Comparative commercial evaluation of alternative Superplastic Forming processes, tooling concepts and related post-forming operation as a function of production volumes for automotive application

A Master's Thesis submitted for the degree of
"Master of Business Administration"

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15.11.2010

Affidavit

I, Matthew hereby declare,

1. that I am the sole author of the present Master's Thesis "Comparative commercial evaluation of alternative Superplastic Forming processes, tooling concepts and related post forming operations as a function production volumes for automotive application", 69 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool and
2. that I have not prior to this date submitted this Master's Thesis as an examination paper in any form in Austria or abroad.

Vienna, 15.November 2010

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Signature

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Abstract

The automotive industry is comprised of intricate systems and technologies to make up the largest global industry. At the end of the first decade of the 21st century, five major trends began posing pressure on the Automotive industry, namely: the mobilization of emerging markets, the appearance of Mega Cities, a changing demographic profile particularly in the industrialized countries, the growing awareness of the impact of man-made green house gas emissions, and limited availability of ‘inexpensive’ fossil fuel and steeper competition on commodity markets. Principally the last two trends are forcing the automotive industry to invest in research & development for new opportunities to optimize cost and energy efficiency in production and operation of vehicles.

Superplastic Forming (SPF) an innovative production technology has emerged has a proven potential technology-wise to provide the automotive industry with a new metal forming process that fulfills the industries desire for material and energy efficient production processes. As a result, to administer this sustainability, SPF requires ominous amounts of capital expenditure. Its numerous stage forming processes, coupled with pre and post forming operations poses questionable thoughts to companies looking to potentially “make-or-buy” certain sections of the SPF process sequence to ensure that the value-added activities are retained in-house.

This thesis will address key elements to ensure that SPF continues to grow in its vertical path; the supply chain management will need to certify key elements to ensure that diligent business decisions are taken to accommodate smooth operation flow. Once the supply chain has been stabilized, only then can a foundation of criteria be laid out when a company is faced with a make-or-buy decision. This will set a stepping stone towards the financial analysis of whether to outsource the washing /treatment station of the SPF process or to keep it in house. Lastly, considering the fundamentals of this global economy, an analysis the current volume market and of contingent manufacturing markets to apply SPF technology will be assessed.

1 Technological Evolution of the Automotive Industry

The former Commissioner of the United States Office of Patents, Charles H. Duell has been infamously quoted in 1899 saying, that “Everything that can be invented has been invented.” One can only sneer considering we have since then revolutionized the modern world and enhanced the mode of life due to technology. It is not to say that the modern world has not experienced setbacks because of technological advancements, but in the best part we have witnessed quantum leaps in the last century. Technology has evolved immensely from the way business used to be done. Technology has revolutionized society as a whole, leaving a nation of people intoxicated by the effects that technology is never ending. Needless to say, technology will continue to speed up progress as it has inherently improved our way of life. Our workplace is geared towards technology and therefore improves the working process, as a whole, advances in technology is currently meeting and in some cases not meeting business expectations.

The automotive industry is a living testimony of those advancements; the car before the 1900’s was merely a luxurious means of transportation, and vehicle producers were pushing advancements onto the consumer. Henry Ford helped pave the way for the masses by developing the vehicle mass production process with the help of vision and technology, and Enzo Ferrari turned a passion into a leading automotive name focused on styling and technical superiority. Contrastingly, the industry today is now at a different cross road, the consumer market is currently dictating what should be developed and what should be left in concept phase. OEMs and suppliers are battling this effect by succumbing to the pull affect of the market, and too often not capable of bringing their new technologies to market fast enough. However, in order to execute such leaps, proper R&D must be in place to incite new technologies and/or products. These advancements are only possible when one goes beyond the status quo and begins thinking of new manufacturing possibilities.

The stamping industry has made little improvement since the 1960's, the traditional insertion of stamping dies in a mechanical or hydraulic press as remained constant until present. A traditional stamping creates generally 20% value added, and the other 80% is commodity driven. Needless to say, the rising cost of commodities is proving to be burdensome for many stamping facilities considering the value added distribution in the piece price. When hydroforming made its debut onto the market, it proved to be a groundbreaking technology technically, and most importantly financially. It used the conventional lower die, but as oppose to using an upper die to form the part, it forced water under high pressure conditions to extract a seamless part, this enables the stamping facilities to extract complete chassis' in 'one stroke', thus increasing the value-added of every piece.

1.1 Superplastic Forming

Scientific curiosities eventually led to Superplastic Forming (SPF), a groundbreaking manufacturing technology used primarily in the aerospace industry. In the past thirty years there has been a remarkable evolution of SPF in aerospace and automotive industry for making small volume components with very complex geometry and large deformation that otherwise would have been impossible to make or it would have require much higher manufacturing costs. Occasionally a single SPF part can even substitute an assembly of several parts made from conventional materials and processes. The limitation of SPF is its very slow forming cycle time, hindering the possibilities for large volume production (80k plus production volume per year). The choice of specific metal alloys that display exceptional ductility will be the initial commencement to execute the SPF process.. Such alloys are characterized as being superplastic, for example the aluminum alloy (AA5083). The ductility of superplastic metal alloys typically ranges from 200% to 1000% elongation when heated. Therefore, superplastic alloy sheets can be formed by a variety of processes into complex shapes. To obtain these complex geometries, an aluminum blank must be heated to temperatures ranging between 400° to 550° celcius. The traditional way of heating a blank is done in the press between the closed upper and lower die. The sheet is clinched between the upper and lower die under a tight seal, and the only material which is permissible to be formed is the area of the sheet that is within its clinched edges. Once the material is sealed between the upper and the lower, air is then blown at a controlled pressure, calculated by engineers, so the strain induced on the sheet is consistent with the required elongation in order to form the part without any splits. The forming process is where lies the value added, however subsequent operations must be introduced to deliver a finish product. To obtain flawless class A surface, a film must be applied onto the surface, in most circumstance either boron or graphite are the materials of choice. However, once the forming process is done the boron or graphite application must be washed from the part as well as from the tooling. The part is then washed back to its natural state, at which point it is then ready to get laser trimmed. The traditional SPF process is time and energy intensive, in order to speed up the forming process without losing acceptable ductility for automotive applications, significant efforts have recently been made in the areas of material development, tooling, and process/product design.

Aluminium is approximately 40% lighter than steel, with higher impact absorption properties, better strength to weight ratios and superior corrosion resistance. Given the multiple challenges of reducing weight and increasing fuel efficiency, in addition to environmental constraints such as the need to improve the recyclability of materials, it is not surprising that aluminium structures and components remain the subject of massive research and development by the automotive industry. In the case of SPF aluminium, there are the added benefits of;

- Enhanced design freedom
- Potentially lowering tooling costs
- Shorter lead times
- Rapid prototyping

Superplastic Forming technology offers the potential to reduce the weight and cost of automotive parts and structural components for advance vehicle applications. Furthermore it offers potentials in the manufacturing area;

- Reduces weight of the product by eliminating joints, bolts, rivets, welds, etc
- Reduces inventory by eliminating need for assembly
- Reduces overhead and labour costs by cutting out assembly and machining steps
- Higher material ductility
- Allows for more complex structures and more advanced applications
- Final product does not suffer from traditional springback issues or residual stresses
- Can be used to form complex near net shape parts
- Reduction or elimination of subsequent machining (tooling recuts)
- Minimizes the amount of manufacturing scrap produced

SPF process overview

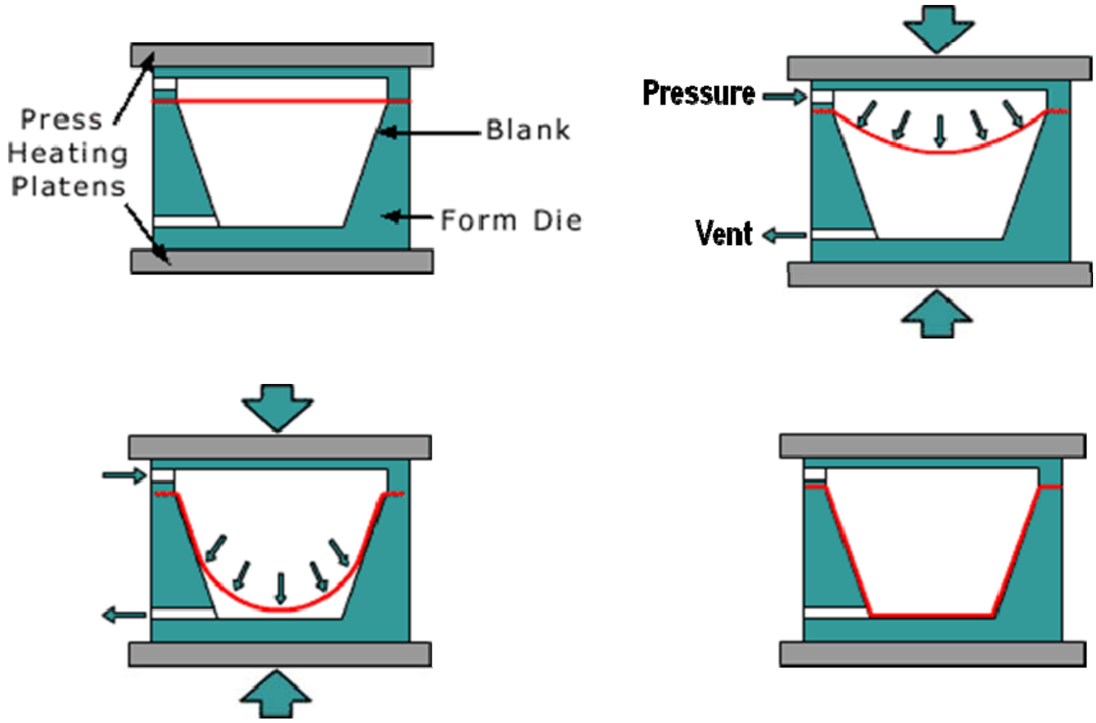

Figure 1-1: SPF Process Overview (Super Plastic Forming (2009))

Having established the latter part of the SPF process, the future sustainability needs to be addressed. Environmental and economical issues have embodied tremendous attention in state legislation during the last decade. The increasing prices of exhaustible fossil fuels, and the lack of feasible alternative fuel sources, coupled by increasing pollution and global warming trends, have lead to continuously growing pressure on the transportation industry, particularly onto the automotive industry to cut fuel consumption and lower exhaust emission levels. Among the different proposed means to achieve such cuts, reduction of weight remains one of the most influential and the least costly. However, the customers' increasing demands for safer, more powerful and luxurious vehicles have been adding more weight to the various categories of vehicles, even the smallest ones, making the realisation of lighter cars even more difficult and challenging. Without the extensive use of light yet strong materials; lightweight materials (LWM), it will not be feasible to achieve the weight reduction targets on the desired scales.

1.2 Importance of Lightweight Materials for the Automotive Industry

Lightweight materials, particularly the metallic structural ones, such as titanium, aluminum and magnesium alloys, have been receiving a great deal of attention over the past decade. Their densities are 40% lighter than conventional steels (Automotive Aluminium (2010); a fact that is highlighting the great weight-saving potentials promised by these materials, if they could be successfully implemented in specific application.

Titanium and aluminum alloys have secured a good position in the aerospace industry, and that is mainly because weight-saving remains a prime factor that surpasses other influential ones, namely, cost and production time. Yet, the last two factors are still dominant in the automotive industry, making the share of titanium almost obsolete, and that of aluminum attracting much attention from the OEMs.

Several interacting factors are responsible for the limited use of LWM in the ground transportation sector. On the manufacturing level in particular, and though it varies by the specific material and the application, all of them share the aspect of limited formability compared to steel. That is why the overall application success of these lightweight alloys is dominated by die casting; and unless their use is expanded to cover other areas, mainly sheet metal body panels, feasible weight reductions will be quite limited and costly. As lightweight alloys' have limited formability, which dampens product design. SPF technique brings new possibilities and creates more opportunities for their widespread use in sheet metal applications. As a result SPF has gained a lot of interest over the past decade, and this trend should indeed become an intricate part of the automotive industry in the future.

As it stands, SPF has proven to be an efficient cost-worthy process in forming various lightweight components for aerospace and medical applications. Yet, this seemingly perfect process-material partnership faces some challenges that still hinder its widespread use in the automotive sector. The aggressive mass-production nature of the industry, which the SPF techniques still cannot meet, represents the greatest potential of all. On the brighter side, the SPF techniques and LWM share an intrinsic characteristic that differentiates them from other conventional materials and processes. In spite of their sustainable nature by their own right, it is the unique combination of SPF/LWM that does indeed strengthen their standing as a prospective promising solution to the escalating environmental and economical issues, and the pressure they are exerting on the transportation industry in general, particularly the automotive industry. The promising potentials of the SPF technique to form lightweight sheet metal parts for applications in the transportation industries, and consequently its role in reducing the industries' adverse effects on the environment, are emphasised.

1.3 Automotive Legislative Changes

The automotive industry has made a voluntary commitment to reduce fuel consumption levels by 25%, by the year 2005, in comparison with the 1990 level. In Europe, Euro 1-6 emission standards have been put in place to curb the CO2 emissions. The seriousness of these commitments was translated by the development of 3L/100 km fuel consumption level vehicles, such as VW Lupo and the Audi A2. The success of these projects indicates the pressure exerted on the automotive industry to reduce fuel consumptions, and hence exhaust gas emissions, due to both economical and environmental issues. Nevertheless, the common customer desires and demands innovations to provide for improved safety and security standards, green technologies, higher connectivity to the external environment and improved entertainment possibilities in the vehicle itself. This inevitably leads to the installation of new components and modules to provide for higher safety standards, fulfil the ever-tightened green gas emission standards and perform to the latest standards of information technologies.

There are many ways to reduce fuel consumption in a vehicle, such as improved power train efficiency, clean diesel, alternative fuels, vehicle weight reduction, and the change of customer behaviour towards the purchase of smaller vehicles. One of the most significant opportunities, yet, is weight reduction by material substitution.

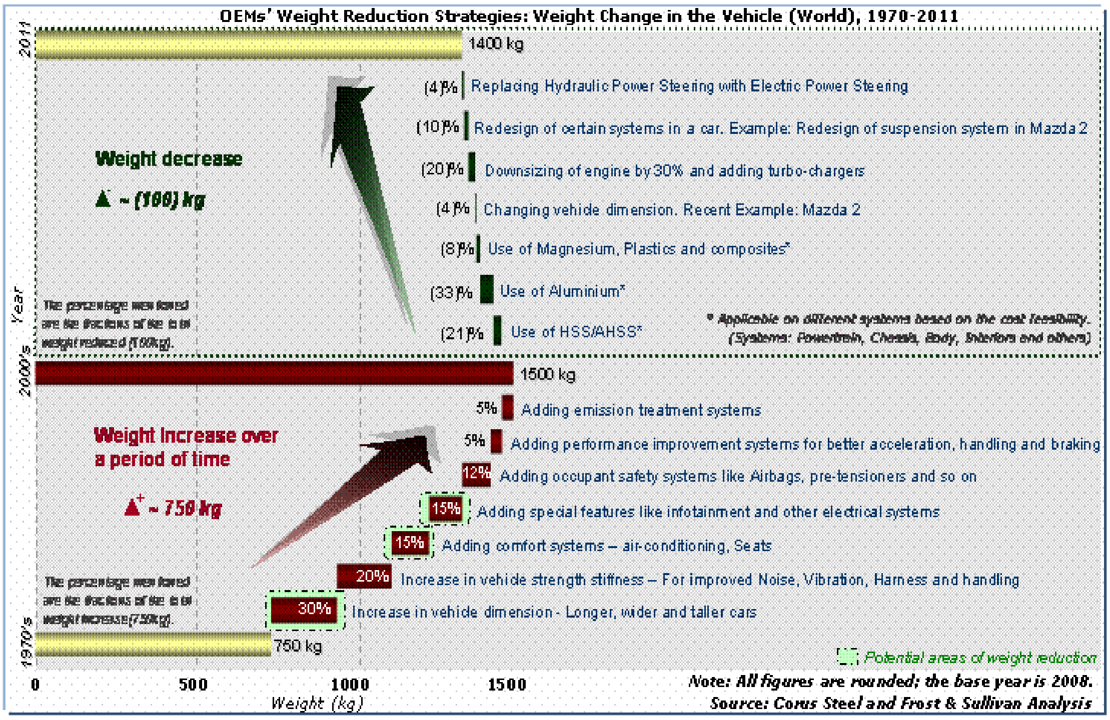

Figure 1-2: Weight Reduction Strategies: Weight Change in the Vehicle (Frost&Sullivan (2009))

The application of light weight materials, in particular aluminum and magnesium is expected to increase from 15% in 2006 to 30% and 5% to 10% respectively by 2015. As a result, aluminum is expected to gain preference over steel in the automotive industry over the next 5 years, as steel is seen to decrease by half .

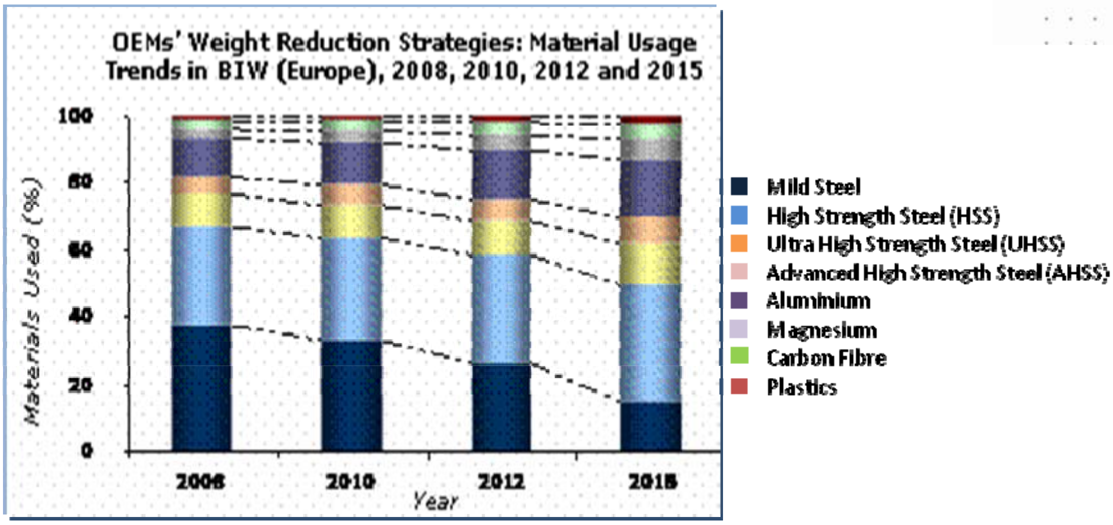

Figure 1-3: OEMs' Weight Reduction Strategies: Material Usage in BIW (Frost&Sullivan (2009))

As a result, many leading car manufacturers have investigated and quantified the direct impact of mass reduction on fuel consumption. In addition, OEM's carefully studied different opportunities for material substitution in vehicles, as well as for light weight design. The following picture gives an overview over identified applications.

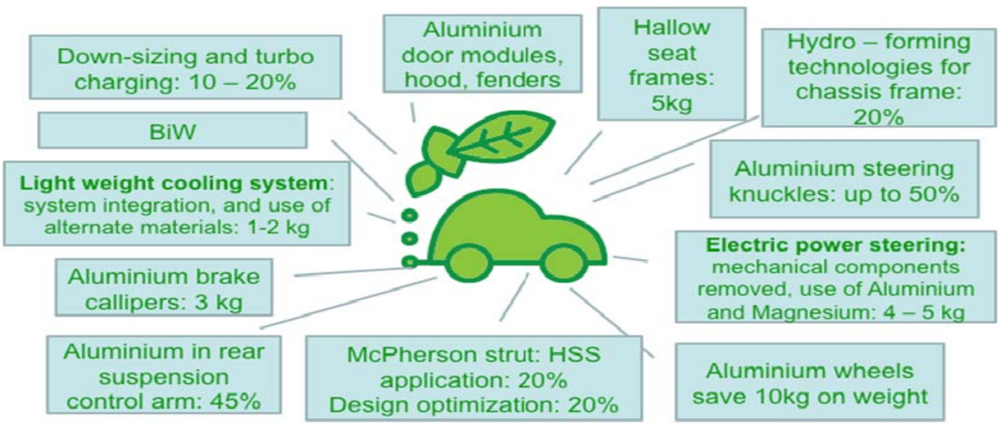

Figure 1-4: Global Analysis of Weight Reduction Strategies of Major OEM's (Frost&Sullivan (2009))

Aluminum provides significant mass savings potential. Each application deserves its own focus. The current study draws its attention towards two issues: Hydroforming and Aluminum application for the chassis frame. A different forming technology is to be explored for material substitution towards aluminum and for higher efficiency than hydroforming. As a general rule of thumb, a 100 kg weight reduction lowers fuel consumption by approximately 5% (Abu-Farba (2008)).

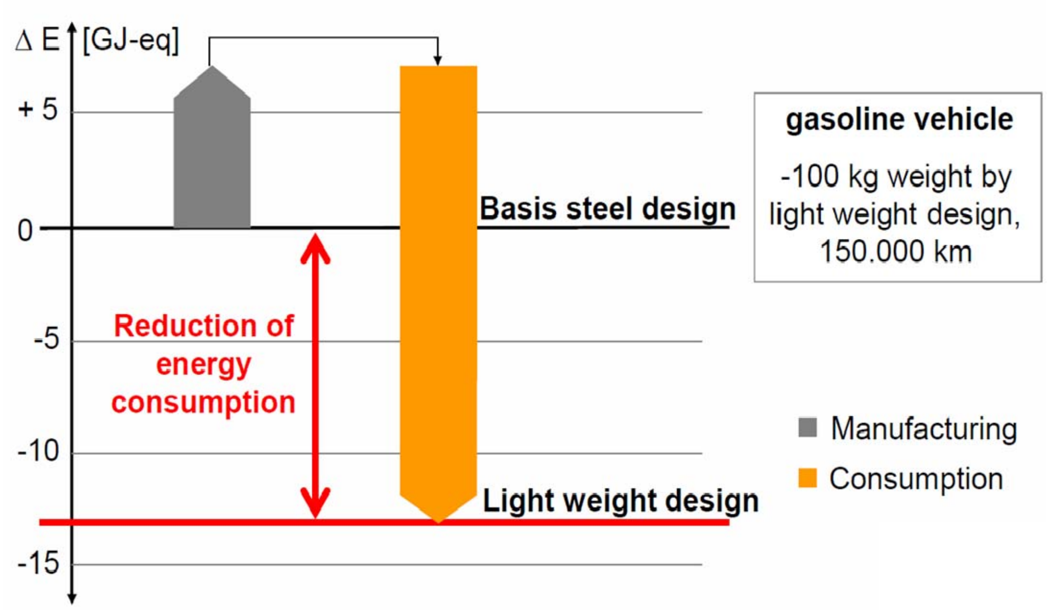

Figure 1-5: Impact of Weight Reduction (Demmel (2009))

In spite of the above mentioned numbers, achieving mass reduction on such scales would be quite hard to realise with conventional materials, even by employing lightweight designs would in certain cases provided inefficiencies. More importantly, the end customers' are more than ever demanding fully equipped cars in all the different vehicle classes; even small cars are getting more luxurious and comfortable. In addition, customers are paying more attention to occupant safety, calling again for stronger and more rigid structures. To keep the performance level of the car, higher-power engines and powertrains are required, which necessitates weight reductions to have significant end of line savings. For mass-production application, the net vehicle weight is getting heavier due to additional safety restraints (air bags, side/front impact beams, etc), and technological additions (entertainment units, individually set motor units ex: seat motor vs ‘hand crank’, etc). The final result is that in any vehicle class, each new model is getting heavier than the previous. Therefore, to escape this vicious circle, the automotive industry is forced to look for new LWM, if the proposed mass reductions are to be realised. Naturally, there is a price to be paid for such promising fuel consumption savings by light weighting, the amount of which is highly dependent on the type of lightweight materials used, the design concept and the area of application. In spite of that, what matters ultimately is the overall energy loss/gain, taking the driving energy savings due to the corresponding weight drop into account. A unique example in this regard is embodied by the successful experience of Audi with the space frame concept used in the A8, in which conventional steel frames are replaced by straight and curved closed-section extrusions made entirely of aluminium. Such a frame provides the maximum rigidity and torsional stiffness due to the fact that extruded sections have no spot welded seams that cause losses in rigidity, and can be manufactured in any complex dimension needed. With such a concept, weight reduction of approximately 40% in comparison to steel, while keeping the same level of rigidity of the body, is achieved. Interestingly, Audi showed that the additional energy consumed to achieve the 200 kg weight reduction by the exclusive use of aluminium could be compensated after driving for just 50,000 km (Abu-Farha (2008)); therefore, the energy assessment works in favour of aluminum.

2 SPF Market Analysis

Considering the distinctiveness of the SPF technology and its use for niche application, it is not surprising that the amount of SPF manufacturers is scarce, especially for automotive application. One can locate two companies that are in current production, one of them being General Motors, and the other UK Superform.

Part of the Luxfer Group, Superform USA and its sister company Superform Aluminium (Superform UK) claim they are the world's leading suppliers of aluminium, magnesium and titanium superformed components', supplying parts to various industries including Aerospace, Automotive, Rail, Medical Systems and Architecture. Having evolved from a 40 year history with a proven track record, Superform UK have broadened and seized a wide range of customers. By strategically diversifying its customer base, it proved to be a cornerstone for the group's 2003 infrastructure expansion. Superform UK invested 1 million GBP at their Worcester, UK production facility (Aluminium Panels (2009)). This capital investment doubled their capacity in the forming and trimming processes. As a result to this investment they now have a 5 axis, twin table trimming capability, which gives them the enhanced in-house flexibility and supplier appeal. All this, coupled with a new boron nitride coating booth and a new robot wash facility which grants the manufacturer complete vertical integration.

Following their new investment, Superform UK has the capability to manufacture aluminum panels up to 3m x 2m x 10mm thick (Aluminium Panels (2009)). This strategic expansion granted Superform UK business with Aston Martin, and complete bodyside panels for the low volume niche vehicle producer Morgan. Their process involves coating the blanks in-house with boron/graphite (by hand for graphite, and spray booth for boron nitride), followed by manually transporting the blank to the press. The UK Superform presses are specifically designed for the SPF process in which the dies are heated up inside the press. By utilizing the SPF presses, the forming process lasts between 15-60 mins depending of the complexity of the part. Once the forming cycle is complete, the finished part is then; 1) removed manually and placed on onto a cooling fixture or 2) the part is formed with a cooling fixture already in place in the press.

Superform UK process overview

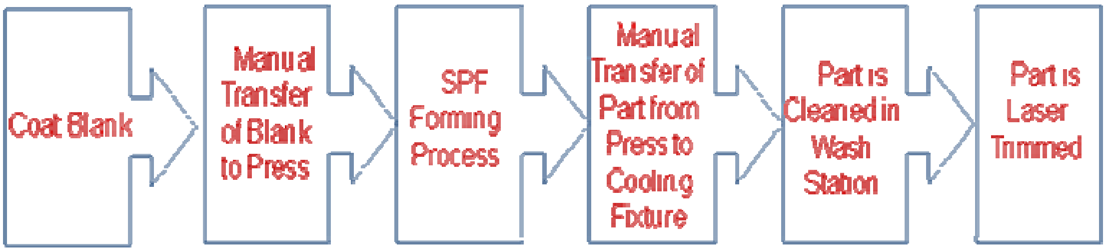

Figure 2-1: UK Superform Process Overview (Foley 2010, Own Illustration)

In response to the already proven SPF process, General Motors developed Quick Plastic Forming (QPF) to challenge the traditionally long cycle time SPF process. Their QPF process is a ‘cost efficient’ process for automotive applications which requires a lower cycle time per part. GM’s QPF realized their ambition by adapting the SPF process into a 100,000 parts per year feat. GM has two QPF cells that successfully produced four production closures including the Oldsmobile Envoy liftgate, Oldsmobile Aurora decklid, Chevrolet Malibu Maxx liftgate, and the Cadillac STS decklid at its New Hudson, MI facility (Quick Plastic Forming (2009)).

The key development of QPF is the use of latest technologies to speed up the cycle time. It uses robots, grippers, automation, and conveyors to transfer the parts from station to station. Following the forming process, GM sends all their parts to outside companies to get trimmed and washed/treated.

General Motors Process Overview

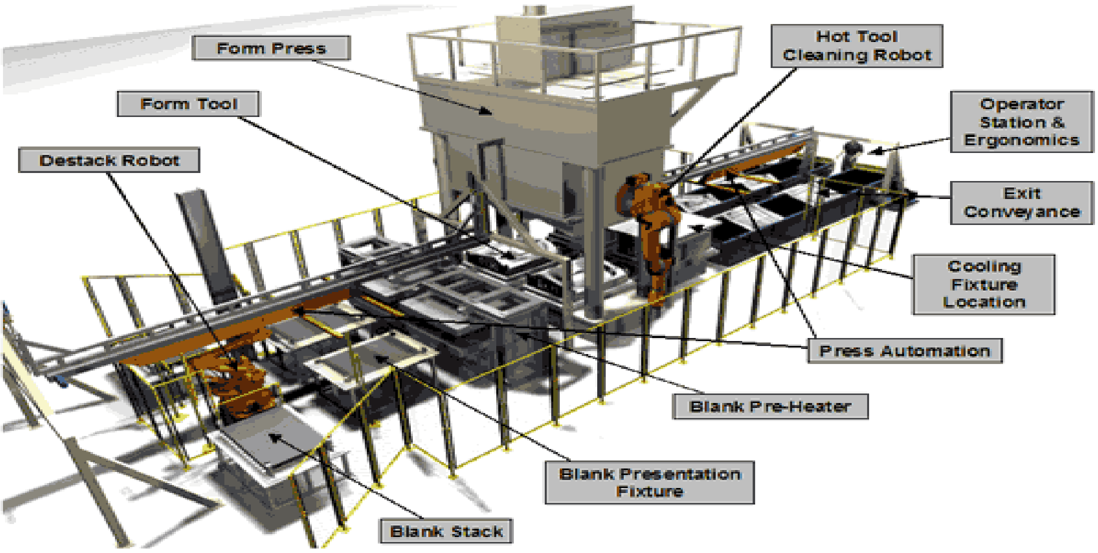

Figure 2-2: General Motors SPF Process Overview (Quick Plastic Forming (2009))

The current GM line very much converges on the Lean Manufacturing concept. Once the blank gets placed into the conveyor, the part is then ‘pulled’ by a one piece flow concept, due in part by the conveyor system in place. This eliminates any unnecessary inventory build-up, thus keeping a high level of quality, and most importantly reducing futile spending on the manufacturing cost.

SWOT Analysis (UK Superform vs GM)

Superform UK		
	Advantages	**Disadvantages**
Superplastic Forming	➢ Partially vertically integrated (S)	➢ High cycle times (T)
	➢ High technical know-how (S)	➢ No automation (W)
	➢ Strong customer base (O)	➢ Difficulties to have stable process (T)
	➢ Experience with complex parts (S)	➢ Exposed to high labour costs (T)
	➢ Supplier to broad range of industries (O)	➢ High logistic costs should they supply inland Europe (W)
	➢ First to market, established technically/commercially (S)	➢ No customer diversification in automotive industy (T)
General Motors		
	Advantages	**Disadvantages**
Quick Plastic Forming	➢ Low cycle times (S)	➢ Low part compexity with their experience (W)
	➢ Highly automated (O)	➢ No oppurtunity to diversify out of product range (unless JV or LA is formed) (T)
	➢ Patents to protect process & technology (S)	➢ No product diversification (T)
	➢ High volume experience (using 2 lines) (S)	➢ Exposed to high labour costs (unions) (T)
	➢ Could license technology to emerging suppliers (O)	➢ Little oppurtunities for SPF/QPF type products in North America (T)
	➢ Could create a JV with OEMs (O)	➢ Reliant on suppliers for the pre&post portion of the QPF process (T)
	➢ Quasi-lean manufacturing concept implemented (S)	➢ Still requires batch production due to the high level of outsourcing (W)

S: Strength
W: Weakness
O: Opportunity
T: Threat

Figure 2-3: Pros & Cons (UK Superform vs GM) (Foley (2009), Own Illustration)

3 Importance of Supply Chain Management

When a company is assessing the implementation of a new business plan or a business model into its organization, the focus point is always to;

1) Successfully penetrate into the market
2) Meet the two broad objectives of reducing cost and to be profitable
3) Maximize customer satisfaction

If the business world was a subtle and fully predictable environment, these objectives can be easily met. The challenge in meeting the objectives is maintaining a permanent balance between the supply and the demand. Considering the usage of delicate engineering to form SPF parts, and the post forming operations, UK Superform faces unexpected events every day in its supply chain operations. By foreseeing a potential “domino effect” of an unexpected event, by using the example of a supplier calling to inform that the last delivery was affected by poor quality (can be due to the forming process, the trimming process, and even the washing process) can unarguably make or break the company’s profit plan.

First of all, once the problem has been acknowledged, the company needs to check the consequences of this delivery on the production schedule. Because of the quality issue, some of the production orders will most likely need to be commenced at a later date than previously scheduled. This delay can actually generate concurrently five different types of imbalances between the supply and demand:

The late supplier delivery creates an unexpected volume of available capacity during a certain period.

1) It could generate a capacity shortage, at which point the delayed orders will be competing for the capacity that may be already allocated to other orders
2) The delayed production orders could ultimately be disrupting the distribution plan
3) Delays in the distribution plan may oblige the manufacturer to breach the delivery promises made to its customers based on the original supply plan
4) The purchasing plans for the sub-assembly parts that were supposed to be consumed in production orders together with the supplier's delayed parts will arrive at the customers docks too early, and will require to be warehoused as oppose to Just-in-Time consumption
5) Supplier can shutdown the customer's production line

This is a challenging situation because of one single unexpected event; the SPF supplier would now be faced with a complex re-planning situation, where a large number of decisions would need to be taken to restore the balance between the supply and demand. Unfortunately these decisions cannot be taken sequentially, because they are all inter-related. For instance, the decision to foresee some production orders to solve the capacity issues must be based on a material availability check to ensure that this decision is feasible. Also, the financial burden of these re-planning actions must systematically be examined, or else the company's profitability may suffer. Unforeseen events are abundant and must be reduced to better control the company's profitability.

These events can actually be grouped in two separate categories;

1) Manageable
2) Unmanageable

A company can reduce the frequency and the magnitude of the unexpected "manageable" events by implementing continuous improvement programs. Manageable events include:

- Material quality problems
- Cycle time variation
- Production quality problems
- Capacity problems

It is in the company's best interest to do a very good job with TQM initiatives to reduce the impact of these unexpected events. The unmanageable category includes events on which companies have no control because they come from the external marketplace (Oakland (2007), p108). The most disruptive unmanageable events are;

- Order modifications requested by the customers on delivery dates
- Quantities and specifications changes
- Periodic sales forecast updates
- Engineering changes
- Production failure from the supply chain (ex: blanks and boron/graphite powder are late coming, and wash line shutdown)

But the core challenge is the speed of re-planning to re-establish the customer's full satisfaction. At the end of the day, satisfied customers are the desired end results of any supply chain management strategy; therefore management should gain a grasp on as many of the unmanageable events as possible to be able to directly manage its production and ultimately reduce chances of unsatisfied customers.

3.1 Expectation Gap

The customer's satisfaction lies on two very important expectation gap pillars which are most of the time undermined by companies supplying OEMs:

1. The expectation gap represents the difference between the customer's and the supplier's expectations of importance of factors as they relate to the services or outsourcing delivered. When the size of this gap is significant, the supplier's expectations are out of line with the customer's expectations of importance and can adversely affect the service delivery process. When the supplier's expectations are lower than the customer's expectation, the rendered quality is likely to suffer. In some cases, the supplier's expectations may actually be greater than customers' expectation. This would indicate that resources might be spent on delivering a higher level of service than necessary to satisfy the customer. More often than none, the negative perception is with customer via the supplier. Time and again in the automotive industry, streamline and direct communication would reduce disparities in the expectation gap, thus bringing the customer and supplier closer together.

2. The delivery gap represents the difference between the supplier's expectations of importance and their perceptions of performance of the quality delivered. If the supplier's perception of the quality of parts delivered meet or exceed the customer's expectations, then theyr will be satisfied with the overall operations of their organization. If the customer perceives that the quality of service delivered does not meet their expectations, steps should be taken to determine the cause of the discrepancy so corrective action can be taken. A delivery gap contributes to the inability to meet the customer's expectations. The identification of a gap would enable managers to examine underlying problems in the delivery process.

The SPF process as demonstrated above is highly dependent on post forming operations. Delivery problems may result from poor trimming conditions, as well as out of dimensional problems of the parts. Moreover if the washing station is to be outsourced, handling problems are twice as likely to arise.

1) Packing the parts when finished trimming (in-house)
2) Unpack for washing (supplier)
3) Pack for customer delivery (supplier)
4) Unpack at customer (customer)

By releasing # 2 and # 3, the supplier is increasing the chances of mishaps, thus relying on the supply chain to coordinate the final QA prior to customer delivery. An expectation gap would indicate that the suppliers expectation of the quality of service delivered are different from the actual level of quality.

There are three reasons to highlight the importance of expectation gap:

1) Reason stems from the fact that strong and productive partnerships between customers and suppliers are important for effective outsourcing. Such partnership should be based on mutual understanding and clear communication lines, which otherwise can be hindered by an expectation gap between the supply chain partners with respect to what are the critical factors for a successful customer-supplier relationship. By recognizing the reasons related with a significant expectation gap enables the supply chain partners to realize why these gaps might happen, and eventually lead to rectify them.

2) It is useful for the customer to understand the expectations about what aspects are important for an effective and lasting outsourcing partnership. Both customer and supplier need to strategically align the processes and requirements of each other and then work constantly at improving them.

3) To support a better understanding of outsourcing and is focused on the expectation gap between the supply chains partners with respect to what are the essential aspects for efficiency of outsourcing process.

Once the expectation gaps have been aligned between the customer and suppliers, the remaining factors are to retain proper framework within the supply chain.

3.2 Key Elements to a Successful Supply Chain

The three key elements that must be retained within the supply chain management are:

Customer satisfaction:

It signifies the level of satisfaction among the company's customers. The sense is somewhat very vague. Therefore customer service is often discussed in terms of the representations which are used to measure it. Typical measures of customer service are a company's ability to deliver products to customers within the contractual time, as well as without any quality reclamation.

Inventories:

Manufacturing companies have inventories for raw material, products in work in progress (WIP), and finished products. In addition there are often warehouses or distribution centers between the different levels of the supply chain. Inventories are costly; they incur a holding cost which represents no value added to the finish part, as well as tying up capital in inventories prevents the company from investing this capital in projects with higher return. It is in every company's best interest to keep inventory levels at a minimum. In recent years much operating effort has been put towards “Lean” manufacturing, as a result an entire manufacturing paradigm has come out of it. The main objective of the Just in Time (JIT) philosophy is to virtually abolish inventories to maintain production flexibility and to lower the overall costs.

Flexibility:

The ability to respond to changes in today's current environment is crucial for survival. In the case of a manufacturer, flexibility is the ability to change the output in response to changes in the demand. The overall flexibility of a supply chain depends on the flexibility of all the entities in a supply chain, and their collaboration.

The SPF supply chain, although short compared to other automotive supply chains, still commands meticulous planning. In order to comply with the aforementioned, the suppliers as well as the manufacturer must operate on a seamless scale to avoid any expectation gaps with the final customer. The raw materials must be planned as such that the right material specification is supplied and in the right quantity, and that the tooling and service providers delivers on-time and as contractually agreed.

SPF Supply Chain:

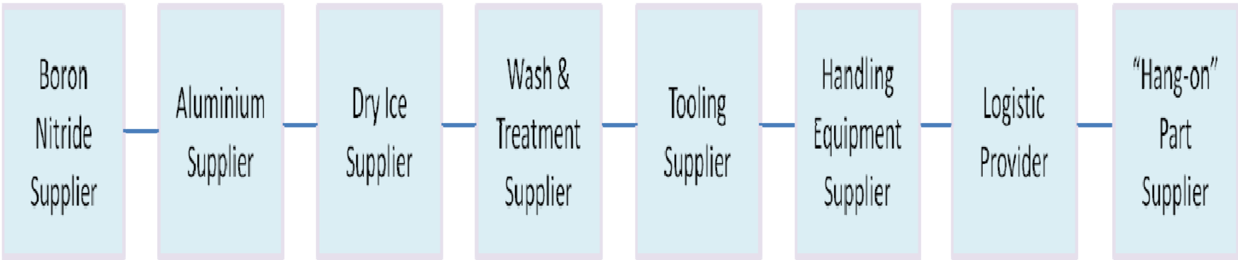

Figure 3-1: SPF Supply Chain (Foley (2010), Own Illustration)

When all processes and costs have been stabilized in a supply chain, only then can a company then assess whether a Make-or-Buy decision would be better suited for its bottom line.

4 Make-Or-Buy Analysis

For SPF application, in order to optimize resources within the supply chain to ensure that customer satisfaction, inventory and that flexibility levels are met; management needs to pose the make-or-buy question. The answer to the question will enable the company to maximize the firm's resources, by knowing which portion of the process to manufacture and which to outsource. The make-or-buy question represents a basic dilemma faced by many companies. By looking again at the manufacturing process of UK Superform, one can see that the company has the opportunity to source out 4 steps of their SPF process before the final part is sent to their customer.

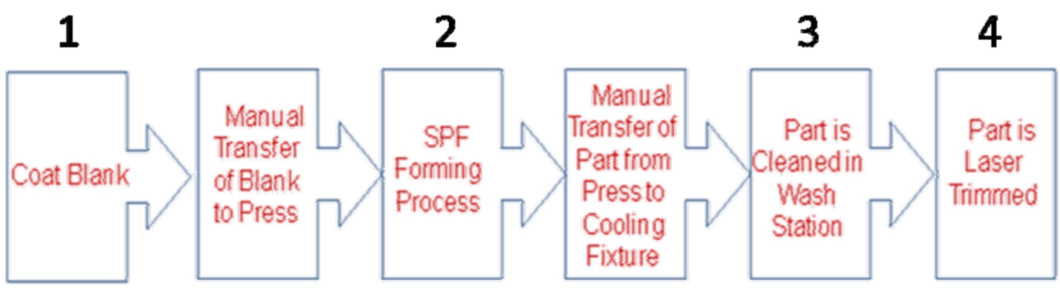

Figure 4-1: SPF Outsourcing Potentials (Foley (2009), Own Illustration)

Companies have finite resources and cannot always afford to have all manufacturing technologies in-house. The last two decade proved to be a corner stone for this approach. The manufacturing industry has ubiquitously directed their corporate strategies to suppliers, inevitably reducing their contribution costs but at the same time reducing potential value added tasks. The outsourcing option has become a forefront strategy in virtually all organizations. The make-or-buy decision has become an important strategic decision and one of the critical factors for maintaining competitiveness.

The make-or-buy decision is the act of making a strategic choice between producing an item internally or buying it externally. These decisions are being made when a company that has developed a product is having trouble with current suppliers, has diminishing/increasing capacity or changing customer demand and/or wants to optimize its cost structure. The decision to buy externally can lead to cost savings in internal manufacturing when a company can take advantage of the expertise, economies of scale and smoother production schedules of external suppliers. The management accountant's role in the decision is to provide an accurate analysis of the relevant costs and expenses versus expected savings or income and support the make-or-buy decision by providing recommendations based on the results of the analysis.

The decision to buy-in should be made when all the costs of the buy-in decision, including transaction and co-ordination costs relating to the subcontractor, are lower than the manufacturing cost. When the supply chain needs to be stabilized, the quality of the final product must be enhanced, a competitive advantage is being provided by the decision or strategic aims are being supported.

The make-or-buy decisions are shaped by and large by the performance of a SPF manufacturing company and have an influential effect on its future survival. The make-or-buy decision is one of the most complicated problems in the business strategy and all the departments of a company must be involved in order to devise a sensible sourcing strategy. In most of the companies, the sourcing decisions are based on the accounting aspect of the problem, but the development of a sourcing strategy requires the consideration of a host of financial and non-financial factors.

Two main make-or-buy decision avenues can be identified. The first avenue aims at answering the make-or-buy question from the cost perspective. The concept of transaction cost plays an important role in many of the scenarios mentioned above. The second avenue approaches make-or-buy from a strategic perspective, recognizing other factors in addition to cost. The idea of make-or-buy is an issue that goes further than cost factors such as to highlight the importance of strategic issues for make-or-buy decisions. A big picture of make-or-buy can be provided by offering a series of standard guidelines to approach make-or-buy decision based on five areas.

4.1 Main Reasons for Make-or-Buy

The main area being core and peripheral activities:

1) Business
2) Environment,
3) Cost
4) Technology
5) Supplier relationship

Some companies choose a vertically integrated structure, while others specialize in one stage of production and outsource the remaining stages to other firms. Vertical integration can be an efficient means of protecting relationship-specific investments or mitigating other potential conflicts under incomplete contracting. The market mechanism entails certain costs: discovering the relevant prices, negotiating and enforcing contracts, etc. Within the company, the general manager may be able to reduce these "transaction costs" by coordinating these activities himself. However, internal organization brings other kinds of transaction costs, namely problems of information flow, incentives, monitoring, and performance evaluation. The periphery of the company is then determined by the opportunity cost, at the margin, between the relative transaction costs of external and internal exchange. In this sense, the company's peripheries depend not only on technology, but also on organizational considerations; that is, on the costs and benefits of various contracting alternatives. (Besanko, Dranove, Shanley, Schaefer (2007), p123,168)

Make-or-buy has always been an important issue for companies. Due to its intricacy nature, it has been approached from different perspectives such as economics, purchasing, operations research, accounting and strategic management. Business planning is defined as a set of choices defining the structure, the resources and the infrastructure of a production system, in order to optimize the integration of the company inside its economic environment. As part of Business Planning, make-or-buy selects among products and/or activities which should be retained internally, and those, which should be sub-contracted or outsource. Then, within any strategic development, a company has to make a make-or-buy decision.

4.2 Assessing the Financial Value Stream

Two important factors to consider in a make-or-buy decision are cost and the availability of production capacity. Cost considerations should include all relevant costs and be long-term in nature. Obviously, the buying company will compare production and purchase costs. The main elements that should be examined in the "make" analysis: (Besanko (2007), p109)

- Incremental factory overhead costs
- Incremental managerial costs
- Incremental capital costs
- Incremental purchasing costs
- Incremental inventory-carrying costs
- Direct labour costs
- Delivered purchased material costs
- Any additional costs related from quality or service problems

Cost considerations for the “buy” analysis:

- Purchase price of the part
- Incremental purchasing costs
- Transportation costs
- Receiving and inspection costs
- Any additional costs related from quality or service problems

4.3 Assessing the Operational Value Stream

Make-or-buy decisions also occur at the operational level. Analysis suggests these considerations that favour making a part in-house: (Heizer, Render (2007), p45)

Core Competency:

- Cost analysis (less expensive to make the part)
- Yearning to integrate plant operations
- Productive use of surplus plant capacity to absorb fixed overhead
- Need to apply direct control over production and/or quality
- Increase quality control
- Process/Design/Product secrecy is required to protect proprietary technology
- Unreliable suppliers
- Yearning to retain a stable workforce (in periods of declining sales)
- Control of delivery time, logistic, and warehousing costs
- Greater assurance of continual supply

Factors that may influence firms to buy a part externally include:

Essential, Non Core:

- Lack of expertise
- Suppliers' know-how exceeds that of the buyer
- Small volume requirements
- Limited production facilities or insufficient capacity
- Indirect managerial control considerations
- Procurement and inventory considerations
- Process/Part/Product not essential to the firm's strategy

Non-Core:

- No added value for the company
- Complete outsource consideration
- Ties up capital otherwise used for other projects

A core activity is essential to companies effectively serving the needs of potential customers. The activity is perceived by the customers as adding value and therefore being a major component of competitive advantage. Distinguishing between core activities and non-core activities is a complex undertaking. Diligence must be taken to ensure the long-term strategic considerations and true benefits are assessed. The conventional strategic perspective to preserve the companies' competency core activities should stay in-house, and non-core activities can be outsourced.

Identifying core competencies for an organization is filled with many ambiguities. Core competencies are intellectually based activities or processes that companies perform better than any other. They are an array of skills and processes that companies do at best-in-class levels and through that companies generate uniquely high value for their customers (Heizer, Render (2007), p45).

Creating best-in-class level commences with an analysis of the company's value chain, as shown above, and identifying few critical activities which are considered by the company's management and workers as the best to compete effectively. The most effective core competency strategies focus on a few (two to four) cross-functional, intellectually-based activities or knowledge and skill sets critical to customers. Once a company develops a true best-in-class core competency, it should never outsource it. The company may even build up boundaries around its essential competencies that customers insist it have or that protect its core. If a company is not best at an activity and continues to produce that activity in-house, the company gives away a competitive edge that it could have had. A non-core activity could be outsourced, unless a company is best-in-class at an activity, whether within a function or inter-functional, it is someone else's core competency, not its own. The company gives up competitive edge by not buying that skill from a best-in-class source. A best-in-class target forces the company:

1) To think clearly about strategic benefits
2) To look laterally at other enterprises not in its own industry when seeking performance similarities and improvements

For a range of reasons including tradition, emotion, and incapacity or unwillingness to assess its internal transaction costs and risks objectively, companies may carry on to execute many uneconomic activities in-house or continue to buy-in activities which otherwise would yield higher value to the company. As a result they endure unnecessary costs and risks for not outsourcing or insourcing the activity from best-in-class sources.

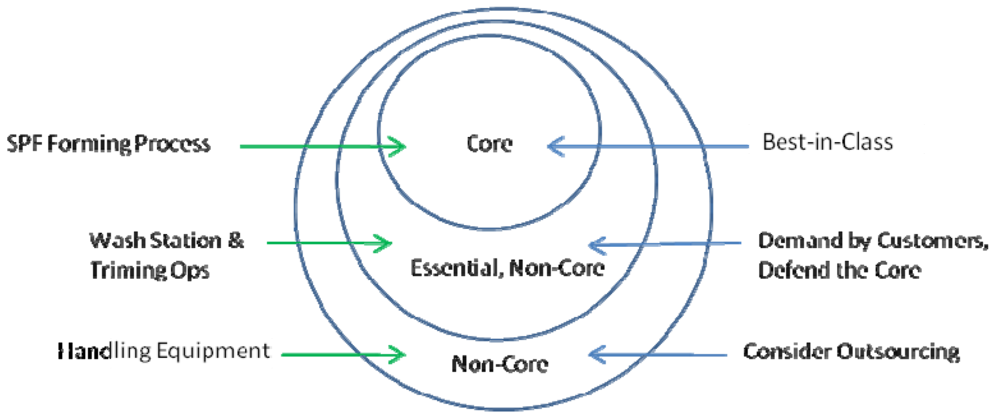

Figure 4-2: SPF Operational Value Stream (Foley (2009), Own Illustration)

As demonstrated above, the Wash Station is classified as an essential but non-core portion of the SPF process. It is entwined so tightly into the process that the entire supply chain and customer is heavily reliant on its output. From the practical and business side, is it the right decision to in-source the Wash Station or should it be left to the suppliers?

5 Financial Analysis

The Wash Station/Treatment line is very capital intensive. When a company is faced with the decision of allocating resources towards such project a proper ROI is required. Therefore, a detail cost analysis must be conducted to ensure the Net Present Value (NPV) will be positive, as will the Internal Rate of Return (IRR). The NPV can be positive, however under many company financial guidelines, the IRR must be over 20% for capital approval. Demanding a 20% IRR would accommodate for any fluctuation and unforeseeable variables that might present itself down the timeline.

5.1 Financial Breakdown Wash & Treatment Line

The standard investment for a wash line and a treatment line requires the following investment:

Investments	Amount
Tools and Equipment of Wash Line	$170,000.00
Tools and Equipment of Treatment Line	$1,100,000.00
Capital expenditures	$1,270,000.00
Increase working cap.	$50,000.00
Project initial net cost	**$1.320.000.00**

Figure 5-1: Wash & Treatment Line Capital Investment Breakdown (Foley (2010), Own Illustration)

In the calculation, the British taxation law will be taken into consideration; the depreciation for the equipment will be executed for 8 years on a straight line at 12.5%.

Variable costs include:

- 1 engineer
- Alodine material cost

Fixed costs include:

- 4 general labourers
- Energy costs for the Wash line & Treatment line
- Software & Hardware for implementation

5.1.1 Wash and Treatment Line Analysis

To know whether a project should be a make-or-buy, there needs to be some external costs for comparison. The current market place as uncovered two suppliers offering wash and treatment services, both located in Germany.

1) AMS (Stuttgart)
2) METOB (Michelau)

AMS offers the price of 9.50€ to wash and treat a 1sq/m panel, and METOB offers the price of 6.83€ to wash and treat a 1sq/m panel. There is a 40% price discrepancy for seemingly the same process:

1. Basic hot degreasing
2. Rinsing
3. Alodine 2040 treatment
4. Rinsing
5. Rinsing with desalinized water
6. Drying in the dry-air dryer

Stages 1 and 2 are the necessary processes involved in the wash station, while 3,4,5,6 are the process requirements for the treatment line. Due to customer constraints, treating aluminum parts is a necessity prior to shipping to the customer, therefore there is no way around the process (investment vs outsourcing).

5.1.2 Financial Analysis using METOB vs Insourcing

- Volume 115,000
- Net Profit = € 1,050
- IRR = 9%
- Discount rate = 9%

		01/01/2012	01/01/2013	01/01/2014	01/01/2015	01/01/2016	01/01/2017	01/01/2018	01/01/2019
Depreciation (MACRS)		12.50%	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%
Depreciation		€158,750.00	€158,750.00	€158,750.00	€158,750.00	€158,750.00	€158,750.00	€158,750.00	€158,750.00
Labour		€100,000.00	€100,000.00	€100,000.00	€100,000.00	€100,000.00	€100,000.00	€100,000.00	€100,000.00
Other Fixed Costs		€75,000.00	€75,000.00	€75,000.00	€75,000.00	€75,000.00	€75,000.00	€75,000.00	€75,000.00
Total Fixed Costs		**€333,750.00**	**€333,750.00**	**€333,750.00**	**€333,750.00**	**€333,750.00**	**€333,750.00**	**€333,750.00**	**€333,750.00**
Material Cost		€34,500.00	€34,500.00	€34,500.00	€34,500.00	€34,500.00	€34,500.00	€34,500.00	€34,500.00
Other Labour Costs		€50,000.00	€50,000.00	€50,000.00	€50,000.00	€50,000.00	€50,000.00	€50,000.00	€50,000.00
Total Variable Costs		**€84,500.00**	**€84,500.00**	**€84,500.00**	**€84,500.00**	**€84,500.00**	**€84,500.00**	**€84,500.00**	**€84,500.00**
COGS		**€418,250.00**	**€418,250.00**	**€418,250.00**	**€418,250.00**	**€418,250.00**	**€418,250.00**	**€418,250.00**	**€418,250.00**
Savings in COGS (income)		€785,450.00	€785,450.00	€785,450.00	€785,450.00	€785,450.00	€785,450.00	€785,450.00	€785,450.00
EBIT		€367,200.00	€367,200.00	€367,200.00	€367,200.00	€367,200.00	€367,200.00	€367,200.00	€367,200.00
Income tax (35%)		€128,520.00	€128,520.00	€128,520.00	€128,520.00	€128,520.00	€128,520.00	€128,520.00	€128,520.00
NOPAT		€238,680.00	€238,680.00	€238,680.00	€238,680.00	€238,680.00	€238,680.00	€238,680.00	€238,680.00
Net operation CF	-€1,320,000.00	**€238,680.00**	**€238,680.00**	**€238,680.00**	**€238,680.00**	**€238,680.00**	**€238,680.00**	**€238,680.00**	**€238,680.00**
NPV Base		€218,972.48	€200,892.18	€184,304.75	€169,086.93	€155,125.62	€142,317.09	€130,566.13	€119,785.44
acumulated CF	-€1,320,000.00	-€1,101,027.52	-€900,135.34	-€715,830.59	-€546,743.66	-€391,618.04	-€249,300.95	-€118,734.82	€1,050.63
				NPV	**€1,050.63**				
				IRR	**9%**				

Figure 5-2: METOB vs Insourcing (Volume:115,000) (Foley (2010), Own Illustration)

The Cash Flow demonstrates a profit for the project of € 1,050, while incurring a 9% IRR. Supplying such volume showcases the near breakeven point of the investment. The 9% IRR shows that it’s in line with the discount rate therefore it might not make sense to invest in the wash & treatment line.

5.1.3 Financial Analysis using METOB vs Insourcing

- Volume 140,000
- Net Profit = € 588,364
- IRR = 20%
- Discount rate = 9%

		01/01/2012	01/01/2013	01/01/2014	01/01/2015	01/01/2016	01/01/2017	01/01/2018	01/01/2019
Depreciation (MACRS)		12.50%	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%
Depreciation		€158,750.00	€158,750.00	€158,750.00	€158,750.00	€158,750.00	€158,750.00	€158,750.00	€158,750.00
Labour		€100,000.00	€100,000.00	€100,000.00	€100,000.00	€100,000.00	€100,000.00	€100,000.00	€100,000.00
Other Fixed Costs		€75,000.00	€75,000.00	€75,000.00	€75,000.00	€75,000.00	€75,000.00	€75,000.00	€75,000.00
Total Fixed Costs		€333,750.00	€333,750.00	€333,750.00	€333,750.00	€333,750.00	€333,750.00	€333,750.00	€333,750.00
Material Cost		€42,000.00	€42,000.00	€42,000.00	€42,000.00	€42,000.00	€42,000.00	€42,000.00	€42,000.00
Other Labour Costs		€50,000.00	€50,000.00	€50,000.00	€50,000.00	€50,000.00	€50,000.00	€50,000.00	€50,000.00
Total Variable Costs		€92,000.00	€92,000.00	€92,000.00	€92,000.00	€92,000.00	€92,000.00	€92,000.00	€92,000.00
COGS		€425,750.00	€425,750.00	€425,750.00	€425,750.00	€425,750.00	€425,750.00	€425,750.00	€425,750.00
Savings in COGS (income)		€956,200.00	€956,200.00	€956,200.00	€956,200.00	€956,200.00	€956,200.00	€956,200.00	€956,200.00
EBIT		€530,450.00	€530,450.00	€530,450.00	€530,450.00	€530,450.00	€530,450.00	€530,450.00	€530,450.00
Income tax (35%)		€185,657.50	€185,657.50	€185,657.50	€185,657.50	€185,657.50	€185,657.50	€185,657.50	€185,657.50
NOPAT		€344,792.50	€344,792.50	€344,792.50	€344,792.50	€344,792.50	€344,792.50	€344,792.50	€344,792.50
Net operation CF	-€1,320,000.00	€344,792.50	€344,792.50	€344,792.50	€344,792.50	€344,792.50	€344,792.50	€344,792.50	€344,792.50
NPV Base		€316,323.39	€290,204.95	€266,243.07	€244,259.70	€224,091.47	€205,588.50	€188,613.30	€173,039.73
acumulated CF	-€1,320,000.00	-€1,003,676.61	-€713,471.66	-€447,228.58	-€202,968.88	€21,122.58	€226,711.09	€415,324.39	€588,364.12
				NPV	**€588,364.12**				
				IRR	**20%**				

Figure 5-3: METOB vs Insourcing (Volume:140,000) (Foley (2010), Own Illustration)

The Cash Flow demonstrates a profit for the project of € 588,364, while incurring a 20% IRR. Also, there would be a 4 year wait until a positive cash flow can appear. Such numbers would solidify any uncertainties into investing in the wash & treatment line.

5.1.4 Financial Analysis using METOB vs Insourcing

- Volume 165,000
- Net Profit = € 1,175,677
- IRR = 30 %
- Discount rate = 9%

		01/01/2012	01/01/2013	01/01/2014	01/01/2015	01/01/2016	01/01/2017	01/01/2018	01/01/2019
Depreciation (MACRS)		12.50%	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%
Depreciation		€158,750.00	€158,750.00	€158,750.00	€158,750.00	€158,750.00	€158,750.00	€158,750.00	€158,750.00
Labour		€100,000.00	€100,000.00	€100,000.00	€100,000.00	€100,000.00	€100,000.00	€100,000.00	€100,000.00
Other Fixed Costs		€75,000.00	€75,000.00	€75,000.00	€75,000.00	€75,000.00	€75,000.00	€75,000.00	€75,000.00
Total Fixed Costs		**€333,750.00**	**€333,750.00**	**€333,750.00**	**€333,750.00**	**€333,750.00**	**€333,750.00**	**€333,750.00**	**€333,750.00**
Material Cost		€49,500.00	€49,500.00	€49,500.00	€49,500.00	€49,500.00	€49,500.00	€49,500.00	€49,500.00
Other Labour Costs		€50,000.00	€50,000.00	€50,000.00	€50,000.00	€50,000.00	€50,000.00	€50,000.00	€50,000.00
Total Variable Costs		**€99,500.00**	**€99,500.00**	**€99,500.00**	**€99,500.00**	**€99,500.00**	**€99,500.00**	**€99,500.00**	**€99,500.00**
COGS		**€433,250.00**	**€433,250.00**	**€433,250.00**	**€433,250.00**	**€433,250.00**	**€433,250.00**	**€433,250.00**	**€433,250.00**
Savings in COGS (income)		€1,126,950.00	€1,126,950.00	€1,126,950.00	€1,126,950.00	€1,126,950.00	€1,126,950.00	€1,126,950.00	€1,126,950.00
EBIT		€693,700.00	€693,700.00	€693,700.00	€693,700.00	€693,700.00	€693,700.00	€693,700.00	€693,700.00
Income tax (35%)		€242,795.00	€242,795.00	€242,795.00	€242,795.00	€242,795.00	€242,795.00	€242,795.00	€242,795.00
NOPAT		€450,905.00	€450,905.00	€450,905.00	€450,905.00	€450,905.00	€450,905.00	€450,905.00	€450,905.00
Net operation CF	-€1,320,000.00	**€450,905.00**	**€450,905.00**	**€450,905.00**	**€450,905.00**	**€450,905.00**	**€450,905.00**	**€450,905.00**	**€450,905.00**
NPV Base		€413,674.31	€379,517.72	€348,181.39	€319,432.47	€293,057.31	€268,859.92	€246,660.48	€226,294.01
acumulated CF	-€1,320,000.00	-€906,325.69	-€526,807.97	-€178,626.58	€140,805.89	€433,863.20	€702,723.12	€949,383.60	€1,175,677.61
				NPV	€1,175,677.61				
				IRR	30%				

Figure 5-4: METOB vs Insourcing (Volume:165,000) (Foley (2010), Own Illustration)

By increasing the volume by 25,000 to 165,000, the NPV demonstrates a near doubling for the investment, which by all rights proves to be beneficial to the company, in turn, yielding a 30% IRR. Increasing the volumes would also represent a 3 year wait until a positive cash flow can surface.

5.1.5 Financial Development Using METOB vs Insourcing

Net Present Value

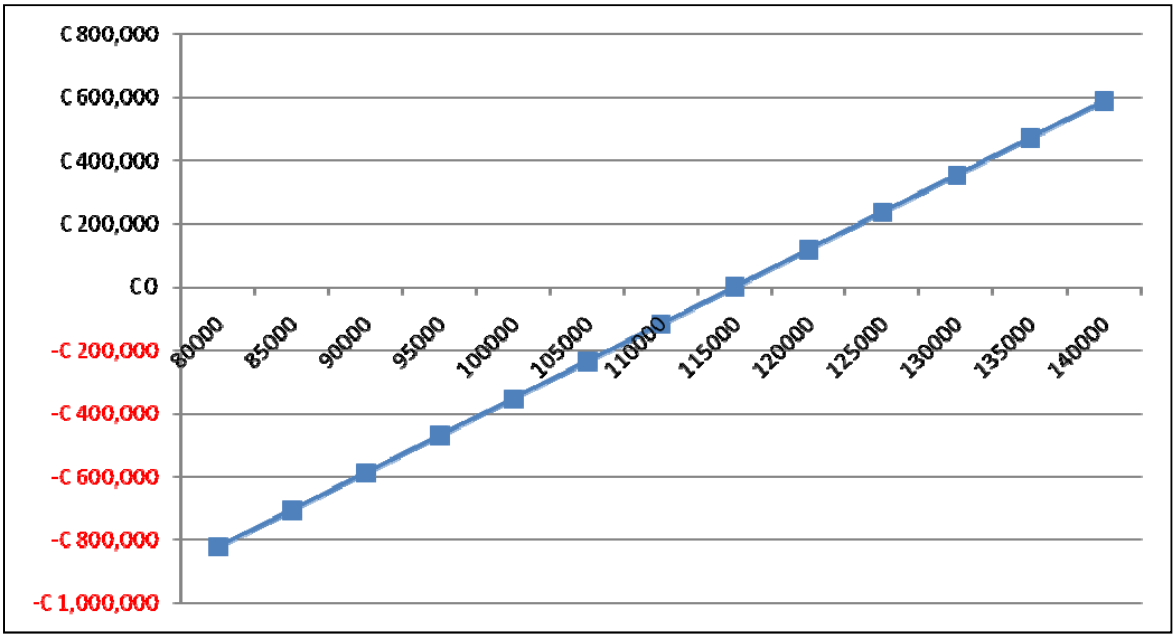

Figure 5-5: Net Present Value vs Volume (Foley (2010), Own Illustration)

Internal Rate of Return

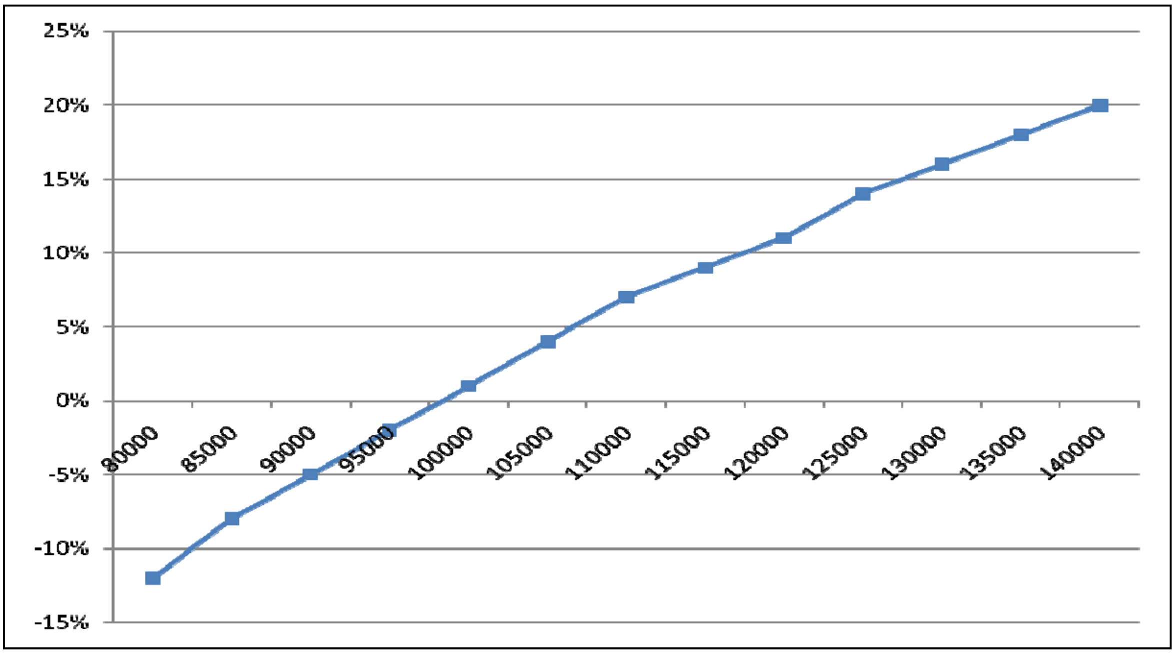

Figure 5-6: Internal Rate of Return vs Volume (Foley (2010), Own Illustration)

The charts above demonstrates the intersections of economic efficientcy regarding NPV and the IRR. Considering the ‘lower-cost’ to outsource the washline/treatment line to METOB, the required ROI will demand a high volume of deliverance. Considering that SPF is geared towards low volume application (10k-45k per year), an immense number of programs would need to be awarded for there to be a payoff within a respectable timeframe (3-6 years).

5.1.6 Financial Analysis using AMS vs Insourcing

- Volume 81,000
- Net Loss = € 19,635,
- IRR = 9 %
- Discount rate = 9%

		01/01/2012	01/01/2013	01/01/2014	01/01/2015	01/01/2016	01/01/2017	01/01/2018	01/01/2019
Depreciation (MACRS)		12.50%	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%
Depreciation		€158,750.00	€158,750.00	€158,750.00	€158,750.00	€158,750.00	€158,750.00	€158,750.00	€158,750.00
Labour		€100,000.00	€100,000.00	€100,000.00	€100,000.00	€100,000.00	€100,000.00	€100,000.00	€100,000.00
Other Fixed Costs		€75,000.00	€75,000.00	€75,000.00	€75,000.00	€75,000.00	€75,000.00	€75,000.00	€75,000.00
Total Fixed Costs		**€333,750.00**	**€333,750.00**	**€333,750.00**	**€333,750.00**	**€333,750.00**	**€333,750.00**	**€333,750.00**	**€333,750.00**
Material Cost		€24,300.00	€24,300.00	€24,300.00	€24,300.00	€24,300.00	€24,300.00	€24,300.00	€24,300.00
Other Labour Costs		€50,000.00	€50,000.00	€50,000.00	€50,000.00	€50,000.00	€50,000.00	€50,000.00	€50,000.00
Total Variable Costs		**€74,300.00**	**€74,300.00**	**€74,300.00**	**€74,300.00**	**€74,300.00**	**€74,300.00**	**€74,300.00**	**€74,300.00**
COGS		**€408,050.00**	**€408,050.00**	**€408,050.00**	**€408,050.00**	**€408,050.00**	**€408,050.00**	**€408,050.00**	**€408,050.00**
Savings in COGS (income)		€769,500.00	€769,500.00	€769,500.00	€769,500.00	€769,500.00	€769,500.00	€769,500.00	€769,500.00
EBIT		€361,450.00	€361,450.00	€361,450.00	€361,450.00	€361,450.00	€361,450.00	€361,450.00	€361,450.00
Income tax (35%)		€126,507.50	€126,507.50	€126,507.50	€126,507.50	€126,507.50	€126,507.50	€126,507.50	€126,507.50
NOPAT		€234,942.50	€234,942.50	€234,942.50	€234,942.50	€234,942.50	€234,942.50	€234,942.50	€234,942.50
Net operation CF	-€1,320,000.00	**€234,942.50**	**€234,942.50**	**€234,942.50**	**€234,942.50**	**€234,942.50**	**€234,942.50**	**€234,942.50**	**€234,942.50**
NPV Base		€215,543.58	€197,746.40	€181,418.72	€166,439.19	€152,696.50	€140,088.54	€128,521.59	€117,909.72
acumulated CF	-€1,320,000.00	-€1,104,456.42	-€906,710.02	-€725,291.30	-€558,852.11	-€406,155.61	-€266,067.07	-€137,545.48	-€19,635.76
				NPV	**-€19,635.76**				
				IRR	**9%**				

Figure 5-7:AMS vs Insourcing (Volume:81,000) (Foley (2010), Own Illustration)

Producing 81,000 parts per year vs using AMS would yield a financial loss of €19,635 and a IRR of 9%. Therefore opting to retain AMS services would be the most financially deligent decision, seeing that the company could place the capex into another area that would yield a higher return, as oppose to taking on capital risk.

5.1.7 Financial Analysis using AMS vs Insourcing

- Volume 100,000
- Net Profit = € 609,230
- IRR = 20%
- Discount rate = 9%

		01/01/2012	01/01/2013	01/01/2014	01/01/2015	01/01/2016	01/01/2017	01/01/2018	01/01/2019
Depreciation (MACRS)		**12.50%**	**12.50%**	**12.50%**	**12.50%**	**12.50%**	**12.50%**	**12.50%**	**12.50%**
Depreciation		€158,750.00	€158,750.00	€158,750.00	€158,750.00	€158,750.00	€158,750.00	€158,750.00	€158,750.00
Labour		€100,000.00	€100,000.00	€100,000.00	€100,000.00	€100,000.00	€100,000.00	€100,000.00	€100,000.00
Other Fixed Costs		€75,000.00	€75,000.00	€75,000.00	€75,000.00	€75,000.00	€75,000.00	€75,000.00	€75,000.00
Total Fixed Costs		**€333,750.00**	**€333,750.00**	**€333,750.00**	**€333,750.00**	**€333,750.00**	**€333,750.00**	**€333,750.00**	**€333,750.00**
Material Cost		€30,000.00	€30,000.00	€30,000.00	€30,000.00	€30,000.00	€30,000.00	€30,000.00	€30,000.00
Other Labour Costs		€50,000.00	€50,000.00	€50,000.00	€50,000.00	€50,000.00	€50,000.00	€50,000.00	€50,000.00
Total Variable Costs		**€80,000.00**	**€80,000.00**	**€80,000.00**	**€80,000.00**	**€80,000.00**	**€80,000.00**	**€80,000.00**	**€80,000.00**
COGS		**€413,750.00**	**€413,750.00**	**€413,750.00**	**€413,750.00**	**€413,750.00**	**€413,750.00**	**€413,750.00**	**€413,750.00**
Savings in COGS (income)		€950,000.00	€950,000.00	€950,000.00	€950,000.00	€950,000.00	€950,000.00	€950,000.00	€950,000.00
EBIT		€536,250.00	€536,250.00	€536,250.00	€536,250.00	€536,250.00	€536,250.00	€536,250.00	€536,250.00
Income tax (35%)		€187,687.50	€187,687.50	€187,687.50	€187,687.50	€187,687.50	€187,687.50	€187,687.50	€187,687.50
NOPAT		€348,562.50	€348,562.50	€348,562.50	€348,562.50	€348,562.50	€348,562.50	€348,562.50	€348,562.50
Net operation CF	-€1,320,000.00	**€348,562.50**	**€348,562.50**	**€348,562.50**	**€348,562.50**	**€348,562.50**	**€348,562.50**	**€348,562.50**	**€348,562.50**
NPV Base		€319,782.11	€293,378.08	€269,154.20	€246,930.46	€226,541.71	€207,836.43	€190,675.62	€174,931.77
acumulated CF	-€1,320,000.00	-€1,000,217.89	-€706,839.81	-€437,685.60	-€190,755.14	€35,786.57	€243,623.00	€434,298.62	€609,230.39
				NPV	**€609,230.39**				
				IRR	**20%**				

Figure 5-8:AMS vs Insourcing (Volume:100,000) (Foley (2010), Own Illustration)

By simply increasing the volume from 81,000 to 100,000 it springs the investment into lucrative territory. Obtaining a 20% IRR also ensures there is plenty of room for risk variance.

5.1.8 Financial Development Using AMS vs Insourcing

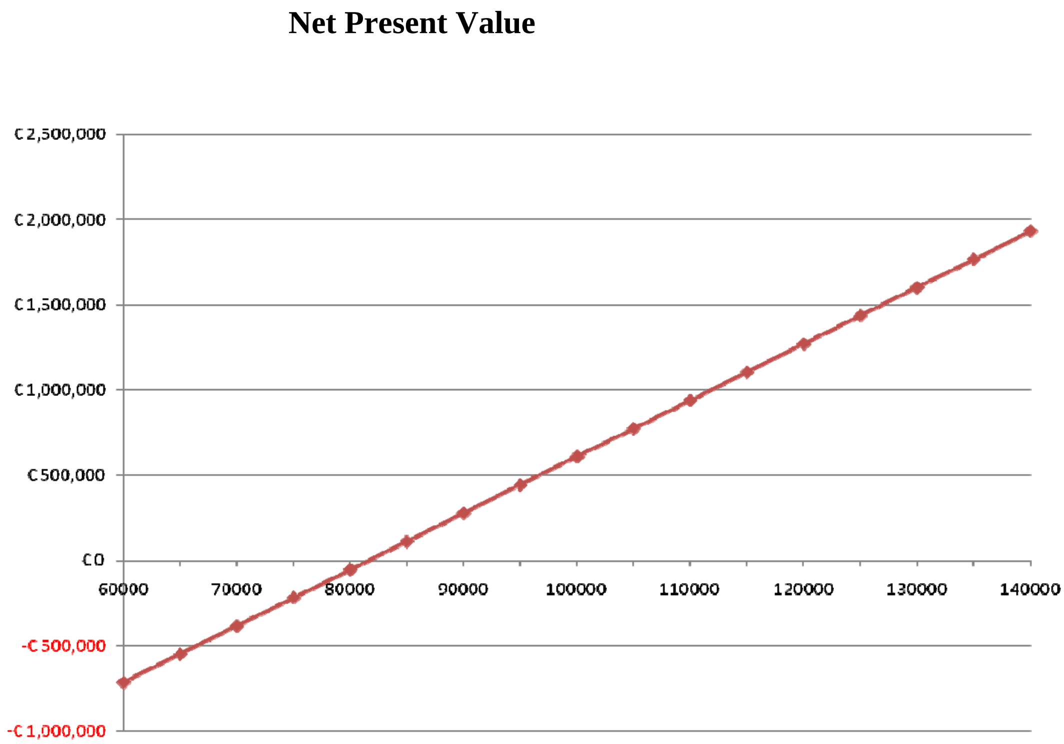

Figure 5-9: Net Present Value vs Volume (Foley (2010), Own Illustration)

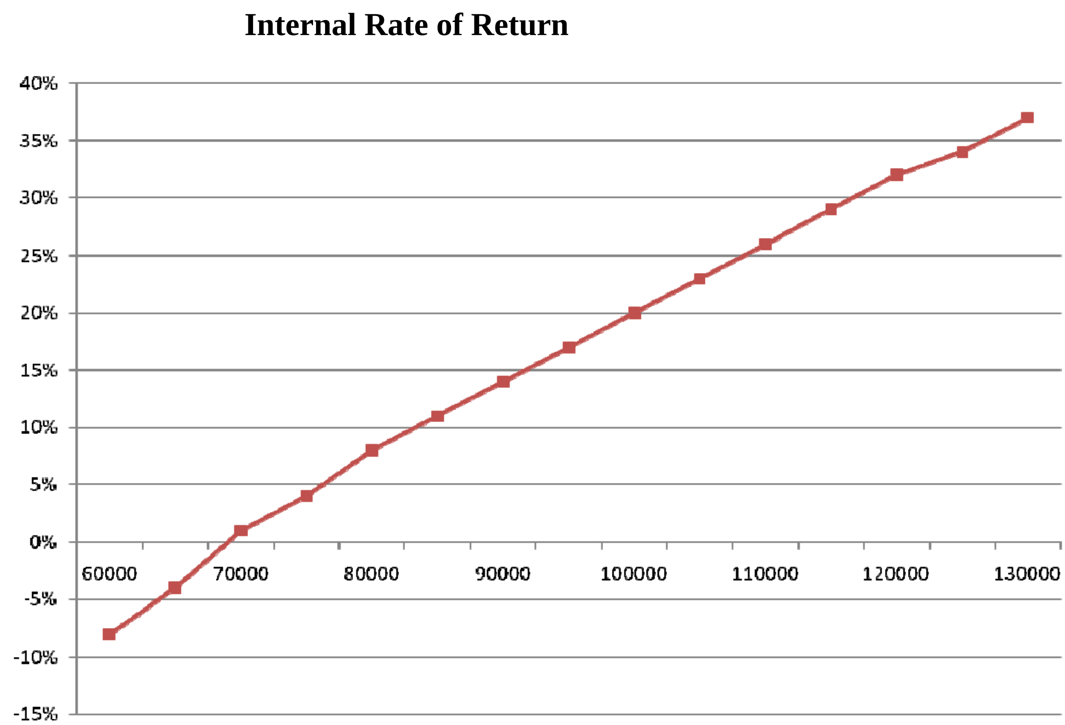

Figure 5-10: Internal Rate of Return vs Volume (Foley (2010), Own Illustration)

The charts reveals the intersections of economic efficientcy between the potential returns and volumes using AMS. However, due to free market and the near proximity of METOB, using METOB vs AMS would present financial advantage. Even if there would be additional logistic cost involved, paying a €2.67 premium for the same deliverance does not make economic sense, and the alternative source should be chosen.

5.2 Financial Breakdown Wash Line

It is quite obvious that the wash and treatment line brings no added value towards the final part. However, by eliminating the treatment process can at least provide more savings towards both parties involved. Should insourcing the wash line make economic, it could eliminate potential hardship towards logistic management, and for the Supply Chain Management.

The standard investment for a wash line requires the following investment:

Investments	Amount
Tools and Equipment of Wash Line	€ 170.000

Figure 5-11: Line Capital Investment Breakdown (Foley (2010), Own Illustration)

In the calculation, the British taxation law will be taken into consideration; the depreciation for the equipment will be executed for 8 years on a straight line at 12.5%.

Variable costs include:

- 1 engineer

Fixed costs include:

- 2 general labourers
- Energy costs for the Wash line
- Software & Hardware for implementation

METOB offers the price of 2.00€ to wash a 1sq/m panel. Their process to uniquely wash a panel is as follows: price discrepancy for seemingly the same process:

1. Basic hot degreasing
2. Rinsing

5.2.1 Financial Analysis METOB vs Insourcing

- Volume 97,000
- Net Profit = € 1,786
- IRR = 9 %
- Discount rate = 9%

		01/01/2012	01/01/2013	01/01/2014	01/01/2015	01/01/2016	01/01/2017	01/01/2018	01/01/2019
Depreciation (MACRS)		12.50%	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%
Depreciation		€21,250.00	€21,250.00	€21,250.00	€21,250.00	€21,250.00	€21,250.00	€21,250.00	€21,250.00
Labour		€50,000.00	€50,000.00	€50,000.00	€50,000.00	€50,000.00	€50,000.00	€50,000.00	€50,000.00
Other Fixed Costs		€25,000.00	€25,000.00	€25,000.00	€25,000.00	€25,000.00	€25,000.00	€25,000.00	€25,000.00
Total Fixed Costs		€96,250.00	€96,250.00	€96,250.00	€96,250.00	€96,250.00	€96,250.00	€96,250.00	€96,250.00
Other Labour Costs		€50,000.00	€50,000.00	€50,000.00	€50,000.00	€50,000.00	€50,000.00	€50,000.00	€50,000.00
Total Variable Costs		€50,000.00	€50,000.00	€50,000.00	€50,000.00	€50,000.00	€50,000.00	€50,000.00	€50,000.00
COGS		€146,250.00	€146,250.00	€146,250.00	€146,250.00	€146,250.00	€146,250.00	€146,250.00	€146,250.00
Savings In COGS (Income)		€194,000.00	€194,000.00	€194,000.00	€194,000.00	€194,000.00	€194,000.00	€194,000.00	€194,000.00
EBIT		€47,750.00	€47,750.00	€47,750.00	€47,750.00	€47,750.00	€47,750.00	€47,750.00	€47,750.00
Income tax (35%)		€16,712.50	€16,712.50	€16,712.50	€16,712.50	€16,712.50	€16,712.50	€16,712.50	€16,712.50
NOPAT		€31,037.50	€31,037.50	€31,037.50	€31,037.50	€31,037.50	€31,037.50	€31,037.50	€31,037.50
Net operation CF	-€170,000.00	€31,037.50	€31,037.50	€31,037.50	€31,037.50	€31,037.50	€31,037.50	€31,037.50	€31,037.50
NPV Base		€28,474.77	€26,123.64	€23,966.64	€21,987.75	€20,172.25	€18,506.35	€16,978.58	€15,576.67
acumulated CF	-€170,000.00	-€141,525.23	-€115,401.59	-€91,434.94	-€69,447.19	-€49,274.95	-€30,768.30	-€13,789.73	€1,786.95
				NPV	€1,786.95				
				IRR	9%				

Figure 5-12: METOB vs Insourcing (Volume:97,000) (Foley (2010), Own Illustration)

In the likelyhood that the OEM would agree to omit the treatment portion of the SPF process, and allow simply the washing of the parts, would definately provide an interesting business case for the manufacturer. Considering that the breakeven is 97,000 parts per year, it would cut in half the handling of the parts which as been outlined in section 3.1.1 thus reducing costs. Not only would it reduce costs, but interestingly enough, it would create significant value added for the manufacturer. At 120,000 parts per year, it would generate a ROI of 100%.

5.2.2 Financial Development Using METOB vs Insourcing

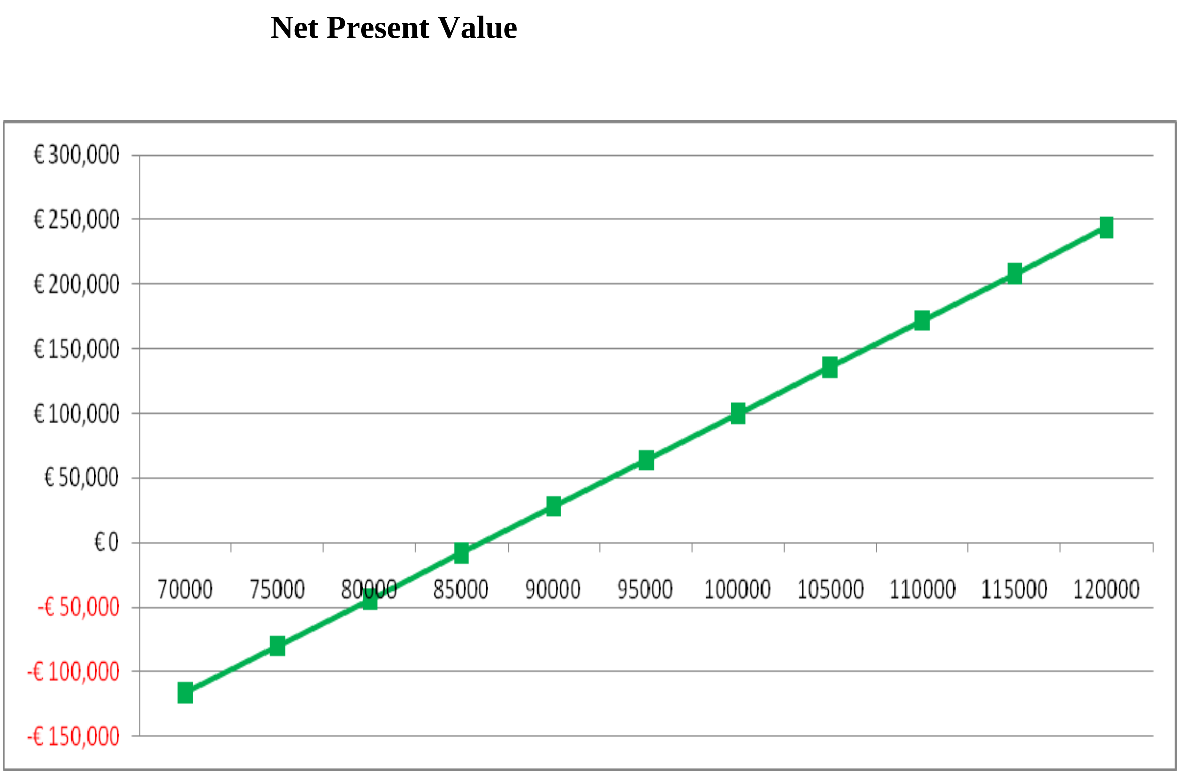

Figure 5-13: Net Present Value vs Volume (Foley (2010), Own Illustration)

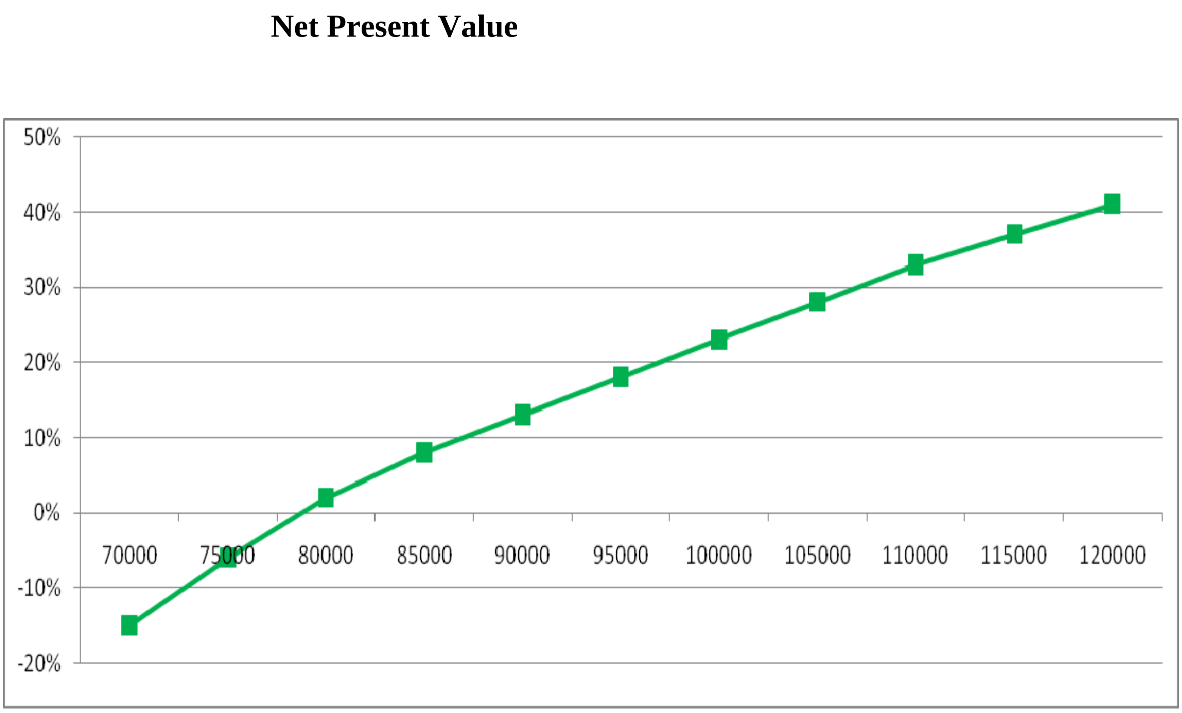

Figure 5-14: Internal Rate of Return vs Volume (Foley (2010), Own Illustration)

5.3 Optimal SPF Process

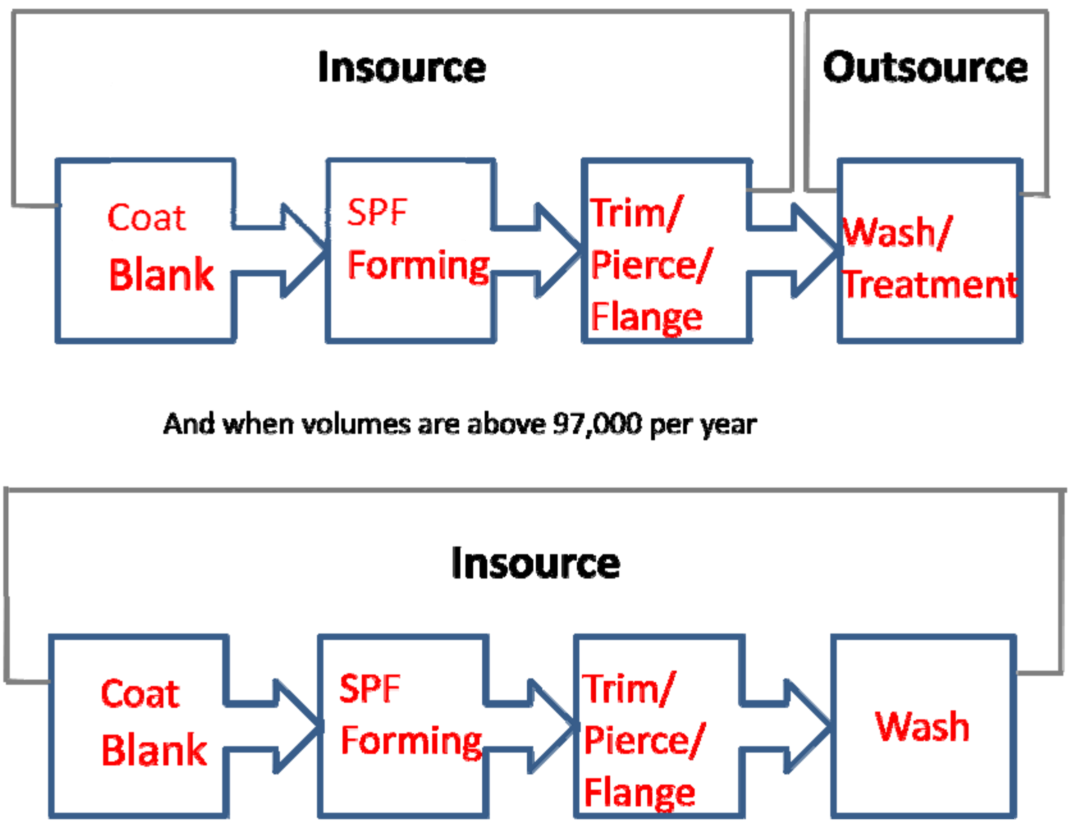

Figure 5-15: Optimal SPF Process (Foley (2010), Own Illustration)

Having dissected the financials of the post-forming process, it has been showcased that for the wash station/treatment line investment to make financial sense, the production volumes would need to be above 115,000 per year. To establish if such market is attainable, a complete breakdown of possible scenarios will be illustrated.

6 Global Vehicle Markets

The global nature of the automotive industry poses many possible opportunities to implement SPF into different regions. Firstly, different regions require singular needs. For instance, the North American market demands performance over styling and practicality, whereas the European market has the opposite prerequisite. Therefore vehicles must adversely be conceived for regional needs. Secondly, market dynamics plays a tremendous role into bringing vehicles out of the concept phase. OEM's in the North American market have rejoiced over the last decade with mass-production (150,000 + per year) vehicles such as some mini-van and the SUV programs. However, a tremendous shift in market dynamics is altering the way OEM's will be manufacturing vehicles for decades to come. Standardization is gaining remarkable traction, with such trends as platform strategies and global cars. The inevitable will come that there will be drastic decrease in plant capacities, seeing that the model 'x' will be produced in several global plants as opposed to solely in plant 'z'. By analyzing different market trends from the demand perspective, it provides insight as to where would be the optimal place to manufacture, or at least target for new SPF business.

6.1.1 China

The Chinese automotive market has experienced tremendous growth over the last decade. In conjunction with this growth came the strengthening of its own domestic OEMs. FAW, SAIC, and Dongfeng Motors all together hold 49% market share, whereas foreign OEM's hold a commanding 42% market share (CSM (2010)). This alone presents 2 different business opportunities.

1) Sale SPF products directly to Chinese OEMs
2) Capitalize on the platform strategy to supply products to foreign OEMs in China

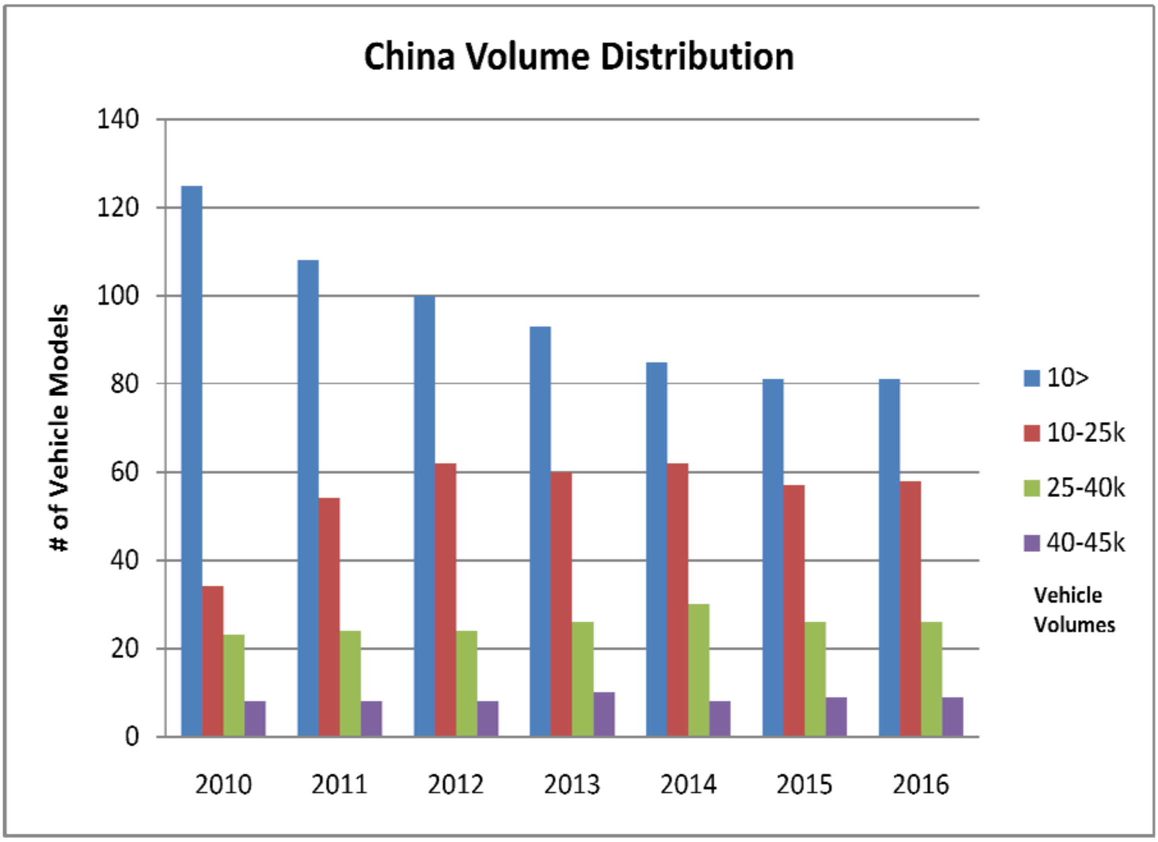

Figure 6-1:China Volume Distribution (CSM (2010))

The chart above illustrates the changing dynamics in the Chinese market. The 10> class will continuously diminish due to the consolidation/elimination of smaller OEMs. However one fascinating element is the stabilizing class of 10-25k, 25-40k and 40-45k. This showcases that there are many different models on the Chinese market; however they each hold a certain element of appeal to the consumers for it to maintain that volume constancy.

6.1.2 North America

The American auto industry has taken its worst downturn since its creation in early 1900. GM, Chrysler, and Ford have all shown financial struggle leading to a massive financial injection, a foreign acquisition, and a complete reorganization, respectively, while Asian and European OEMs have all increased their manufacturing capacities in the southern states. For decades the North American market was dominated by GM, forcefully creating markets for its products, while real-term demand was inherently demanding something utterly different, in terms of size, performance, styling. This shift has created a whole new class of products and competitors. As mentioned, the Asian (Japanese and Koreans) are supplying cost competitive substitutes while delivering superior warranty commitments. Such dynamic entry is cutting into GM's market share, now standing at a fragile 20% (CSM (2010). While there are still a few models commanding production volumes of 150,000 per year, the main shift is transposing into the 65-80K per year range. The biggest growth potential inherently lies in models with production volumes of 25-40k per year. This is highly attributed to the global vehicle trend, which OEMs are segmenting amongst their global production plants. This segmentation is proving to be a strategic entry point for SPF, should the manufacturing capabilities be able to adapt to the higher volumes. The way the Asians and Detroit 3 designs their vehicle bodies might not entertain such technology, but under body parts might create a whole new potential for SPF business.

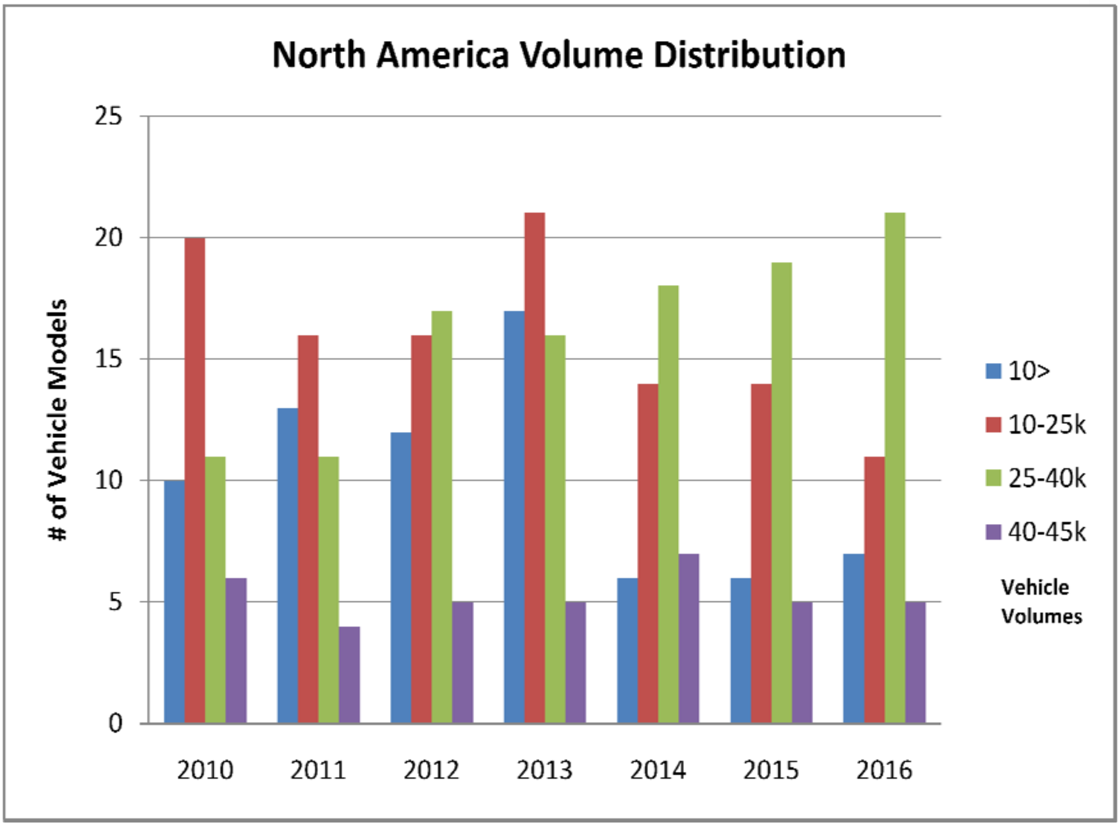

Figure 6-2: North America Volume Distribution (CSM (2010))

Even though the North American market is going through colossal correctional times, the chart above still showcases long term growth for the amount of low volume vehicle programs. More importantly, new CAFE legislation will require OEMs to supply vehicles to the US market with 35.5 miles/gallon by 2016 that it a 40% increase from the 2010 requirement of 25 miles/gallon (CAFE (2010). For OEMs to implement such engineering feat, new material (aluminum, magnesium), and technologies (e-drives, alternate fuels) will need to be employed to reduce and meet the aggressive legislation.

6.1.3 Europe

The European automotive market has equally been hit by the downturn. The OEMs have all instilled recovery plans to smoothen the transition from cash conservation to vehicle development. To avoid future reoccurrence, the

OEMs will need to assure that their overcapacity issues will be quickly resolved to eradicate waste. A market consolidation will need to take effect to streamline the industry into a leaner state. The likes of Volvo, Saab, Jaguar, and Land Rover have all since been sold off to foreign OEMs which is proving to be a cornerstone for the larger European picture that will succumb to future consolidation. Recent years have also demonstrated that the automotive industry is at the forefront of the green movement, partly motivated by the media, but also by historically stringent government legislation. Since 1992, EU governments have imposed the European Emission Standard to curb the growing CO_2 levels that the vehicles were emitting. In 2010, the OEMs are facing the Euro 5 standard, which is calling for 65% of their total fleet to be emitting 130g/km or less, and by 2016 Euro 6 will be in effect requiring that 100% of the fleet be emitting 130g/km o less. Neglecting the emission standards will result in a heavy financial penalty of 25€/g that is over the legislative standard (Cars (2010)). We've seen earlier that a 100kg weight reduction will result in a 5% fuel consumption saving, as a result lighter materials, advanced engineering, and new product initiatives will need to be addressed by the OEMs to tackle these legislative cufflinks. SPF would flawlessly correspond to such market shift. Its ability to reduce weight by cutting the amount of assembly parts, as well as to deliver seamless parts would cater to both of the OEMs needs; financial and social responsibilities.

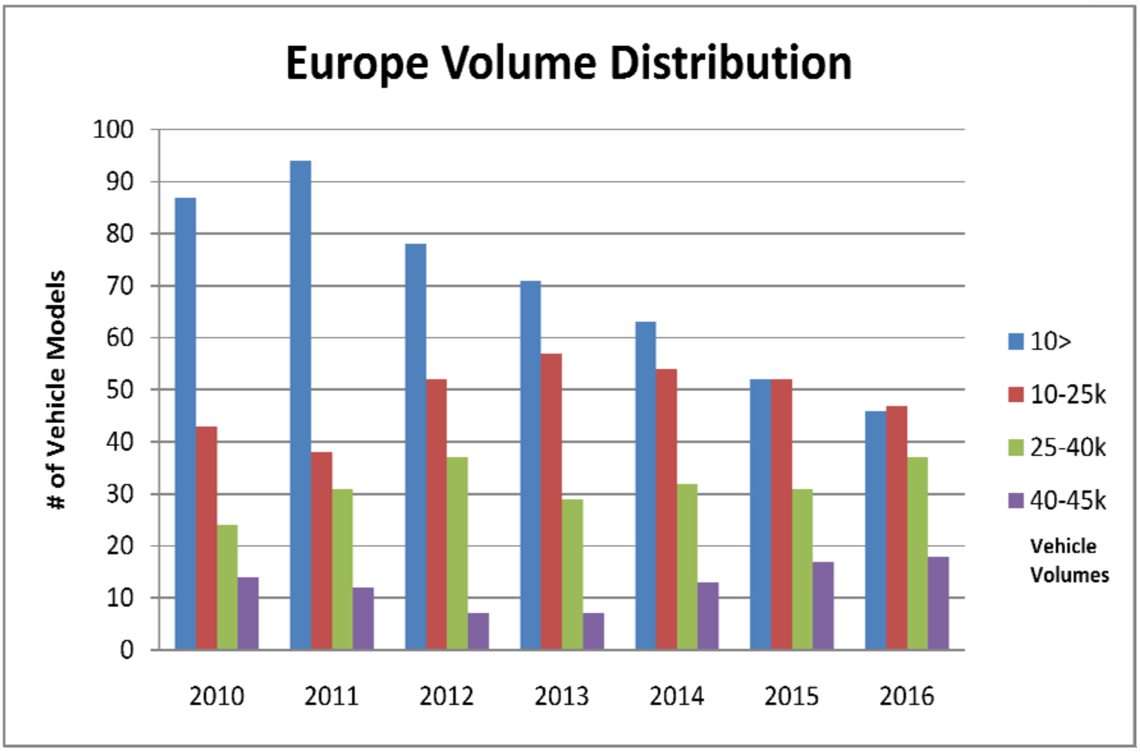

Figure 6-3: Europe Volume Distribution (CSM (2010))

The chart above demonstrates the endless possibilities of SPF onto the European market. The increasing sum of models in the volume range 25-40k is showing tremendous potential for UK Superform. Even though there's a drastic decrease in the amount of models in the 10k> range, Europe remains the primary market for niche vehicles.

6.1.4 SWOT Analysis of Global Marketplace for SPF

Region	Advantages	Disadvantages
China	➢ Many opportunities with a large range of different OEMs (O)	➢ Mass-consumer not seeking design as priority (W)
	➢ High potential for under body/floor panel (O)	➢ Cost conscious OEMs (no risk) (T)
	➢ Dynamic and quick changing market conditions (S)	➢ No experience with complex parts/processes (T)
North America	➢ All major OEMs have manufacturing footprint (O)	➢ Small number of niche vehicle production (W)
	➢ Large growth in market 25-40k (O)	➢ Low degree of product difficulty, design is set for general public (W)
	➢ Environmental pressure will cause to re-assess material choice and product design (S)	➢ Tremendous cost pressure from OEMs (T)
	➢ Risk taking culture (O)	➢ Potentially unwilling to diversify from present (W)
	➢ Large potential for under body parts (O)	
Europe	➢ All major OEMs have manufacturing footprint (O)	➢ Soverall life cycle energy / regulation may prove to be an obstacle for long term success (T)
	➢ Large growth in market 40-45k (O)	➢ Not a risking taking culture (T)
	➢ Environmental pressure will cause to re-assess material choice and product design (S)	➢ Tremendous cost pressure from OEMs (T)
	➢ Pioneers for new technology (O)	➢ Potentially unwilling to diversify from present (W)
	➢ Large potential for under body parts and Body-in-White in niche segment (O)	

S: Strenght
W: Weakness
O: Opportunity
T: Threat

Figure 6-4: SPF Global Market SWOT Analysis (Foley (2010), Own Illustration)

6.1.5 European SPF Market

The niche vehicle market will always remain a trademark in Europe. The biggest market for sports cars is Germany, followed by UK and Italy. This segment as lately received tremendous attention from the OEMs that had previously abandoned this segment. Nearly all the OEMs have product in these segments, VW has acquired Bentley, Lamborghini, and Bugatti, and BMW has acquired Rolls Royce. Manufacturers have invested heavily in this segment since 2008 (CSM 2010), and some new models will soon be coming to the market. To remain successful in this segment, OEMs will need to pay more attention to the design of the vehicles, which is ultimately the primary attraction for the customers.

The niche vehicle market is sub-segmented:

1) Independent Manufacturer
2) Original Equipment Manufacturer

The European independent manufacturers include:

- Ginetta British (UK)
- Morgan (UK)
- Arash (UK)
- Spyker (Holland)
- Noble Automotive (UK)
- Gumpert Sportwagenmanufaktur (Germany)
- Ascari (UK)
- TVR (UK)
- Westfield (UK)
- Caterham (UK)
- Fornasari (Italy)
- Pagani (Italy)
- Koenigsegg (Sweden)
- Venturi (France)

6.2 Carbon Fibre vs SPF

The niche manufacturers above truly showcase their uniqueness through their distinctive design and powerful engines. Most of them use Carbon Fiber (CF) to fabricate the complete body-in-white. The biggest advantage of using CF over aluminum or steel is the weight reduction. It has a 75 % weight reduction over steel and 15% over aluminum , therefore the independent manufacturers have a higher weigh-to-power ratio when using CF. The problem is that carbon fibre composites costs approximately $10,00 vs $1,05 per pound for aluminium (Deaton (2010)), that is 8.5 times as much as aluminium, and production of carbon fibres is generally slow and expensive. Similarly to SPF, CF involves high capital equipment to obtain a final part. It requires a high labour overhead, and high energy costs. The second hurdle is waste disposal. When SPF parts are damaged/scraped, the aluminum can be melted and used to construct other parts. Carbon Fibre cannot be melted down, and it is not easy to recycle. When it is recycled, the recycled carbon fibre is not as strong as it was before recycling. Therefore, the recycled CF is will not be suitable to be reintegrated into another.

As a result, carbon fibre composites cannot directly compete economically with aluminium in the auto industry. However, a potential option would be to blend both technologies to cater to specific and niche application, ex: SPF underbody, with CF outerskin.

Material	Part	Sq/m surface	Process	Material Cost	Tooling Price	Piece Price
Carbon Fiber	Roof	0.7 sq/m	RTM	$160.00	$250,000	$700.00

Material	Part	Sq/m surface	Process	Material Cost	Tooling Price	Piece Price
Aluminum	Door	1 sq/m	SPF	€29.92	€450,000	€[illegible]11.35

Figure 6-5: Carbon Fibre vs Aluminum (Foley (2010), Own Illustration)

6.3 European OEM base

The second opportunity for SPF in Europe lies within the existing OEM base. As aforementioned, much of the tradition of niche vehicle production lays in Europe. These vehicles are designed for both family and exclusive use; in parallel it encompass' unique styling and performance. Consumers in Europe have always had a customary willingness to pay more for performance and individualism. This approach has led for OEMs to seek after new markets and revenue streams. This vehicle segment has sprouted in leaps and bounds during the last decade due to new found wealth in emerging countries. As a result, these market advancements are presenting tremendous business opportunities for UK Superform.

OEM	Platform	Program	Nameplate	Plant	SOP	EOP	Vehicle	CY 2012	CY 2013	CY 2014	CY 2015	CY 2016
Aston Martin	VH	AM305(2)	Vantage V8	Gaydon	2012-01	2019-06	Aston Martin Vantage V8	2,527	2,938	3,509	3,911	4,220
Aston Martin	VH	VH500(2)	DBS	Gaydon	2013-01	2019-06	Aston Martin DBS	0	784	731	768	741
BMW	L6	Z6	Z6	Dingolfing	2013-01	2020-01	BMW Z6	0	2,493	3,673	3,960	4,147
BMW	RR01	RR05	Phantom	Goodwood	2013-01	2022-12	Rolls-Royce Phantom	0	358	628	802	818
Daimler	W212	R231	SL	Sindelfingen #2	2012-07	2020-06	Mercedes-Benz SL	2,027	20,418	17,870	15,420	14,770
Daimler	W222	C217	CL	Sindelfingen #1	2013-07	2020-06	Mercedes-Benz CL	0	1,166	8,252	10,568	10,883
Daimler	W222	W222	S-Class	6th of October City	2013-04	2018-03	Mercedes-Benz S-Class	0	262	349	528	618
Daimler	W222	W222	S-Class	Chakan (DCX)	2013-07	2018-06	Mercedes-Benz S-Class	0	334	442	570	596
Daimler	W222	W222	S-Class	Pekan (Isuzu Hicom)	2013-07	2018-06	Mercedes-Benz S-Class	0	305	476	496	516
Daimler	W222	W222	S-Class	Samut Prakarn	2013-07	2018-06	Mercedes-Benz S-Class	0	519	680	828	804
Daimler	W222	W222	S-Class	Wanaherang	2013-07	2018-06	Mercedes-Benz S-Class	0	146	270	286	320
Daimler	W222	W242	57/62	Sindelfingen #2	2013-10	2023-09	Maybach 57/62	0	68	295	314	322
Fiat	FERRARI	F142(2)	F458(2)	Maranello	2015-10	2021-09	Ferrari F458	0	0	0	228	3,601
Fiat	MASERATI	F149(2)	California(2)	Maranello	2014-10	2019-09	Ferrari California	0	0	131	3,348	3,801
Fiat	MASERATI	M145(2)	GT Coupe	Modena	2013-10	2019-09	Maserati GT Coupe	0	813	3,182	3,567	4,157
Fiat	MASERATI	M147(2)	GranCabrio	Modena	2015-07	2020-06	Maserati GranCabrio	0	0	0	645	1,429
Fisker Automotive	Nina	Nina	C-Car	Wilmington	2013-07	2018-06	Fisker C-Car	0	2,671	9,102	11,077	11,281
Porsche	970	970(2)	Panamera	Leipzig	2015-07	2021-12	Porsche Panamera	0	0	0	8,948	20,729
Porsche	9X1	981	Cayman	Osnabruck	2012-07	2018-06	Porsche Cayman	3,250	9,987	10,057	9,615	9,557
Porsche	MSC	PO374	PO374	Osnabruck	2013-04	2018-03	Porsche PO374 [PO374]	0	7,183	12,273	14,601	15,029
Proton	GX	007D	Compact SUV	Hangzhou	2012-01	2020-03	Lotus Compact SUV	11,179	11,214	12,056	12,434	13,877
Proton	GX	WRM44(2)	L3 Jingsu	Jinan	2013-01	2021-03	Lotus L3 Jingsu	0	2,567	3,273	3,967	4,234
Tesla Motors	Model S	BlueStar	Tesla 3	Downey	2013-01	2017-12	Tesla 3	0	4,019	4,135	3,989	3,665
Tesla Motors	Model S	WhiteStar	Tesla 2	Downey	2012-03	2017-02	Tesla 2	1,189	1,834	1,955	1,763	1,641
Volkswagen	BUGATTI	BG834	Veyron	Dorlisheim	2014-10	2019-09	Bugatti Veyron	0	0	10	48	44
Volkswagen	LAMBORGHINI	AU724	R8	Neckarsulm #2	2015-01	2019-12	Audi R8	0	0	0	5,078	5,701
Volkswagen	LAMBORGHINI	LA724	Gallardo	Sant-Agata	2012-01	2021-12	Lamborghini Gallardo	686	1,443	1,363	1,290	1,349
Volkswagen	MLB	BY621	Flying Spur	Crewe	2012-03	2019-02	Bentley Flying Spur	2,262	3,108	3,205	3,090	2,916
Volkswagen	MLB	BY625	GTC	Crewe	2014-01	2019-02	Bentley GTC	0	0	2,156	3,820	4,281
Volkswagen	MLB	VW621	Phaeton	Dresden	2014-01	2019-02	Volkswagen Phaeton	0	0	5,767	6,608	7,049
Volkswagen	ROLLS ROYCE	BY835	Azure	Crewe	2013-10	2018-09	Bentley Azure	0	16	155	156	152

Figure 6-6: European Vehicle Volumes (CSM (2010))

The chart above showcases vehicle programs that are set for Start-of-Production (SOP) in 2012 or later. This showcases tremendous opportunities for UK Superform to acquire further business from the OEM base in Europe. The SOPs that are extended past 2013 gives additional time and leeway for UK Superform's engineers to work closely with the OEM's designers to integrate the use of the Superplastic Forming process into its parts. The higher end niche vehicle market; Aston Martin, Ferrari, Bugatti, and other premium brands, will inevitably always have a strong need for an unconventional design and lightweight applications. Consumers are paying more for distinction, and prestige which SPF would be able to deliver on body-in white panels, and at the same time potentially delivering uniform floorpans to reduce the overall vehicle weight thus increasing the power-weight ratio for the OEMs.

6.3.1 Electrification Trend

The likes of Fisker and Tesla have emerged from an idealistic electrification business concept into a near start of production phase. Both OEMs are demonstrating the current transformation of the automotive industry. They mutually cater to a niche market, by providing electric vehicles to a new market base. The entire supplier market is seemingly at an even quell for battery performance, however it will be through design and individual features that Fisker and Tesla will be enticing future buyers. Design and performance will be the marking point to bring millions of future buyers into the showroom to display and sway the consumers away from the traditional internal combustion engine vehicle. The forecasted volumes are presently in the ideal range to implement SPF into their part design. Considering the billions spent by foreign governments to accelerate the electrification to market, and the billions mores spent on environmental protection, the body-in-white deserves as much attention as the drivetrain. According to the Aluminum Association of America the use of aluminum in electric will benefit from the following (Smock (2010) :

1) A hybrid electric car with an aluminum body would be 13 percent more energy efficient than with a steel body.
2) The driving range of the vehicles could be improved approximately equal to the mass saved. Reduce the mass of the vehicle 20 percent, go 20 percent further
3) Every dollar invested in reducing the weight of an electric vehicle with aluminum saves three dollars in battery cost.
4) Aluminum use in cars already saves 660 million tons of carbon dioxide emissions annually by making cars more efficient.

6.4 Logistics Value Added?

Logistics is always a sticking point when making business decisions. The topic of whether it is value added to the final product will forever be immensely discussed. We’ve seen that the major business expansions for SPF opportunities lay in Europe. UK Superform’s facility is well situated to continue to supply the small niche market potentials of the UK. However, if their aim and ambition becomes larger to supply Europe’s mainland OEMs then logistic costs will need to be assessed for a contingency plan. The numbers have already been shown that UK Superform is at a cost handicap due to their investment of the wash-treatment line. Now considering the distances between UK Superform’s facility and the OEMs in the mainland, logistic costs would quickly ramp up into exorbitant numbers. These two costs combined are presenting irrational spending which otherwise could be evaded should the right opportunities and long term cooperation with an OEM present itself.

Figure 6-7: Europe Logistic Map (Google Maps (2010))

Figure 6-8: Logistic Cost UK Superform to METOB (Foley (2010), Own Illustration)

7 Conclusion

Examining the complete business model, from the supply chain to logistics is quintessential when conducting trade in a global market place. Conducting business in a global environment presents many opportunities. As the opportunities grow larger, so does the intricacy of the company's operations and logistics. The supply chain management has never been so crucial to the survival of the tier 1 suppliers. The customer is seemingly always right but by aligning the expectations of both Customer and Supply will not only ensure smooth and seamless program launches, it will benefit both of the company's bottom line. It truly does take a lifetime to build up a strong reputation in the automotive industry. The suppliers are only as good as their last program, but by successfully managing the unmanageable occurrences, the company will ensure successorships. To ensure the latter, a committed and collaborative relationship between supply chain partners will need to be in effect. Basically trust needs to be the backbone of any Supply Chain to secure successful program launches and profitable Program Life Cycles. If trust is present, it can improve the chances of a thriving supply chain relationship; if not, transaction costs can increase through meagre performances. Companies need trust in order to be flexible and agile. Trust in a supply chain grows based on commonalities among the partners and takes tolerance and time to develop. To develop this, companies must be careful as to how to optimize this trust as it can take resources from elsewhere of the supply chain. So the Supply Chain members must be careful not to over or under invest in developing trust. It is apparent that trust only exists when both parties think it exists, that it is critical to treat supply chain partners like they are important, information needs to be shared freely, and that partners need to follow through with promises made. Once the relationship is solidified, quality, process optimization for cost reductions and ultimately customer satisfaction will all follow suit.

By diligently analyzing the supply chain, it ensures that the company has the right portion of their process insourced/outsourced. The analysis will highlight any possible flaws which other could be detrimental to its long term success. By segmenting and highlighting the core competencies it will retain the value-added in-house thus providing the customer with the optimal economic solutions. Superplastic Forming has indeed much benefit to the OEMs in this increasingly competitive market place, but without having the proper cost structure in line with the technology, companies will never succeed. Having a vertically integrated process seems at first glance to be quite glamorous and beneficial; however ensuring that the financial numbers have been calculated will enable a much diligent and strategic business decision. The make-or-buy analysis should be conducted for every portion of the process that is not deemed to be core to make sure no resources are squandered carelessly which otherwise could have boosted profit.

UK Superform have an establish network of business partners who trust and work with the company year after year, model after model. Through financial investigation UK Superform could have avoided making such a capital investment for their wash and treatment line, and opted to use a local supplier. This decision proved to be the wrong one financially considering their production volumes are extremely low and will most likely never produce 115,000 parts per year to break even on the investment. Besides UK Superform do not have the proper process line and manufacturing infrastructure to cater to the potential of having higher volume programs.

Making strategic financial decisions for companies come every day, conducting a simple NPV and IRR analysis not only showcases the investment's potential return but most importantly it provides strategic advantage over the competitors. UK Superform at current time does not have a problem with competition, but rather, they seemingly have problems grasping the complete process costs.

The automotive industry has evolved organically from standard stamping dies using mechanicals presses to highly advanced forming processes through the natural course of research & development. One thing is certain; the OEMs will increasingly be making their green mark onto environment by reducing their carbon footprint, but keeping in stroke with their strong purchasing culture. Building strong working relationship with the OEMs will be the only way SPF will be able to successfully penetrate and take market share away from the traditional stamping process. Whether SPF has a long term success in the industry it is still very primitive to say, however the short term success is definitely clear, and opportunities are there for the takers. Charles Duell must have been wrongly quoted, what he must have said is “The world is now only beginning to change, manufacturing through the help of technology and innovation will lead us into the 21st century”.

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