. This process is called rapid prototyping. Nowadays, companies are using this technology for rapid manufacturing, meaning that companies manufacture printed objects that are not prototypes but the actual end user product. This allows companies to create custom made products in a faster and frequently way. Latest developments are enabling companies to create more and more complex products with a wider range of materials (Exhibit 3).

In 2011, personal 3D printing or domestic 3D printing interest started to grow. This fact led to a rapid development of this new market for 3D printers. As a result printers are getting cheaper and more affordable for the general population. Nowadays, smaller 3D printers' price range is between 250 – 2,500 dollars (Exhibit 4).

[11] http://3dprinting.com/what-is-3d-printing/#history
[12] http://www.livescience.com/34551-3d-printing.html

Figure 6 – Expected growth of 3D printing equipment sales 2012-2020

	Billion USD
2012	1.3
2020	5.2

Source: *Disruptive manufacturing: The effects of 3D Printing, Deloitte*

It is expected that sales of 3D printers will quadruple by 2020, highlighting, once again, the importance of this sector in the nearby future.

4.2 Type of materials used

Nowadays, Industrial 3D printers allow companies to print objects with a quality that some years ago would not be possible ([13]). In parallel, the type of materials that can be used by these machines has increased. Below, it is described the most common type of materials used by these machines ([14]): These inputs are used in the form of powder. Plastic and metal are the types of materials that will be most relevant for this case study.

Plastic

Nylon, or Polyamide, is frequently used. It is a strong, flexible and durable plastic material that showed to be consistent with 3D printing. This can also be combined with Aluminum to produce another common 3D material called Alumide. ABS is another common type plastic used. It is especially strong and is available in an extensive variety of colors. Another plastic material that has been gaining importance is a biodegradable plastic called PLA, however, it is not as durable or flexible has the first two materials.

Metals

An increasing number of metals and metal composites are being used in industrial 3D printing. The most common are aluminum and cobalt derivatives. Another metal that is

[13] Interview with Pedro Teixeira, R&D Engineer in the Portuguese company Beeverycreative. A company that is manufacturing 3D printers.

[14] http://3dprintingindustry.com/3d-printing-basics-free-beginners-guide/materials/

gaining importance is stainless steel due to his strong structure. Gold and silver have been added to the range of metals that can be printed, with direct applications in the jewelry industry. It is also important to state that titanium, one of the strongest metals known, is now being used as a material to be printed.

Ceramics

This is a new group of materials that is being used by 3D printers. However, it is important to state that after being printed, these ceramic parts will have to go throw the same process as any ceramic part produced in the traditional way. Since it is required to put the piece on the oven in order to cook. Only after this, the final product is created. As result printing final products it´s impossible.

Bio Materials

There is a huge amount of research and interest regarding the use of 3D printers for these types of materials. Living tissue is being investigated with the objective of creating applications for printing human organs or external tissues. For example, it is expected that Organovo, a bio-printing company, will reveal the first printed organ in 2014([15]).

Food

Printing food experiments have exponentially increased over the last few years. Chocolate is one of the most common materials used. Printers are already capable of working with sugar too. There are also trials with more complex ingredients, pasta and meat. Researchers believe that in the future will be possible to print finalized meals. Anjan Contractor, a mechanical engineer has already developed a machine capable of printing a pizza ([16]).

[15] http://www.computerworld.com/s/article/9244884/The_first_3D_printed_organ_a_liver_is_expected_in_2014

[16] http://www.ndtv.com/article/offbeat/nasa-s-3d-printer-makes-pizzas-for-astronauts-475964

4.3. 3D Printing applications

3D printing technology is being used as an important manufacturing tool by industries/sectors nowadays ([17]). Highlighting the sectors where the impact of this technology has been higher is important in order to understand the capabilities and functionalities of these machines ([18]). Once again the Automobile industry will be the most relevant for this case.

Figure 7 – Industry applications and advantages

Industries	*Applications*	*Advantages*
Aerospace	Prototyping Product development	Time and cost efficiency ([19])
Medical/Dental	Prototyping Personalized implants Hearing aids Orthopedic shoes Skin Bone Tissue Pharmaceuticals, Human organs	Time efficiency Simplicity Personalization
Jewelry	Jewels	Design freedom Elimination of all traditional manufacturing steps
Art/Design	Exact replicas	Past relevant sculptures
Architecture	Accurate creation of models developed	Innovation Communication
Fashion	Shoes Head-pieces Hats Bags	Innovation Personalization
Food	Chocolate structures	Customization of meals ([20])
Costumers	Simple objects	Customized products
Automobile	Rapid prototyping Discontinued products Car components	Cost efficiency Time efficiency Innovation

[17] http://3dprintingindustry.com/3d-printing-basics-free-beginners-guide/applications
[18] http://www.techrepublic.com/article/10-industries-3d-printing-will-disrupt-or-decimate

4.4. 3D Printing impact in manufacturing processes

Could this new technology "lead the second industrial revolution?" ([21]) This question is quite relevant due to the capabilities and constant developments in the 3D printing sector.

As stated before, this technology is being revolutionizing the way that manufacturing companies develop new products and technologies. There are several positive impacts that additive manufacturing can bring to enterprises.

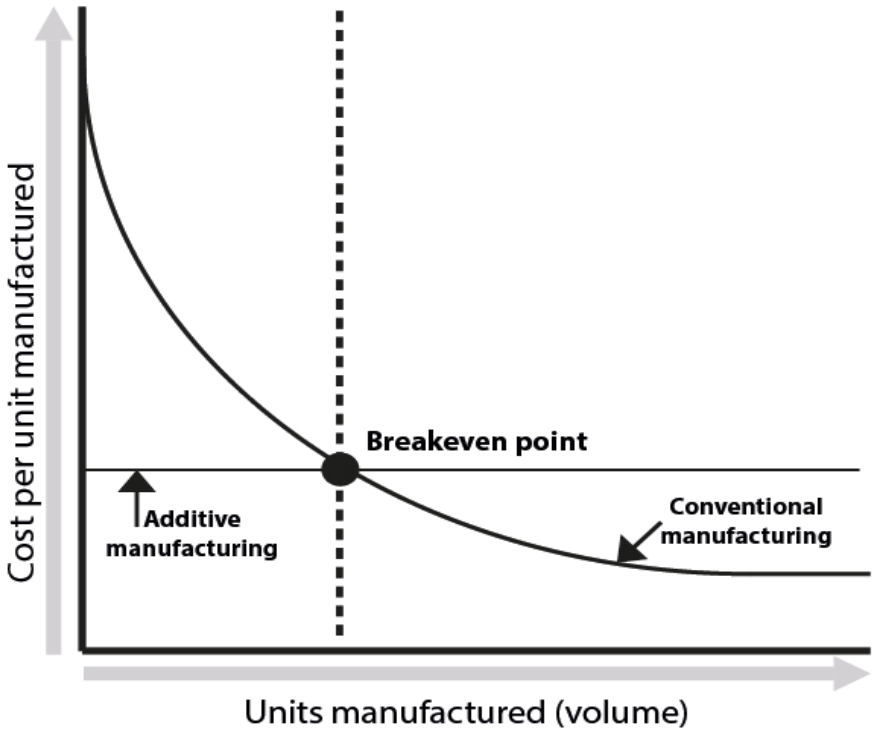
Minimum Efficient Scale ([22])

The relationship among costs and scale is captured by in the concepts of economies of scale and minimum efficient scale. This represents the scale of operations at which the average cost of each unit of production is minimized. When this minimum is high means that big capital costs are required to start the production.

3D printing is capable of reducing this minimum efficient scale. This technology allows companies to satisfy their need without big expenditures in capital or labor. With these printers the minimum efficiency scale can be potentially achieved at lower unit volumes, meaning that is possible to print one object without the setup costs and tooling required by the traditional manufacturing processes.

[19] http://www.thenational.ae/business/industry-insights/technology/3d-printing-is-the-new-dimension-for-aerospace-industry
[20] http://www.livescience.com/40445-the-ultimate-iron-chef-when-3d-printers-invade-the-kitchen.html
[21] http://www.autoexpress.co.uk/car-news/consumer-news/64799/3d-printing-future-car-industry
[22] Cotteleer, M., & Joyce, J. ,2014, 3D opportunity: Additive manufacturing paths to performance, innovation, and growth. *Deloitte Review* , *Issue 14*.

Figure 8 - Breakeven analysis: Traditional manufacturing costs vs. 3D printing



Source: *Deloitte University Press*

On the graph presented above, it is possible to see a decrease in the average unit cost as a result of an increase in the number of units produced. Traditional manufacturing processes yield cost advantages at higher volumes (economies of scale). When looking at 3D printing, the cost of producing units remains flat, not depending so much on volumes. The intersection between these two lines is the breakeven point, where traditional manufacturing surpasses the cost advantages of 3D printing. However, is expected that this breakeven point will continue to increase in the future as the technology improves.

Scope Economies ([23])

This concept is applied to the lowering of the average cost of a firm in producing more than one product; namely as a result of flexibility of a unit of capital. Scope economies present an advantage by producing with the same installed equipment, multiple different products. Traditional manufacturing methods often create limitations in product development due to

[23] Cotteleer, M., & Joyce, J. ,2014, 3D opportunity: Additive manufacturing paths to performance, innovation, and growth. *Deloitte Review* , *Issue 14*.

the high number of parts required to create that final component. Additive manufacturing surpasses all of these problems by creating the final component with a single machine, in one step. A good example of AM capabilities can bee seen in the case of GE new generation aircraft engine. With a printer, GE was able to manufacture the final engine component that in the traditional manufacturing required the welding of 20 small pieces ([24]). Flexibility with decreases in capital costs and increases in innovation.

On the table below its possible to see the potential future economic impact of this technology by 2025:

Figure 9 – Potential impact of additive manufacturing by 2025

Applications	*Potential Economic Impact ($billion/ annually)*	*Potential Productivity or value gains by 2025*
Consumer use of 3D printing	100-300	60-80% value increase per 3D-printed product. • 35-80 % cost savings to costumers • 10% value of customization
Direct product manufacturing	100-200	40-55% cost savings to buyers of 3D-printed products
Tool and mold manufacturing	30-50	30% production cost reduction using superior 3D-printed molds

Source: *McKinsey Global Institute analysis ([21])*

Consumer use of 3D printing: The potential economic impact is based on the reduced cost printing a product versus buying the item in directly in the retailers, and also the value of customization. It is expected that a 5-10% of products like toys, jewelry, and accessories among others, to be printed.

Direct product manufacturing: The potential economic impact comes from printing direct manufactured products with the elimination of tooling, waste, and handling costs ([25]).

Tool and mold manufacturing: This technology has the capacity of reducing setup times, eliminate tooling errors and increase productivity of the injection molding process. McKinsey

[24] http://www.technologyreview.com/featuredstory/513716/additive-manufacturing/

stated, "*We estimate that 3D printing of tools and molds could generate $30 billion to $50 billion in economic impact per year by 2025, based on an estimated $360 billion cost base for production of injection molded plastics in 2025 and assuming that about 30 to 50 percent of these plastics could be produced with 3D-printed molds at around 30 percent less cost."*([25])

If we sum the total potential economic impact of this technology within these three main topics, the value will range from 230 to 550 billion dollars by 2025. It is also important to highlight the potential impact of 3 D printing in the tool and mold-manufacturing sector. This fact will impact directly Simoldes, as a plastic injection and mold making company. Another important figure is correlated with cost advantages. It is expected that by using 3D printed molds their cost will suffer a 30 % reduction.

4.5.Impact of 3D printing in the automobile industry

The Automobile industry was one of the first adopters of this technology, using these printers for the fast creation of prototypes. Due to the latest developments, the scope of the usage of this technology has increased. Many companies are realizing the potential benefit of the incorporation of these machines in their manufacturing processes.

There are several examples of companies that are using 3D printers as part of their production and product development process. Bentley Motors, a luxury car company, is printing small-scale models and parts for assessment and testing ([26]). A Swedish manufacturing company called Koenigsegg, responsible for the creation of the model One:1, one of the fastest cars in the world, used 3D printers as a tool from the beginning until the final production of this car. Initially, for the creation of the prototype, and then for manufacturing metal parts for the turbocharger and exhaust system ([27]). Another important development was the creation a car called Urbee. This car is cheaper and more fuel-efficient

[25] Manyika, J., Chui, M., Bughin, J., Dobbs, R., Bisson, P., & Marrs, A., 2013, *Disruptive technologies advances that will transform life, business, and the global economy*, McKinsey Global Institute, pp.111
[26] http://3dprintingindustry.com/2013/09/15/a-peak-inside-bentley-motors-with-stratasys/
[27] http://3dprintingindustry.com/2014/03/12/koenigsegg-striving-make-worlds-fastest-car-3d-printing/

than almost any other car in the world, and it's the first vehicle that was manufactured essentially from 3D printed parts. Many other big car companies, such as, Volkswagen, Toyota, and GM, are using this technology as a complement of their activities ([28]). Another important application is the reproduction of old replacement car components that are not being produced anymore.

In essence many auto companies already identified many benefits in using 3D printing processes. These advantages range from saving time and money in the development process, innovation, and replacement of some components that required the development of the mold (traditional process of producing a component). Will this technology, in the future, be able replace Auto-component car manufacturing companies, like Simoldes? How should they react regarding these new advances?

5. Simoldes and additive manufacturing

Managers of Simoldes Group are already aware of the capabilities of this technology. A budget was set in order to purchase a 3 Dimensional printer. It is obvious that, due to strong economies of scale, the traditional process will always be preferable when comparable to printing component by component in a big scale. However, when looking at the constant developments in this area, it is expected that the cost of producing units using this technology to decrease. Consequently, the gap, regarding economies of scale between additive and traditional manufacturing will fall.

As stated before, big car manufacturing companies are already using this technology. They are producing components that at a certain extent are replacing the need for auto component companies like Simoldes. Being able to print a final product without the need for the traditional methods is allowing these companies to fasten their product development reducing normal associated costs. Furthermore, car-manufacturing companies are using this technology for special components, key elements for engine or safety parts. Products where quality is more important than the costs associated with production.

[28] http://archive.timmmmyboy.com/2012/12/3d-printing-volkswagen-parts/

There are several advantages that could be explored by integrating 3D technology into Simoldes manufacturing processes.

Concluding, it is important to sum up the most important potential advantages of additive manufacturing: time and cost efficiencies, flexibility of capital, decrease of the minimum efficient scale, innovation, shape freedom, and customization.

Printing in metal is possible, something that some years ago was considered to be very difficult to achieve.

Technology in this area is growing exponentially; products are being printed with higher levels of complexity on a daily basis.

5.1. Alternatives going forward

There are several approaches that Simoldes managers could have regarding the introduction of this technology in its manufacturing processes.

Wait and see

In this approach Simoldes managers do not have a proactive attitude regarding 3D printing technology. They will wait the future developments of these machines, having more time to check more facts and statistics regarding this topic. Since they are not the fist adopters, managers will see how competition is proceeding. Only after the deeper analysis, Simoldes will incorporate additive manufacturing into their processes.

Just for rapid prototyping

Purchasing a 3D printer for the fast creation of prototypes. Rapid prototyping can be useful for both divisions of this company. As stated before, in the Plastic division it will allow a deeper study of the component before embarking in the creating of the mold. As for the Tool division, prototyping parts of the mold will be helpful in order to detect future conception mistakes. These machines will act, mainly, as a tool to avoid future problems in its traditional manufacturing processes.

Simoldes Tool Division

This approach implies a deeper incorporation of this technology in Simoldes Tool Division manufacturing processes. The creation of printed parts of the mold is the main propose. It is also possible the development of fast prototypes. The full capabilities of additive manufacturing will be explored in this approach.

Simoldes Plastic Division

As in the previous approach, additive manufacturing is incorporated as a complement to Simoldes plastic division manufacturing processes. 3D printers will be used to create directly the final components. It is also possible the creation of fast prototypes for further study.

Exhibits:

Exhibit 1: *Example of a small dimension plastic injection mold*

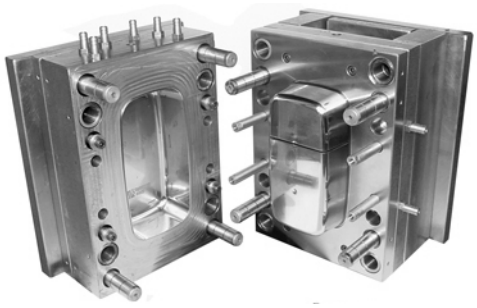


Exhibit 2: *Example of plastic final components manufactured by Simoldes Plastic Division*

Source: *http://www.simoldes.com/plastics/products1.html*

***Exhibit 3**: Example of an industrial 3D printer*

Source: *Stratasys Ltd, World's Most Effective Large Format 3D Printer for Industrial Scale Prototypes*

***Exhibit 4:** Example of the 3D printer of the Portuguese Company Beeverycreative*

Source: *https://www.beeverycreative.com/*

Exhibit 5: *3D printing manufacturing companies (Industrial printers)*

Companies	Revenues (€ million)
Stratasys	484
3D Systems	230
EOS	124
Objet Geometrics	120

TEACHING NOTES

1. Introduction

The teaching notes section aims to provide the instructors with a plan. It is a written note of the class plan. The goal is to identify the key aspects that are presented in the case. Furthermore, some theoretical analyses will be presented aligned with suggestions and recommendations for the class discussion.

2. Synopsis

Simoldes is a multinational Portuguese owned company. This firm is divided into two different, but yet, related divisions. Simoldes tool division and plastic division. The first one is responsible for the manufacturing of plastic injection molds. As for the second division, they are accountable for the injection of the plastic and consequentially production of the final plastic component. The main stream of revenues comes from this division. Simoldes works mainly for the automobile industry being one important and recognized supplier of this economic sector. In order remain competitive; this company has to keep up with the new technologic advances.

3 Dimensional printing or additive manufacturing is a technology that appeared some decades ago. However, latest advances are allowing manufacturing applications and advances to companies' value chains. This technology consists in a printer that is capable of printing 3 dimensional products. Manufacturing companies are already using this technology, noticing several advantages in the incorporation of AM in their processes.

Simoldes is already planning to explore these advantages; they already set a budget for the purchase of one of these printers. Should they incorporate this technology into their manufacturing process? Or ignore it? Could this affect both divisions? What should be the best strategy regarding 3D Printing?

3. Suggested questions

3.1. Core assignment questions

1. What advantages to you think 3D printing technology can bring to manufacturing companies?

2. Do you think that Simoldes should adopt this technology? What are the potential benefits?

3. In which of Simoldes Division do you think 3 D printing technology has a better fit? What are the potential threats?

3.2. Additional assignment questions

In this set of additional assignment questions students will be able to apply the frameworks presented above.

4. How you describe the Portuguese auto component industry?

5. How would you define Simoldes evolution and strategy? Which do you consider to be their KSF?

9. Regarding their internationalization strategy, will this technology help Simoldes in this process?

4. Teaching objectives

Simoldes case study was developed with the fallowing teaching objectives:

- Understanding the impact of a new technology advances into companies' strategy.
- Understanding the benefits that additive manufacturing technology can bring to Simoldes manufacturing processes.

- Throw the additional assignment questions students will analyze and interpret the internal and external environment of Simoldes company and automobile industry; it is expected the use of strategic framework tools, such as SWOT, PEST analysis, and Porter five forces. With this, students will be able to comprehend this sector and furthermore, understand the potential implications of 3D printing in this sector.

- Understanding and decoding of the main data and figures correlated with Simoldes and Automobile Industry

5. Use of the case

This case study was developed with the objective of demonstrating a real situation about a Portuguese company. New technology advances that can bring major changes into their manufacturing process. The objective is to create a class discussion allowing students to think in a strategic perspective using tools that where previously learn and studied. Due to this fact, strategy courses will be the target of this case. For master programs: Strategic management and Innovation Management are good examples of potential courses that could use this case. For Undergraduate students, it is suitable for more advanced courses, since it implies some preview strategic knowledge.

6. Relevant theory

In order to analyze and discuss the case presented, students can use several strategic framework tools. These theoretical approaches will allow a deeper understanding of the industry along with Simoldes strategy. The frameworks should be related to the company structure and the external environment of this industry. In the list below it is possible to find several theoretical strategic tools that where used in order to answer the additional assignment questions. These concepts can be seen and studied in most of the strategic management books, for example:

- Lynch, Richard, 2009, Strategic Management, fifth edition, Prentice Hall;
- Hollensen, 2011, Global Marketing: A decision-Oriented Approach, fifth edition, Pearson Education Limited

Strategic framework Tools:

- *PEST Analysis*
- *Porter´s 5 Forces*
- *Value chain Analysis*
- *SWOT analysis*
- *Entry Modes strategy*

7. Analysis and case discussion

Core assignment questions:

1. What advantages to you think 3D printing technology can bring to manufacturing companies?

From the case study, students are able to identify main advantages of the incorporation of 3 D printing technology in companies manufacturing process. Additive manufacturing had proven to be helpful in almost every industrial sector in the world. From **FIGURE 6** it is possible to see that the sales of this machines are expected to growth over 300% in the next 8 years. The increased interest in this subject is leading also to constant technological advances in this area. The complexity and range of materials that can be printed is growing in an exponential way. When looking at **FIGURE 7** it is possible to see the main industries that are using additive manufacturing as part of their value chain. Companies are now able to develop products in a way that traditional manufacturing processes did not allow. Therefore, there are several advantages that can be pointed out:

- *Rapid prototyping:* companies are now able to develop quick prototypes in an inexpensive way. The cost associated with development of a new product in a traditional way is much higher. It requires a set of procedures that are completely

eliminated when using a 3 D printer. Creating and testing new products is now easier involving fewer risks.

- *Mass customization*: the ability of creating customized products is very high. With only one machine, companies are able to overcome several complex steps that make mass customization very hard. The outcome is the creation of single products for every costumer in a fast and cheaper way.

- *Decreasing of the minimum efficiency scale:* by eliminating traditional manufacturing processes (set up and tooling costs), companies with additive manufacturing can have this minimum efficiency scale reduced to only one product.

- *Scope Economy advantages ([29])*: increased flexibility of the capital. Using additive manufacturing, companies with only one machine are able to manufacture a big range of different products. In the traditional process, normally, different machinery is required for each individual product line.

All of these facts can be placed into two main advantages: cost and time efficiencies. When looking at all factors stated above, it is possible to see that traditional manufacturing process are capable of creating the same products as additive manufacturing. However, the costs (not taking into account economies of scale) and time required to create a product is different, being more efficient with this new manufacturing procedure.

[29] Cotteleer, M., & Joyce, J. ,2014, 3D opportunity: Additive manufacturing paths to performance, innovation, and growth. *Deloitte Review* , *Issue 14*.

2. Do you think that Simoldes should adopt this technology? What are the potential benefits?

As stated on the case, manufacturing car companies were early adopters of this technology. Additive manufacturing can bring several advantages for Simoldes, however it can also creates a threat to their business. Companies like Volkswagen Group, Toyota, and GM are already using printers to produce some special car components. At a certain extent, they are already substituting the services of companies like Simoldes. However, when looking at **FIGURE 8** it is possible to see that due to economies of scale, molds and injection still presents cost advantages, especially, when a big volume of products is required, which normally happens in automobile industry. As a result, nowadays, it is impossible for car manufacturing companies to produce their all components through this technology.

Despite this fact, implementing this technology in Simoldes manufacturing process is key and brings several advantages. We already know from the case that Simoldes has a set budget for the purchase of a 3D printer. It is the first step towards this technology. There are several advantages that can be highlighted with the deeper incorporation of 3D printing technology in Simoldes manufacturing process.

- *Rapid prototyping:* as stated before this technology can help the Plastic division to print the final component, allowing a richer analysis before starting the traditional manufacturing process. Moreover, the Tool Division can create a prototype of the final mold or parts of them, allowing employees to detect mistakes in a much faster and cheaper way.

- *Supplying of final components immediately*: automobile industry is very demanding. Additive manufacturing can allow Simoldes to start supplying final components to their clients in a much shorten period of time. If we look to the graph in **FIGURE 8,** we see that the cost of production in AM is constant. Also due to economies of scale the traditional process will have cost advantages. Simoldes can take advantages of both processes. From the moment that they receive an order they can start using printers to supply immediately the final plastic

components. At the same time Simoldes is developing the mold for further injection. Allowing them to be much faster than the competition. A characteristic that is key for their demanding sector.

- *Low number of components required by the client:* also when we take a look a graph of **FIGURE 8** it is possible to see a breakeven point between traditional and additional manufacturing. This point represents the time that molds and injection processes start to have cost advantages when compared with the printing of a component. After determining this breakeven, Simoldes can decide which of the process will offer better cost advantages. If the order requires a number of products until this point, additive manufacturing is the right path to fallow. On the other hand, if the number is superior, traditional processes will be the right process to choose. As stated on the case, it is expected that the breakeven point will decrease in the future. This means that the cost of producing each unit using additive manufacturing will decrease. Meaning that, in the future, on a volume based production, the gap between additional manufacturing and traditional will decrease.

- *Manufacturing parts of the mold*: printing a mold as a whole unit it is not possible yet. Due to the complexity of parts of each of these units, it will be very difficult to create a mold solely using this technology. However, printing some parts of each mold is already possible. When we look at **FIGURE 9** it is possible to see a potential economic impact in tooling and mold industry of 30 to 50 billion of dollars. Furthermore, regarding the productivity gains it is expected a 30% cost reduction in 3D superior printed molds by 2025.

- *Expansion of product diversity:* Simoldes is specialized in plastic components. If we take a look at **FIGURE 3**, it is possible to see that revenues of their main competitors are much higher. The main reason for this difference is the range of components that the other companies supply. With additive manufacturing Simoldes will have the capacity of offering a larger range of products, not only in plastic, taking into advantage of the economies of scope presented on the case.

Allowing the manufacturing of new products without the usual massive investment required.

- *Components complexity that due to their specifications do not depend on price:* As it can be seen in **FIGURE 7,** human tissue is already being printed. Probably the most complex material in the world. This fact shows, once again, the potentiality of these machines. The components that are linked with safety, normally, the ones that absorb the impact in case of a crash have certain special characteristics. For automobile manufacturing companies these products are not that price sensitive. Additive manufacturing can allow Simoldes to produce these special components. Simoldes will able to create components with different and completely new shapes. Furthermore, they can use higher set of complex materials complementing their plastic final products. A good example is titanium, a material that can be already used by additive manufacturing, which proven to be very good as a crash absorber.

- *CSR (Corporate Social Responsibility)*: company's activities, normally, have a negative environmental impact. Waste, high consumption of resources, and pollution are examples of this fact. Additive manufacturing will help Simoldes in their CSR activities. This is "green" technology with minimum levels of material waste plus low energy consumption rates.

Adopting this technology will bring several advantages to Simoldes. Due to all facts stated before, investing in additive manufacturing should be one of the priorities of this company. By being in the vanguard of 3D printing manufacturing processes Simoldes will create new sources of competitive advantages when compared with their main competitors. Concluding, when looking at the paths to go forward the immediate incorporation on additive technology in both Simoldes divisions is the right will be the right move.

3. In which of Simoldes Division do you think 3 D printing technology has a better fit? What are the potential threats?

It is clear that both divisions can benefit with the incorporation of this technology in their manufacturing process.

In the plastic division the fast creation of prototypes will the first objective/application of this technology. Furthermore, supplying components only with the use of these machines could be the next step. Then, the creation of more complex final products will also be possible. A positive direct impact of this technology in this division implies the immediate incorporation of 3D printing technology.

Regarding the tool division, the constant technology advances are allowing bigger objects with a higher number of materials to be printed, making 3D printing a good fit for this division. By printing some parts of the molds the cost of these tools is expected to decrease. Additive manufacturing will have also a positive direct impact in this division. The immediate incorporation of this technology into this division is also recommended.

There are several threats that this technology can bring to Simoldes business model. As stated before, their main clients are already exploring the capabilities of these machines. With constant technological developments, additive manufacturing can reach a point that allow big car companies to upstream their value chains by producing their own components and molds. This threat reinforces the fact that Simoldes have to take advantage of this disruptive technology before it is too late.

Additional Assignment Questions:

4. How you describe the Portuguese auto component industry? (Students should bear in mind the potential impact of additive manufacturing in this industry)

In order answer this question; there are several strategic framework tools that can be used. Pest analysis and 5 porter forces are two good examples. With PEST analysis students will be able to identify the macro environment factors that affect the automobile industry. It comprises four different parameters: political, economical, social, and technological. Furthermore, with 5 porter forces it is possible to assess the competitive intensity and attractiveness of the market. Allowing a micro-environment perspective looking at five different perspectives: bargaining power of suppliers, bargaining power of buyers, threat of substitute products, threat of new entrants, competitive rivalry in the industry. Moreover, the potential impact of additive manufacturing in this industry will be discussed.

PEST Analysis- Portugal and main markets of Simoldes

Political factors

When analyzing political factors, students have to take into account that Simoldes is a multinational company. However, the location of their Head Quarters is in Portugal and the main markets are in Europe. Nowadays, due to the economic crisis, political environment in Portugal is facing some problems. Population is not happy with the constant increase taxes, either on a personal level, either on a company level. However, it is possible to state that the political environment is stable.

Being a part of European Union brings several advantages to Portuguese political environment. Free movement of individuals and goods allows companies to export their products without additional costs. The trade restrictions are very low within this area.

Regarding the tax policy, its possible to state that the level of company taxes is high in Portugal, when compared with other developed countries. This fact creates some

restrictions to potential investments. However, labor law is suffering reformulations. Nowadays, it is easier to change companies labor force, a fact that was very strict some years ago. There are also several business laws to support private initiatives and investments in EU zone.

Economical Factors

The activities of Simoldes do not depend on Portuguese domestic market. It only accounts for 2 million euros in revenues. However, major activities are centralized in Europe. Due to international crisis, mainly in Europe, growth rate of country´s economies had been very low if not negative. Furthermore, when looking at interest rates, borrowing money from the banking system at a sustainable interest rate had become very difficult. This credit crisis impacts in a negative way, the amount of investment that Simoldes is capable of doing. On the positive side, inflation rates had been controlled by European Union and due to the Euro currency; there is no need of using different exchange rates in Simoldes major markets.

It is also important to look at Brazil economical factors, where Simoldes has manufacturing facilities. Brazil economy is showing high growth rates. However, there are several factors that can affect Simoldes activities. The high interest rates creating barriers to investment. Inflation rate is also high and not strictly controlled. Finally, exchange rates are volatile.

Social Factors

Social indicators in Portugal and Europe showed that the population life expectancy had been increasing over the last decade. Medical practices and increase awareness for the healthy habits are increasing population quality of life. However, the population growth has remained quite stable. This has an economic impact and affects directly the recruiting process of companies. The workforce is becoming older leading to increases in labor costs. On the other hand, academic formation is increasing. Youngest working population is used to high job rotation, acquiring an experience that some years ago, with the job for life attitude was not possible. The wiliness to embrace international projects and carriers is very high. This fact can help Simoldes in their internationalization process.

Technological factors

Technological factors represent an important element for the development of any economy. The manufacturing industry is highly dependent on automation processes, R&D activities, and innovation, in order to remain competitive. Portuguese companies are not well recognized for their degree of technology advances and processes. This fact affects the image of Portuguese corporations. However, efforts are being made in order to change this view. Nowadays, the brand made in Portugal is gaining worldwide recognition.

Porter ´s 5 Forces

Bargaining Power of Suppliers

There are two main sources of suppliers: labor and raw materials. Simoldes as stated before, have their main facilities in Europe. Having access to raw materials in this zone is quite easy. The main materials required are for this company is: steel, for the production of molds (**EXHIBT 1**), and plastic and derivatives, for the injection/production of the final component (**EXHIBT 2**). The availability of companies selling these raw materials is high. Furthermore, due to the dimension of Simoldes, the power to negotiate prices and conditions with their main suppliers is high. However, skilled labor, with knowledge in this sector is not easy to find. Therefore, the bargaining power of suppliers is *MEDIUM/LOW*

The incorporation of additive manufacturing will not have a big impact in this area. There are several companies developing 3D printers. Due to the increase interest **(FIGURE 6)** in this area, it is expected that the number of companies supplying this technology to increase. As result a the bargaining power of the suppliers will continue *LOW*

Bargaining Power of Buyers

Simoldes is a B2B company in both divisions. Their main clients are big car manufacturing companies for the plastic division (Porsche, Toyota, Citroen, Peugeot, Volkswagen) and auto component manufacturers for the tool division. It is possible to state that this company, despite of having several costumers, they depend on some major multinational

corporations. They tend to enroll in multimillion-euro contracts, which lead to some degree of dependency on these costumers. However, there are no substitute products and the buyer price sensitivity is not very high. As stated on the case, quality of the molds and final components has to be very high. As a result, costumers prefer quality over price. Regarding switching costs they are low. Taking into account this factors, it is possible to state that bargaining power of buyers is *MEDIUM.*

With additive manufacturing, Simoldes will be able to supply a higher range of products. Not only focus on plastic. As a result, their number of clients and projects can increase. This fact will have a direct impact on the bargaining power of their clients; it will decrease it to MEDIUM/LOW. A more diversified set of costumers.

Threat of Substitute Products

The threat of substitute products is LOW for both divisions of Simoldes, when we look at todays manufacturing processes. Nowadays, there is not on the market any other product that could satisfy the same need. Molds and plastic components are key elements in the manufacturing car industry.

However, the latest developments in additive manufacturing are disrupting this sector. Printers are now able to develop final components without the need of creating a mold. This fact creates a potential threat to Simoldes. For this reason and taking into account a close future, the threat of substitute products is *MEDIUM.*

Threat of New Entrants

The automobile components industry is big and profitable (**FIGURE 1 and 2**). Normally, it should attract many companies searching for the spare profit. However, there are several barriers and aspects when entering this sector. The first barrier is the set up costs. In order to be competitive companies, have to spend a large amount money building facilities and acquiring machinery. Then, skilled workforce with experience in this sector, is not easy to find and also expensive. As a result, the sunk costs are very high. Big players like Simoldes benefit from economies of scale, making very difficult for new entrants to compete in terms of costs and prices. Costumer loyalty is another fact that has to be taken into account.

Simoldes, for example, have already a established and recognized name. Their costumers are loyal and tend to repeat purchases for many years. It is also important to state that all these factors apply for both company divisions. Assuming all the barriers stated before, it is possible to say that the threat of new entrants is *LOW*

Additive manufacturing can bring several companies into this sector. As stated on the case, the flexibility of these machines is very high. Companies can start using this technology to produce plastic components and molds without many of the barriers stated before. It is also important to state that manufacturing car companies, Simoldes clients, are already using 3D printing technology to create some components. As a result the potential threat of new entrants is *MEDIUM/HIGH*

Competitive Rivalry in the Industry

Regarding rivalry in this industry, it is important to differentiate Simoldes divisions and then make an overall assessment. Regarding the plastic division, there are several major players in the market (international competition) (**FIGURE 3**). They are bigger than Simoldes. However, they supply a range higher range of products, not being specialized in plastic injection components. These companies have a strong name in this market having many years of expertise. For this reason the competitive rivalry in this division is *HIGH.* On the other hand, tool division is the European leading in the mold-making process. In Portugal there are many small companies making molds, however they cannot be consider as rivals due to their dimension. As a result competitive rivalry in this division is *LOW.* Furthermore, when looking at Simoldes and their linkages between both divisions (**FIGURE 5)** it is possible to state that there is not a major player with the same characteristics of Simoldes. When taking Simoldes without separating their divisions the competitive rivalry appears to be *LOW.*

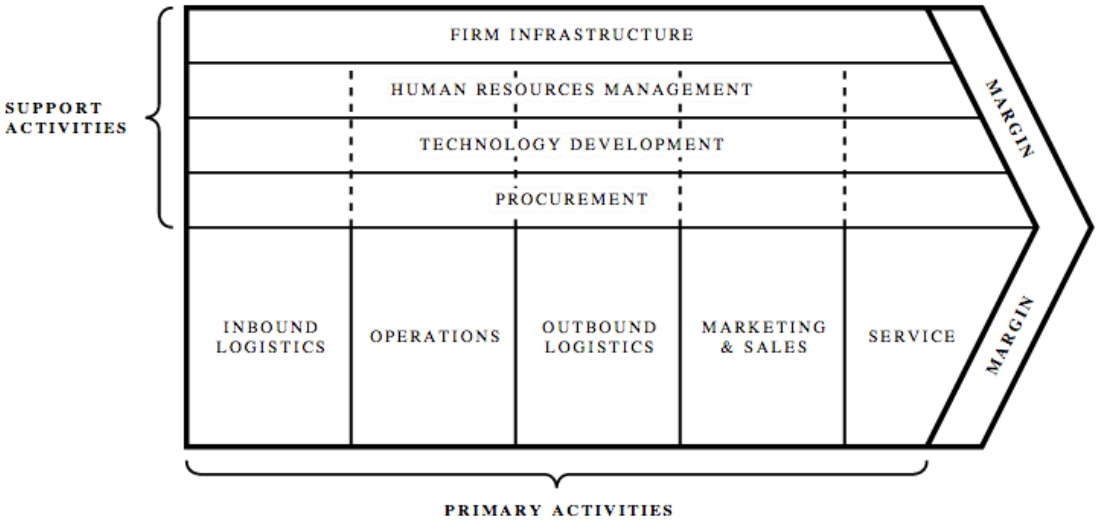
Additive manufacturing, as stated before, can bring more companies to this sector. It is expected that the potential rivalry in the industry to be *HIGH* for both divisions (plastic and tool)

5. How would you define Simoldes evolution and strategy? Which do you consider to be their KSF?

In order to understand the main characteristics of Simoldes Company, it is important to organize the information provided on the case. A value chain and SWOT analysis will help student to summarize all information and identify Simoldes key success factors,

Value Chain Analysis

Value chain is the chain of activities that a company performs in order to deliver their product or service in the market. It allows an understanding of the different activities, classifying them as primary and support. With this tool it will be possible to recognize with of this activities are more important for Simoldes.



Michael Porter´s value chain

Taking into account the primary activities: Operations and services are the most important. Regarding Operations, the set activities required to achieve final products, are key for this company. This incorporates product development and manufacturing process, the linkages between both divisions are critical (**FIGURE 5**). The after sales services departments (ACS, CSC) (**FIGURE 4**), are also important in order to ensure the working effectiveness of Simoldes products. Concerning, the outbound activities are also important is order to ensure the distribution of the final product effectively. In automobile industry delays cannot happen.

On the other hand marketing is not that important, since Simoldes has already a established strong name in this market

When looking at support activities: Infrastructure and technological Development are the most valued. Simoldes comprises a total of 16 different companies, having this complex structure it requires an infrastructure (general management, finance, legal, accounting) that links and ensures the good functioning of all the companies in the group. Regarding the technological development, it´s one of the most important activities. All the equipment have to be technological advanced and it requires a high level of technical knowledge in order to remain competitive.

Nowadays this is Simoldes value chain, however, additive manufacturing has a capacity to change and disrupt this process. Taking into account the primary activities: operations can suffer a significant change. As stated before, 3D printers have the capability of reaching the final component in just one step.

SWOT Analysis

This framework helps students to organize all the information that was discussed by the other analysis (PEST, Porter 5 forces, Value chain). SWOT analysis allows a deeper understanding of the strengths and weaknesses of Simoldes and also the possible threats and opportunities to its business. With this framework it is going to be possible to deduce the key success factors of this company.

Strengths:

- Recognized brand name in the sector, costumer loyalty.
- Quality and reliable products.
- Leading company in Europe for the production of injection molds.
- Value chain: having a division responsible for the manufacturing of the molds and other for the injection of the plastic leads to more control over their value chain;
- Time efficiencies: the time required to development of the mold and production of final component is low.

- Experience and know-how: this company operates since 1959 which allow them to have major expertise advantages;
- Linkages between 2 Divisions (**FIGURE 5**): the interconnections of knowledge and experiences leads to with quality molds and final components
- Skilled workforce with higher levels of experience.
- International experience: they have already manufacturing plants in Brazil, France, and Poland (**FIGURE 4)**

Weaknesses:

- Dependency on major costumers
- Complex structure that comprises a total of 16 different companies within several countries.
- Family leadership: this fact often results on conflicts.
- The biggest competitors in international markets have a much higher revenues **(FIGURE 3)**

Opportunities:

- This company still has many geographic locations where they can enter and expand their global presence.
- Presence in a market that is growing (**FIGURE 1 and 2**) which can allow them to expand their business.
- Expand their range components for this industry, not focusing only in Plastic.
- Additive manufacturing / 3D printing can decrease their unit manufacturing costs either for small series in the plastic division, either for the parts of the mold. (**FIGURE 9**).

Threats

- Potential lack of skilled workforce in order to sustain their internationalization process.

- 3 Dimensional printing technology will eventually affect this company sales due to the increase manufacturing capabilities of this machines (**FIGURE 7**): Simoldes main clients could be able to print either the mold required or directly the final product.

It is clear that Simoldes key success factors depend mainly on its manufacturing processes. Having both divisions working as a complement to each other is allowing full control over this company value chain. As outcome, the quality of products and the seed of their processes are key differentiating factors. Also important to state that their strong name aligned with more that 80 years of experience created a strong and recognized brand name in this industry. Finally, the international presence of this company associated with skilled workforce is allowing a continuous revenue growth.

6. *Regarding their internationalization strategy, will this technology help Simoldes in this process?*

Simoldes has two different types of entry modes: Investment Based and Contract Based.

Investment Based with full Ownership

As stated on the case, when Simoldes decides to enter in new market, fully owned subsidiaries is the preferred strategy. Normally, they start from the scratch, building their manufacturing plants. Part of their competitive advantage remains on manufacturing processes. As so, their structure is homogeneous over the world. This strategy allows them to have more control over their value chain. Since quality and reliability of products is key in this sector, fully owned subsidiaries allow them to remain with their reputation untouched. However, this type of entry mode brings some disadvantages. The investment is very high, building a new and technological advanced plant. As a result there is a big exposure to risk. A exit strategic, due to high sunk costs it will result a high losses. Furthermore, disadvantage is related with the labor. The expertise required to work in this sector is very high, finding a qualified employees is not very easy. Normally, Simoldes have to send expatriates to work overseas.

Contract Based: Licensing contracts

As stated on the case, there are two similar but commercial different types of licensing contract that Simoldes have. In the first one, they are responsible for developing one project, building a manufacturing process of a company not being responsible for the final product. They charge a fee for their services. On the second one, the process is similar, however, they receive a royalty for each product manufactured. Therefore, they are responsible for the product and maintenance of the production. The advantages correlated with the low levels of investment required. However, the control over their products is not as good as in investment based entry strategy.

Additive manufacturing and internationalization process

This new technology can be helpful in the internationalization objectives of Simoldes. The main advantages could be seen in the investment based ownership strategy. As was stated before there are two main disadvantages related to this strategy: high costs, skilled workforce. 3 D printing technology can help to overcome these disadvantages. Setting up a plant with additive manufacturing will decrease the machinery costs required. As we know, the flexibility of this technology is very high. It could be used for both divisions. It will allow setting overseas manufacturing plan, initially, with less initial investment. Regarding the workforce required, it will be low. These printing machines are capable of doing part of the work required to develop a mold or inject the plastic for the final component.

Regarding the contract based strategy, Simoldes, being an early adopter of this technology, will the also able to licensing their expertise/know how in this area.

8. Conclusion and recommendations

The main purpose of this case study was to provide a real experience to students about a Portuguese multinational company that is facing a strategic challenge. New advances in additive manufacturing: 3D dimensional. Students will be able to discuss the potential advances of this technology in a real situation.

The automobile industry is very important for the Portuguese economy; it is growing sector despite of the crisis. Simoldes is an important company in this sector. Their main costumers, big manufacturing car companies, recognize the quality of their final products. Furthermore, it is important to recognize their level of internationalization.

Their manufacturing processes, the linkages between both divisions, presence in several markets, and brand recognition are some of their main competitive advantages. However, additive manufacturing has the capacity of disrupting this sector. As can be seen before, 3D printing technology, in one hand, can bring several advantages; on the other hand, can bring threats to Simodes business model. The incorporation of additive manufacturing into their processes is key for the future sustainability of this company. As early adopters they can gain know how in this area and easily create new differentiating factors.

My final recommendation to Simoldes managers is too incorporate immediately additive manufacturing in the both divisions. This path will allow Simoldes to add several advantages in its manufacturing processes. From the rapid prototyping they will be able to avoid product mistakes before embarking into the normal traditional processes, resulting in time and cost advantages. Regarding the Plastic division, by being able to supply components immediately, they will provide instant response to an order, decreasing the normal manufacturing time required, which key in this sector. Furthermore, using additive manufacturing for orders that do not reach the breakeven point stated on the case, result on cost benefits. Furthermore, levels of innovativeness can also increase. With the flexibility of these machines, Simoldes can expand their product diversity and characteristics of the products supplied. Regarding the Tool division, by printing parts of the mold, is expected a 30% cost reduction on this tools.

Concluding, there are innumerous potential advantages that additive manufacturing can bring to both divisions of Simoldes, as so, immediate incorporation in its manufacturing processes is key. This technology will help this company so sustain and create new sources of competitive advantages resulting on continuous company growth.

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