Development of a System to Adapt Automobiles in Emerging Nations


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Abstract

In spite of its popularity, auto-mobility has never been an accessible transportation medium to the majority of the world’s population. Big amounts of resources are spent every day to support auto-mobility yet, only about 12% of the world’s population has the possibility to acquire a car, and even less has the option to acquire a new one. (Humphrey 122)

However, the automobile is still the most desired type of transportation because it is the most versatile. If automobiles are meant to be the main tool for human transportation in the years to come, it is important that important changes in the way they are marketed and consumed take place in order to ensure that every body can access them, otherwise they will remain with a “white man goods” status.

Lower segments of the population usually have access to old cars because of their low cost however, as they age, most of these vehicles retain little or almost no value to offer to their customer and quite often their usage conveys a high price that the user has to pay as exchange for the transportation.

One way in which automobile’s access could be expanded to lower segments of the population is by expanding their lifespan. If cars remain unchanged in the market for a longer time, then the costs associated with their acquisition and operation tend to be lower. A good example to this is the VW bug in Mexico or the Nissan Sentra.

This however requires changes in the way automobiles are sold and changes in the design of the automobiles. If we can ensure that old automobiles retain their fundamental value as mobility providers, then the lower segments of the population would find value in a platform whose cost of operation is reasonable.

This thesis project will explore a possibility to design a multipurpose automobile platform. A vehicle intended to remain unchanged in the market as long as the basic technologies it employs do not change. This basic mobility platform in the form of an automobile will enhance the experience of new-cars and old-cars users by providing them with the basic value of mobility, while letting them adapt their vehicles to their specific needs, and by allowing them to perform this adaptation using a broad range of resources.

The context of this project will be emerging nations, the rationale is that the consumption patterns in emerging nations are still substantially different than those present in industrialized nations, and thus represent the appropriate scenario of applicability for a project like this.
Other issues, such as vehicle migration, and the cultural value of aesthetics are also explored and will help to illustrate the value of universal design in auto-mobility solutions.

My interest in this topic is somehow the result of my previous and current studies in industrial design, and my interest in automobiles. Two issues “I got in touch with” during my Master’s studies, which have expanded my own vision of Industrial Design, and have also influenced this project: first, the need to find sustainable alternatives to the current platform of product fabrication and consumption, and second, the need to de-centralize design out of the first world in order to achieve successful local solutions. I strongly believe that the “United Statesization” of the world is not a viable long term strategy for the development of the world.

It is my firm belief that it is important to find alternate ways to do business and create profitability potential doing more sustainable practices appropriate for the conditions of the developing world. This project represents my personal attempt in this direction.

G.C.G.
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Introduction

As many new possibilities and perspectives may have been opened through increased auto-mobility during the last forty or fifty years, it remains to be seen whether it has solved the transportation requirements of most users in the world. In view of the apparent limits that are set on the development of mobility, the increasingly urgent question arises as to what extent the idea of going after the traditional form of automobile is still desired?

As an example of the previous, we can point to the fact that many developing countries are still dealing with the consequences of adopting erroneous transportation solutions, and now face the task of seeking alternatives that are well contextualized.

The automobile was developed in the industrialized nations and then recommended to the whole world as a shining example. However, the consumption capacity of the people in developing countries has always been different. The sense of individuality and collective use are by need or by conviction substantially different, and this directly influences the way products and automobiles should be planned.

In the countries of the South, just as the economic and technological development of the means of production is uneven, so is the development of the modes of consumption. This uneven development means that the spatial and other contradictions of auto-centered transport are more accentuated.

What is being exported to countries of the South is not only technological forms that originated in the North, but consumerism that is mainly modeled on the US. These newly emerging auto consumption patterns have influenced urbanization, contributed to oil dependency, created massive environmental problems, and drained scarce public resources.

USA, Japan and Germany account for 48 percent of vehicle consumption. No surprise that current automobiles are designed to fit in these markets although they log only 8% of the world’s population. When the same automobiles are pushed into other markets to achieve economies of scale they create all the problems that a diverse and undeveloped automobile infrastructure comprises. (Landman 122)

The historic pattern of rather thoughtless direct transfer of technology such as the auto (and its consumption patterns) from North to South, has been a problematic undertaking in which, the major gain to the South, has been learning what mistakes to avoid.
The central problem with regard to automobile’s impact on socio-economical diversity, is that it commands dedicated consumption, and resources to support it. The current system of consumption of cars is costly, consumes energy, and produces a great amount of waste. Nobody highlights the fact that approximately between 20% and 25% of the global population living in the industrialized nations are using about 80% of the earth’s resources and are responsible for more than 75% of atmospheric pollution. It is clear that we are obligated to find a way to restrict excessive consumption and expand the benefits of mass production to lower segments of the population. (Landmann 89)

In addition to all of the previous, there are fundamental differences between industrialized and emerging nations, which exert important differences in product attributes. In the developed world, as markets get over-saturated, more and more manufacturers adopt the strategy of making money by adding features to their cars. In these items, the difference between the purchase price from the suppliers and the price charged to the car buyers can be as much as 400%.

In the particular case of developing economies however, most of these “enriching” features only help to make cars more inaccessible to lower segments of the population.

As quite often “form prevails over function” in the “first world”, important needs remain unattended for most of the people outside of it. Yet, as the world’s population rises exponentially, it is foreseeable that there will be an increase on the demand of automobiles.

In this setting, the current direction of the automotive industry appears to have few solutions to offer. The evolution of the car has been substantially affected by the requirements of industry to comply with high volume and low cost production standards, rather than with attending the needs of low-income segments of the population. This conflict of interests within the industry moves the automobile away from solving real needs, and makes it a sumptuous object.

New approaches to automobile consumption and use are required in order to satisfy the growing and diverse mobility demands of emerging regions so they can sustain their growth. We require of a platform versatile enough to reduce consumption, and still foster directly and indirectly the economic development of these regions.
PART I

Problem
CHAPTER I
Study Case

1.1 Situation Observed

A common situation observed in developing nations, is that there is a good number of old automobiles modified by their users. The vehicles that circulate the streets, present modifications that range from the adaptation of a turn light, to extensive transformation of the structure of the car.

Most body transformations take place in collision-repair workshops, however some other adaptations can take place in general metal-workshops. Some other transformations to the interior are performed in upholstery workshops or a combination of upholstery, mechanical workshops.

Analyzing this how this network operates is important because for instance, many car owners transform their cars using this network of workshops at very low cost. Many users actually know someone that has a workshop of this kind, and have the confidence to ask them to perform a customization, many times even in exchange for favors, other services, or goods rather than money.

New vehicles are usually transformed in specialty workshops, sometimes even before they leave the auto-dealer. In this case, the customization process uses more add-on parts and fewer processes (i.e. police cars.) In general, most new cars in Mexico are transformed due to functional and styling requirements of their user, whereas old automobiles are transformed due to repair and functional needs of their users.

Appendix D has extended information about research done in automotive workshops in Mexico.
1.1.1 The used car market

There is a tendency to think of new-car demand as a distinct market, and to ignore the used-car market. However, it is impossible to ignore the impact of the steady expansion in the stock of cars in circulation, the so-called “PARC”. As cars in general become more reliable and last longer, new cars become relatively less attractive. While there is a segment of the population that demands new cars, the real demand is for personal transportation, or car ownership, that can increasingly be fulfilled with used cars. Thus, there is a gradual transformation of the role of the new car, from functional transport provider to fashion accessory; a feature that is likely to make demand for individual models much more volatile. However, it is evident that in developing countries, fulfilling the transportation needs still represents the best business opportunities.

One consequence of saturated markets and the growth in the stock of cars in circulation is the emergence of a chronic over capacity. There is a far greater potential to produce vehicles around the world than there is a capacity to buy them, and yet the process of competition is forcing the vehicle manufacturers to install new capacity faster than the markets can grow to absorb the available supply. The vehicle manufacturers are faced with the high fixed costs of not producing cars once the investments required have been made. They are repeatedly tempted to over-produce, hence the over-supply on the market.

The growing stock of newly manufactured cars leads to a further point: that new cars become less and less valuated and hence less valuable, as expressed in the high depreciation rates on new cars and the low prices of used cars. However, at the same time, less and less benefit (or use value) is to be derived by consumers from cars, despite the necessity of ownership.

Mature markets for instance, present a tendency to double the number of cars sold second-hand each year. In France for example, for every new car sold in 1995, 2.1 were sold. By the mid-1990s, the total value of the used-car market began to overtake that of the new-car market. (Nieuwenhuis 92)

Another important aspect that has been observed, is that a large number of cars in developing nations, are not chosen by their users, but they acquire them in several ways like:

- A gift from relatives
- In exchange for other good or services
- Selection forced by the low cost
1.1.2 Automobile Migration

Another phenomenon that contributes to increase the PARC in emerging nations is Vehicle migration. Probably the best scenario to exemplify this situation is North America. Automobile “left-overs” from the US are sold at low prices in Mexico and eventually Central America.

For many car owners in the border region, it represents a better deal to re-sell their car on the Mexican side rather than to take it to the auto-recycler. The financial difference, in this case, makes it an attractive proposition. For example, a car that would be worth $500 dollars in the auto-recycler can be sold in the other side of the border for $1,000 or even more. (Old cars find new life in Mexico)

The problem with this situation is that a car designed for someone in the first world ten years ago, hardly matches the requirements of its new user, which often require functional and technical modifications.

Even beyond the change of place, automobile migration implies a change of culture. It is the culture of ambulant sellers in Latin America for instance, that transform pick-up trucks into “moving establishments.”

In the realm of lifecycle management, migration is one of the ways in which automobiles “leak out” of their “planned” life cycle (LC) Loop and brings a whole new spectrum of problems and possibilities as they “arrive” in societies with developing or non-existent recycling infrastructure.

A good example of the socio-ecological impact of this phenomenon is the fast growing number of junkyards in Mexico which contribute to visual and environmental pollution. (Dinker)

If handled smartly however, automobile migration could be part of a strategy for re-use, and a useful tool to reduce recycling, which has proven to not be a longterm strategy for sustainability.

The market in the United States and Canada is expected to remain large, but highly cyclical. A feature that, on the one hand, encourages large productions volumes, and hence a greater inclination towards steel vehicle body structures, and on the other hand, demands make the high fixed costs of steel production technology a real liability.
1.2 Cases

The following scenarios, illustrate real situations observed where automobiles have been adapted, and illustrate which features that could facilitate these desirable adaptations. These cases are:

- Maintenance/Reparability
- Change in user’s desires (Up/Downgrade),
- Changes in User needs and
- Changes of context

1.2.1 Maintenance/Reparability

When someone buys an old automobile, depending on its age, some of its components may not be functioning or may be close to breakdown. This becomes a problem for two reasons: the spare parts may not be available, and replacing them can be very complicated.

For example, when the speedometer of a car break-down, there are several things the user could do:

1) Use the car without the speedometer. (Which cannot be done with other important components)
2) Get a “used” functioning speedometer from a junk yard (if available).
3) Buy a replacement part directly from the company.
4) Buy an aftermarket replacement part (if available).
5) Adapt a “generic” speedometer to the car.

Spare parts however, are as scarce as an automobile’s age, and some vehicles can be as old as 15 years or more. In these cases, spending 20% of the price of the car on replacement parts is simply unaffordable for most users. On the other hand, adapting generic parts or parts from other vehicles (a very common practice in developing nations), commonly conveys all the problems of a “brute force” modification.
However, spare-parts availability is not the only obstacle that encourages the use of generic components. If the repairing process is difficult, or if it requires sophisticated equipment, it discourages the replacement of the broken component. In the previous example, if replacing the speedometer requires taking apart the entire instrument panel, the user might simply prefer to get another speedometer and put it somewhere else in the cabin.

Another good example to illustrate the need for reparability, and the importance of sustainability, can be seen in those car models that are produced for a long periods of time. In this case, even if the model changes, many of its parts are still interchangeable, or are “close” to being adaptable, whereas in the case of models that only remain in the market for a couple of years, finding replacement parts is difficult.

1.2.2 Changes in User Desires

A second scenario under which customization is a useful characteristic is when users wish to add or take features out of the car. For example, if an old car with electric windows ends up sold to a user who does not need this feature, this user should have the possibility to “go back” to the manual mechanic system. On the other hand, if a user wishes to add speakers to the standard sound system of the car, it should not be necessary to undertake the tedious tasks of taking apart interior trims, making cuts and drilling holes in the door panels.

For these specific situations, the user could choose to give up his desires and continue to use the car without any changes, or adapt external components whether they come from another car, or if they are generic aftermarket products.

In the last case, the problem is that automobiles do not provide “extra” room for additional components. In consequence, most users perform “brute force” adaptations with their implied complications.

For the producers of aftermarket solutions, it is a problem to provide products that fit all the makes and models of cars because their components do not share the same technical interfaces. Using the same example of the speedometer, all speedometers in cars are different, sometimes even in cars of
the same brand. This implies a lot of development efforts and resources invested for aftermarket producers of speedometers.

Adapting generic components also carries all sorts of problems that disrupt the original aesthetics and function of the car. Let’s think for instance of how common it is to see large speakers that have to sit in the trunk or in the back seat of the car because it is easier to just “put them there” than trying to permanently fix them to the vehicle.

1.2.3 Changes in User Needs

The third scenario in which customization is highly desirable, is when the transportation requirements of the user change. For instance, a user who uses a small sedan to go to school, might require different functionality if he suddenly starts a business of homemade pizzas.

This situation is very common in societies where the economic instability makes job uncertainty a constant. In Mexico for instance, there is large amount of workers who do secondary activities in order to complement the low income received as employees of companies. Fig ones shows the predominance of the segment of the population that earns 1 to 2 minimum wages, the equivalent to 5 to 10 Dollars per day.

On the other hand, for a user in a highly consumerist society, the obvious answer to this problem would be to sell the sedan and buy a truck. A solution not viable in developing countries, because the money a person would get for their old vehicle would not be enough to buy a truck, not to mention the costs associated with selling and buying.

1.2.4 Changes in Conditions of Use

Finally, the last scenario in which a Customizable/Adaptable automobile could be of great benefit, is when it is necessary to adapt cars to the particular conditions of use in a given environment. The cultural and physiological differences of the users in diverse contexts exert an important influence on the way a vehicle is used. These conditions change, and require adaptations and/or adjustments in order to make the car usable.

Let’s put the case of a pick-up truck, the actual height of pick-up trucks is a problem for many users in the south of Mexico and Central America where the population tends to be short.
The reason why it is very common to see trucks equipped with custom built running boards to facilitate easier access to the cabin.

There is not any design feature in the structure of the truck however, that facilitates the installation of these custom built running boards (Ready made holes or additional metallic fixtures upon which to weld). Even more difficult is to find a manufacturer that actually provides information on how to build these custom parts, and how to attach them to the vehicle in case it is necessary.

Another good example of this case, are the grill guards. Widely used in Mexico in the past, the “crossing” of animals (cows mainly) on the roads required additional protection to prevent the grill from being damaged in the eventual crash with these animals. This again was often ignored in the design of the car because it did not constitute a problem in industrialized nations.

A final good example of this type of adaptation, are the automobiles that are adapted to protect them from thieves. In this case the conditions of the environment force the user to adapt the components so they can be used in a different way.

In any of the previous cases, the options for the user are: To use the car as it is, which reduces its functional efficiency, or to do the necessary adaptations which are generally difficult, time consuming, and expensive.

An automobile designed to be adapted could solve the problems described in the previous cases. It would allow the re-use of the car by facilitating not only the maintenance of the vehicle, but also the adaptation of changes according to the user’s needs. Also, it would promote local economic development by integrating the transformation process into all of the local available workshops.

Appendix C has extended information and examples of “forced” customization done to old automobiles in México.

1.2.5 Conclusions

There is physical evidence demonstrating developing nations modify their used-cars in order to fit their particular needs, thus the adaptability features of the automobile must be expanded in order to guarantee its survival as a predominant transportation platform.
As the used-car market steadily overcomes the size of the new-cars market, the features that can satisfy the needs of second-hand car users become more and more important.

By reviewing the information previously presented, it can be concluded that the reason why people modify old cars in Latin America, relative to the examples describe, is because:

- Users did not buy the car, they do not have money to buy a new one, and yet they need different or additional features than the ones the car currently offers.

- If they try to sell their actual car to buy the one they need, they would not get enough money to actually do the purchase.

- Because the cost they will pay to get their cars modified is more reasonable (or might be null) than doing anything else.

- Because they have time to do it.

### 1.3 Problems Found

Also from the situations previously described, it has been found that the forced modifications in automobiles convey a number of problems that can be appreciated in the following example:
These problems could be summarized as:

- Waste of resources
- Corrupted aesthetics
- Limited success
- Dangerous operation
- Irreversible changes
- Non-development of aftermarket & Workshops
- No support to economies of scales
- Customer dissatisfaction

1.4 Needs Detected

By studying the information previously exposed, it is concluded that there is a tangible need for:

a) Spare parts that can keep old automobiles in operation.

b) A car that can be adapted/adjusted to the particular conditions of use of emerging nations.

c) A car that can be adapted/adjusted to the culture and physical characteristics of different users.

d) A car that promotes the use of aftermarket/generic components.

e) Standardize components in automobiles.

f) A car that can be easily adapted to the changes in transportation needs of the users.

g) A car that provides enough room to add features according to the desires of each user.
1.5 Justification

Addressing the previous needs are important for several reasons; first of all, the market of used automobiles is constantly growing and surpassing the market of new cars. In consequence, it is important that the needs of second-hand car users are fulfilled.

For the industry, it is also important to attend this market regardless the fact that these customers do not buy directly from the dealer. If a car retains more value that its competitors, it will affect the sales of new cars of the same model. In Argentina, for instance, while the sales of new cars in 2003 numbered 155,000 units, the sales of used cars reached 873,000 units, achieving a percentage growth of 43%, compared to 20% of the new-cars market. (Situación actual de la industria automotriz)

Futurists say that by the year 2020, the major mode of passenger transportation will be the modular automobile: an automobile that consumers will buy possibly over the Internet, by choosing base modules like the body, chassis, doors, engine, and transmission, and adding feature modules like seats, cockpit, and other items according to their needs and preferences. The familiar brand names such as Ford and Toyota might remain, but the major source of added value will not be with the auto makers, but with the suppliers of electronics and other functional systems and major modules. This scenario raises a whole new paradigm for the operation of the industry.

For society, solving these needs is also important. From the disrupted aesthetics resulting from forced transformations, to the resources wasted during these transformations, or the unnecessary consumption and disposal of new vehicles, solving these problems could substantially enhance the impact of automobiles in urban spaces.

1.6 Solution

The problems generated by the inflexibility of automobiles could be solved by an integrated system initiated by global automobile manufacturers and the local workshops that adapt vehicles sharing common characteristics in emerging nations. This system should consider all the stakeholders involved in the process, and offer enough flexibility so that new and old vehicles could be modified.
This system would require of ID actions to develop the hardware elements involved in the system such as:

- The automobile
- The Parts to modify it

The development of that hardware constitutes the primary subject of study for this thesis project.

**1.7 Objective**

**What**> Develop a concept to adapt automobiles in emerging nations. Determine the main stakeholders involved, their requirements, and translate these into the design of the hardware involved in the system.

**Why**> Because there is an important number of old automobiles being empirically modified resulting in problems for the user, the society, and the industry.

**What For**> Solve the problems generated by brute force transformations and enhance the way in which automobiles are consumed and used in emerging nations.

**For Whom**> Users of new and second-hand cars in emerging nations who look for the functional value of a car when they acquire one.

**Where**> Emerging nations that share the similar characteristics of development.

**How**> Using a multi-purpose modular automobile platform that can be easily transformed by changing the modules. These can be produced by the manufacturer of the car, by aftermarket producers, by local workshops, or by user itself.

This “basic” automobile can be “completed” by local industries, a scheme that could actually prevent globalization practices that leak-out capital of developing countries, and would help to decentralize profits of the automobile industry.
PART II

Research & Analysis
CHAPTER II
Existing Solutions Study

When someone “forces” a certain product to either look, function, or just stand differently than it originally did (as is the case of old automobiles in Latin America), it seems clear that there is a lack of understanding about the requirements of the current users of that product.

In the previous paragraphs, the necessity of a new kind of automobile that can address the needs of a larger number of users (all those who buy the car used, for instance) has been demonstrated. For this purpose, the concept of customization has been briefly explored as well as its potential for the materialization of this new kind of automobile.

Customization in the realm of automobiles is not new by any means. Unfortunately, in terms of automobile design there has never been a fundamental approach to universality. In fact it is only in the last few years that we have seen basic customizable features in production automobiles, however, these features are far from being useful for different users and diverse contexts, and appear to only solve the needs of very specific niches.

On the other hand, it is common to see that for many aftermarket producers, customization is mainly a medium to do re-styling. After all, contemporary automobiles are constructed in such a way that achieving deeper modifications (like functional ones) is almost impossible.

The challenge for the auto-industry then, is to find a way to preserve economics of mass production while still meeting demands of diverse customers in a much more sustainable and universal way.

2.1 Reference product analysis

Several attempts have been made in the past by different manufacturers and automobile experts to create modifiable cars. Some of them have been more ambitious than others, but almost none of them made it to production and even less have been successful.
One of the challenges of studying concept cars, is that we can only speculate about the reasons why they were not taken to production. However, we can observe similarities among them that can give us a clue to understanding their failure.

The following three examples have been studied in order to determine their qualities and the attributes that could be incorporated into this project as well as those that should be avoided.

As early as 1970, George Holman had worked in a Modular car. However his design never was produced.
Nissan EXA.

Name: EXA
Manufacturer: Nissan
Year: 1987
Produced: Yes
Sold in Emerging Nations: No
Dealer network support: No
Description: Customers that buy the automobile can use it as it is or can re-configure it by changing the canopy as is shown in the images.
Chevrolet AVALANCHE.

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<td>Aesthetics:</td>
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<td>Average</td>
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<tr>
<td>Technical feasibility:</td>
<td>Complicated</td>
<td>Average</td>
<td>Simple</td>
</tr>
</tbody>
</table>

Name: AVALANCHE
Manufacturer: Chevrolet
Year: 2000
Produced: Yes
Sold in Emerging Nations: Yes
Dealer network support: N/A
Description: The cab rear-panel can be folded-removed so the cargo area is extended up to the base of the driver's seat.
Ford PRIMA.

Name: PRIMA
Manufacturer: Ford
Year: 1976
Produced: No
Sold in Emerging Nations: -
Dealer network support: -
Description: A first attempt to a modular platform to obtain four different vehicles, a pickup, a coupe, a station wagon and a sedan. Not intended to be modified by the user.
2.2 Design for Disassembly

Design for Disassembly is commonly grouped with other trends that have been “in vogue” recently such as: **DFM**: Design for Manufacturability, **DFA**: Design for Assemblibility and **DFR**: Design for Recyclability.

Fiksel has defined Design for the Environment (DFE) as a systematic consideration of design issues related to environmental and human health over the life cycle of the product. Eight aspects which should be included in design for the environment: (Fiksel 43)

- Manufacture without producing hazardous waste
- Use of clean technologies
- Reduce product chemical emissions
- Reduce product energy consumption
- Use of non-hazardous recyclable materials
- Use of recycled material and reused components
- Design for ease of disassembly
- Product reuse or recycling at end of life.

Although the efforts put into designing automobiles for ease of disassembly could indirectly be beneficial for adaptability, in practice these become more of a tool for recycling, and a recycling tool for mass consumption. Additionally, none of these concepts have been accompanied with a proposal to operate and support its disassembly from a business standpoint.

Some technologies developed in these concepts can be useful for customization though. For example; SMC, a plastic material used to develop the exotic hood of the past Ford Mustang is compatible with fiberglass reinforced plastic, a material widely available in collision repair workshops all over the world.

2.3 Other Flexible Platforms

Perhaps, pick-up trucks are the most versatile production vehicles that the industry has generated so far. The reason can be found in the way in which they are constructed because the leader type of frame allows the incorporation of all kind of elements in the rear of the cabin.
A good example of the positive economic impact of this platform on local economies can be found in Mexico, where a local industry that produces different kind of rear structures for pick-up trucks has been well established over the years. This not only promotes the creation of small companies, but also contributes to customer satisfaction in a context where it would be difficult for large corporations to "learn" about particular ways to address the needs of the local customers.

The "redilas" type of truck bed is a perfect example of an add-on solution that provides with benefits that no pick-up truck directly from the manufacturer can offer. Yet what makes is possible is the fact that the truck bed is removable.

One disadvantage of pickup trucks however, is that what makes them versatile is the leader frame upon which they are constructed. However, the leader frame lost popularity in automobiles due to its weight (which directly affects fuel economy), height (it makes the cars taller) and safety issues (derived in part from height). Best selling cars in emerging nations nowadays are compact sedans because of their costs of acquisition and operation.

Another good example of the benefits that a car can provide after it is sold can be found in the old VW Beetle, one of the most successful cars ever sold in Latin America and especially in Mexico. With such a rational structure, replacing parts like the wheel fenders is a task that can be easily accomplished in the Beetle. Accessible bolts make this something that a general user could do without difficulty. Additionally, since the parts were common to models even with 10 years of difference, they were cheap and easy to get. Today on the contrary, changing a fender is a task that can involve the removal of several more parts, and which can take up to many hours.

Without a doubt, the most remarkable example of how the right approach in product development can re-write the whole story of an industry is the PC computer. With the flexibility of an open technology where several manufacturers find a space for production, the PC computer represents the potential of a basic platform that can be upgraded and modified to suit specific needs as long as the interfaces (dictated by the technology) remain the same. This fosters economic and technological development around the world and gives benefits to different groups of stakeholders.

On the other hand, we have examples of how not having access to a base module upon which to do business can prevent the creation of companies.
Mastretta Automobiles for instance, was producing the “Mastretta” car in Mexico, an automobile built on the platform of the VW Beetle (the only platform that could be bought separately in Mexico). When the Beetle went out of production, Mastretta Automobiles looked for alternatives to keep the car alive, but finally ended up out of business as well.

2.4 The chinese motorcycle industry

What has been happening in the Chinese motorcycle industry, which has become the world largest (13 million per year), can be regarded as a typical example of the “modification of product architecture.” The industry followed the process in which it started with copying foreign products (such as Honda’s regular model), and gaining the ex post facto consent from the government for the copied parts, which consequently generated “general purpose parts,” of which domestic production expanded, launching several hundreds of Chinese assembly companies that engage in assembly and remodeling using such generally used parts, followed by excessive supply and exacerbated profitability due to severe competition. This negatively affects the performance of Japanese companies, and a strong Chinese company’s emergence that has survived such competition.

Thus, the key concept to discuss in the Chinese industrial competitiveness is “modification of product architecture”, in which process the products that had been developed as “integral type” in Japan. Things such as automobiles, home appliances, and motorcycles, are transformed into “pseudo open modular type” products, almost like the scratch combination of generally used parts, through the repetitive imitation and remodeling.

In such context, a private company, Geely, has played the role as a pioneer in opening architectures in the Chinese automobile industry. Geely has adopted the method of auto manufacturing close to “open modular style,” purchasing engines and transmissions from foreign companies.

China’s case is of particular interest for this project, because it evidences the importance of both the open product architecture and interface development as boosters of economic development and reduction of prices. At the same time, it increases quality through the cooperative development and understanding of similar parts that allow after-sale sustainability. It does this as a result of facilitating repairs and maintenance by permitting the interchangeability of parts among products of different brands.
2.5 Low Riders

For many automobile-journalists, Low-Riders represent the most important trend in automobile modification. Studying the motivations behind lowriders is of particular importance for this project, because there are many similar aspects, for instance, the fact that lowriders use old automobiles for their creations.

Although, nowadays lowriders have access to a wide range of resources, the idea of making an old car look interesting, attractive and something to be proud of driving, is of remarkable importance. Lowriders, are the root of many contemporary trends in automobile customization and the need to show-off. Import-car tuning for instance has come to prove how important it is to reinforce the identity of the individual through the car one drives. In fact, some people associate the modification of cars to minorities, because the car constitutes a way of reinforcing an identity that users struggle to sustain within the majority.

In this sense, lowriders have a cult status, a medium of expression, whose mission is to make a public statement. Lowriders prove that old cars can be beautiful and useful for a long time and how important is to design automobiles than can express the culture of their users.

Appendix E has extended information about Lowrider’s history.

2.6 Conclusions about the reference solutions

We could conclude that the reasons why past attempts to create a flexible automobile platform fail can be summarized as follows:

- Approached the wrong market
- Developed the wrong product
- Appeared in the wrong time
- Did not develop any system to support the product.
- Did not consider the inclusion of other industries
- Did not intend to reduce consumption
-Did not consider the needs of second-hand users.

First of all, none of these customizable cars targeted the right market. Customizable features can be greatly appreciated by second users and users in developing economies where the value of labor is significantly cheaper. This makes customization practices more reasonable than they would be in a highly consumerist environment. For instance; the same user who sells a sedan to buy a pick-up truck in the United States could transform the same sedan into a pick-up truck in India, simply because the cost of labor makes it feasible.

In addition to this, some customizable cars developed in the past featured technologies that made them more expensive and required changes exactly in the area of car manufacturing that does not allow flexibility, the frame. Without developing a new structure for automobiles, any attempt to make them customizable has resulted as either expensive or inappropriate.

A third reason was the fact that some of these customizable automobiles were mere experiments of corporations that really never intended anything other than exploring new possibilities. In some other cases they were the result of random ideation during the development process, like the Nissan EXA. (Car styling Magazine)

Also, the previous attempts to create a customizable automobile did not contemplate any change in the operation of the industry. But instead, they designed customizable concepts without “backing” them up with an appropriate business plan. It is absurd, though, to have a customizable car if the industry does not support its modification in any way after the sale is made.

It can also be concluded, that with a customizable platform, aftermarket producers can find solutions that large manufacturers do not have the ability to discover. This in consequence, can notably impel the development of small companies.

When markets "go modular," competition expands, and this is important because competition in a lot of industries is now as integral and intense at the component level as it is at the final product level. The best example to this is the “Intel” processors. The global competition in the PC components industry is very important, and helps to prevent brands from becoming monopolies.

The customizable car proposed in this project not only aims to address the needs of new-car buyers, but also considers the needs of second-hand car buyers in developing regions.

Also “basic” technologies will be used to achieve customization, in order to enable the inclusion of local manufacturers and workshops to participate in the economic benefits of this platform.
Appendix B has a full review of studied customizable concepts.
CHAPTER III
Stakeholders

3.1 Stakeholders Analysis

As stated previously, a concept to adapt automobiles in developing nations would require the conjugation of the different stakeholders that integrate the system. These stakeholders are enumerated next, as well as their particular requirements.

The manufacturer of the car
Large automotive manufacturer that produces the automobile that can be modified.

- A car that can be produced using the resources available in the industry
- A large enough market
- A good profitability margin

The producer of parts
Aftermarket producer of different versions of the standard parts that are required to transform the car as well as some other parts of their own design.

- Opportunity to develop new products
- An easy to reproduce interface
- A good profitability margin
- The knowledge base to develop new products

The owner of the franchised workshop that performs standard modifications
Person that owns the place where the standard modifications to the car are performed.

- A good business opportunity
- The knowledge base to perform the modifications
- The resources to perform the job
-A well-designed product for that purpose

*The owner of the small workshop that performs totally custom modifications* > Person that owns a workshop where non-standard modifications to the car are performed.

-A good business opportunity

-Knowledge base to perform the modifications

-An automobile designed for that purpose

*The user of the car when it is new* > Person who buys the car directly from the dealer because it values the standard features it provides as sold.

-A car that provides the average functions of any other car on the market.

-Added value.

*The user of the car when it is old* > Person who buys or acquires the car after several years of use.

-An affordable car

-Reliability

-Low cost of operation

-Solution to their specific transportation needs

*The society* > Context in which the car is expected to operate.

-Low environmental impact

-Visual harmony

-Efficiency
3.2 Conclusions

It has been observed that the adoption of modular design and modularity-driven strategies has to be understood and supported. If the top management of companies, and even government institutions, adopt these strategies, it changes the way in which the organizations work. In consequence, a successful solution to the current problems of flexibility of the automobile would require the participation of all of the different players involved.

All of these players have particular requirements over the characteristics of the product design, which should be carefully addressed to guarantee the efficient operation of the system.
PART II
Research & Analysis
CHAPTER IV
Attributes & Criteria

4.1 Desirable Attributes

After analyzing the information obtained through researching the reference products, and after evaluating the requirements of the stakeholders; the following list of desirable attributes in the automobile was created:

- Ability to change the type of vehicle. (sedan, pickup, or wagon)
- Allow space for the expression of the user’s identity
- Easy of modification
- Changes can be reversible
- Standard modification parts can be produced by aftermarket and local workshops
- Conserves the image of an automobile
- Can be produced by current large manufacturers
- Avoids the disadvantages of a ladder frame, but keeps its advantages
- Uses simple interfaces and mechanisms and easy to reproduces
- Is durable
- Can be modified with standard tooling

It would be impossible to entirely comply with all of these attributes, however this list serves as a reference during the ideation stage.
4.2 Design Criteria

According to Cross, the first thing to do before determining the requirements of any design project, is to determine the generality level in which the design is going to be conceived, this generality levels proposed are: (Cross 88)

1. High (Alternatives of the product)
2. Intermediate (Types of the product)
3. Low (Characteristics of the product)

In the case of this project, part of the generality level has been already determined by the case itself. The objective is to find a new type of automobile, thus and due to the complexity of the system to design, the generality level in this case is located at some point between intermediate and low.

4.3 Requirements

The following requirements have been extracted from the scheme proposed by Rodriguez for any Industrial Design project. This list has been complemented with the requirements listed in point 6.5.1 of the previous chapter. (Rodriguez 73)

- Requirements of Use
- Requirements of Function
- Requirements of Structure
- Requirements of Production
- Requirements of Marketing
- Requirements of Form
- Requirements of Law

It is important to note, that the requirements were filtered according to the systems that determine the capacity of the automobile to be transformed, into a truck or delivery van. The rest of the systems would remain similar to the ones found on an average, and thus no special requirements were established for them.
4.3.1 Requirements subordination

Ordering these requirements according to their relative importance for the development of this project, the list would look like this:

A. Legal requirements  
B. Functional requirements  
C. Usage requirements  
D. Structural requirements  
E. Formal requirements  
F. Production requirements  
G. Marketing requirements

It is important to note that most Methodists of design coincide in the fact that it is precisely this hierarchization that determines the differences of solutions different designers may have for the same problem. The relative weight that every designer gives to each requirement varies from case to case.

In this case the legal requirements have been given top priority, because whatever the solution found looks like, it will operate in public spaces (roads and streets) and in consequence, it will be subject to legal dispositions.

**NOTE:** Due to the nature of the project, the level of specification intended may NOT reflect the fulfillment of all of these requirements listed. However, this does not mean they have not been considered, due to their importance to describe the innovation of the project.

4.3.2 Legal requirements

A1. Consider that the automobile must have a space for carrying license plates with the following dimensions: 300mm X 150mm.

A2. Consider that the automobile must have a space for carrying stickers about the license plates with the following dimensions: 75 X 180.

A3. Consider that the automobile must have rear lights permanently mounted located in the corner.

A4. Consider that the automobile must have brakes in all of the wheels.

A5. Consider that none of the components of the fuel system should pop-out of the widest part of the vehicle.
A6. Consider that the gas tank must not be in front of the engine or in front of the front axle of the car.

A7. Consider that the exhaust pipe exit must not be below the gasoline tank.

A8. Consider that, the automobile must have a bumper with prevents another car from going underneath in the case of an impact.

A9. Consider that the automobile must carry an extinguisher inside.

A10. Consider that, the automobile must comply with the regulation 571.215 of the NHTSA which consist of supporting 110% of the weight of the car by the roof panels when the car rolls over.

A11. Consider that, if seats are used in the rear part, the must comply with the regulation 571.207 of the NHTSA which consist of supporting 1.2 tons of force at the point where the seat is fixed to the structure of the car in the case of an impact.

### 4.3.3 Functional requirements

B1. Consider that the automobile must be able to be used as a sedan with a capacity of four passengers

B2. Consider that the automobile must be able to be used as a light truck with a bed surface equal to 270 boxes of shoes (9X3) or a minimum of 550kgm of payload. (2 square meters of bed surface)

B3. Consider that the automobile must be able to be used as a delivery van with a capacity to transport a minimum of 270 boxes of shoes (9x3x10) or a minimum of 550kg of payload. (3 cubit meters of volume)

B4. It is desirable that the car could have a small trunk, or storage space even when used as a sedan with four passengers.
4.3.4 Usage requirements

C1. Consider that the automobile normally will be used as a sedan for four passengers without any cargo space, or, as a two passengers sedan with an exterior cargo space.

C2. Consider that the automobile will be transformed into pick-up or van, in local workshops with the resources determined in appendix D.

C3. The operation of the vehicle should be similar to any other automobile.

C4. It is desirable that the automobile could use tires of different capacities in the rear axle.

4.3.5 Structural requirements

D1. Consider that the automobile should be based on a common automobile platform that has been used already for several configurations. Like the B platform from Ford.

D2. Consider that the automobile’s chassis should be able to be strong enough in the areas where an eventual change of parts and change of stress forces is expected.

D3. Consider that some of the automobile’s chassis parts must be removable.

D4. Take into account that it is desirable that the rear suspension could be leafs-based.

D5. Take into account that the rear cabin-panel must be removable.

D6. Consider that the interface of union among customizable parts must be very simple to use and reproduce by local workshops in Mexico.

D7. It is desirable that the car could have an extra space for an additional fuel tank in case the user wants to use LP gas.
4.3.6 Formal requirements

E1. Procure that the automobile is styled following the good form principles.

E2. Consider that the finishes and colors of the car must be common and natural whenever this is possible.

E3. Procure that the vehicle has a “car” look at the extent that it is possible.

E4. It is desirable that the automobile modification of car could allow space for loading it with the current user’s cultural identity.

E5. Procure that the car avoids a “cheap” or bad quality appearance.

E6. Avoid a flashy and complex surfaces styling.

4.3.7 Production requirements

F1. Consider that the automobile must be manufactured using the main production methods that are used on “average” automobile construction.

F2. Consider that the materials used in the automobile, have to be compatible with the materials and methods that the Mexican workshops utilize.

F3. Procure replace welding and gluing assembly methods for methods that can be easily maintained and repaired whenever this is possible.

4.3.8 Marketing requirements

G1. Consider that this car should not exceed a price 10% higher that the car that compete in the same segment (around 115,000 pesos).

G2. Consider that the commercialization of this automobile must be accompanied by a business plan to give service to these cars and transform them into the three available variants (sedan, pick-up and delivery van).

G3. Take into account that the car is intended to remain unchanged in the market for a long number of years (10).

G4. Consider that this car when new is competing in market of the sub-compact cars, and is intended to appeal the same customer.
4.3.9 Requirements conditioning

The following table shows the previous requirements that are conflicting among each other, and thus which should get most of the attention at the time of proposing solutions. Also, it shows which areas of the design offer better opportunities for innovation.

The symbols found in the table can be read as:

- **P** = Possible. There is a possible conflict among requirements
- **C** = Conflict. There is a certain conflict among requirements
- **R** = Related. This requirement has a relation to other requirements that should be observed.

The requirements marked in green are desirable requirements not obligatory, thus, its fulfillment is conditioned to the possibility that they can be accomplished.
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From the previous table, it can be concluded that the requirements; B1, B2, B3, C1, C2, D1, D2, D3, D5, D7, E1, E3, F1, F3 and G1 are conflicting with other requirements on the list a decision on which requirements to preponderate above others is necessary.

**4.4 Platform Selection**

As stated in the first of the structural requirements (D1), the base platform for this vehicle should be of a car that is already used to produce several variants of a model. There are two reasons why this is desirable; first, if a platform has been developed for this purpose, many of the engineering considerations of weight and packaging are more likely to be suitable for this project for obvious reasons. Also, automobiles derived from these platforms have been already successfully marketed in developing nations.

A good example for this kind of platforms is the Ford B platform, which is currently used to build various models such as the Ikon. This platform is currently in use in India, South Africa, Brazil, Mexico and China, countries with similar characteristics. (Wikipedia)

For the purpose of this project, and due to the availability of technical information about it, the project will be based in the General Motor’s Gamma platform. This is a subcompact front wheel drive automobile platform used to produce the most successful global car in history, the Opel Corsa, and just like Ford’s B platform, is used for different configurations of vehicles that range from the sedan, to pick-up, station wagon, and delivery van. The Gamma platform is currently used in most Latin-American countries and many other emerging regions. (Wikipedia)

**4.4.1 Sub-Systems**

The following list synthesizes the main identifiable structural systems that determine the capacity of the automobile to change its type, and in consequence, represents in a broad range, the hardware parts involved in the modification of the car.

- Chassis
- Panels
- Wheels
- Windows
- Bumpers
- Doors
- Tail lights
- Gasoline Tank
- Roof
- Suspension
- Union Systems
- Movement/Articulation Systems

If the previous list is “translated” in terms of the systems that each component integrate, and are involved in converting an automobile into a pick-up truck or into a delivery van, we would obtain the following list:

- Support of the modules
- Union of the modules
- Connection to main cab
- Tail lights
- Rear bumper
- Occasional seating
- Access of passengers
- Occasional roof
- Occasional Pannels

From this chart, it is inferred that the rear seats determine a lot of the characteristics of the product, and thus is where most of the attention and design efforts should be put. Also is where conflicting requirements occur.

**4.5 Hypothesis**

The analysis of existing solutions, made clear that a smart approach towards re-configuration almost necessarily involves the use of a modular system. Modular systems have the ability to:

A. Add components to them.
B. Remove components from them.
C. Adjust their components.
D. Replace their components.
The design problem then could be stated as follows: *Design an automobile with a degree of modularity that allows it to change its type (Sedan, Wagon, etc), by interchanging parts designed for each specific modification purpose.*

### 4.5.1 Possible solutions

Considering the design problem previously stated: “*Design an automobile that can be transformed into different types...*” The following concepts of solution were generated:

1. The problem of designing a car that can be transformed into different types (pick-up truck and delivery van) could be solved by: *Designing a car with a combination of a monocoque and a ladder frame chassis that could incorporate different rear bodies like in a pickup truck.*

2. The problem of designing a car that can be transformed into different types (pick-up truck and delivery van) could be solved by: *Designing a car with a disassembleable rear body that can be re-configured into each of the modifications mentioned.*

3. The problem of designing a car that can be transformed into different types (pick-up truck and delivery van) could be solved by: *Designing a car with a detachable rear body that could be interchanged with other bodies depending on the modification desired.*

At this point, each of the previous solutions as well as their combinations constitutes a viable alternative to solve the problem. The total universe of possible solutions is:

1, 2 and 3 plus 12, 13, 32, and 123, which generates a poll of 7 possibilities of solutions to choose from.

However, due to its potential to comply with the main requirements of the stake holders in terms of creating a feasible and practical solution is represented by option number two, that would be then the hypothesis of solution.
A car with a disassemblable rear body that uses standard parts designed so that it can be re-configured to function as a pick up truck or a delivery van, and will solve many of the problems of inflexibility in function that users of second-hand cars experience. At the same time this will offer extra functionality to the average user of new-cars.
CHAPTER V
Ideation

5.1 Method

The first stage of the ideation process consisted in obtaining a basic configuration of the different elements that integrate the car. Each of the systems involved (Chassis, Union systems, Panels, Moving systems... etc) was approached separately, and different alternatives were generated through the method of brainstorming.

The second part of the ideation process took place on paper and also in the computer. At this point, more specific details about the components and the way in which they should operate together were addressed. (Cross 108)

5.2 First Stage, Sketching

The following pages are a sample of the first part of the ideation process.
5.2.1 Ideas for operation of components
5.2.2 Ideas for the configurations of components
5.2.3 Ideas for front graphics
5.2.4 Ideas for the rear modules
5.2.5 Ideas for the interior systems
5.3 Evaluation and Selection

During the ideation process, each of the alternatives generated were “compared” against the main requirements established in the criteria of design, in order to select the best solutions. Then they were modified or adjusted while being integrated to the rest.

A. Legal requirements
B. Functional requirements
C. Usage requirements
D. Structural requirements
E. Formal requirements
F. Production requirements
G. Marketing requirements
5.4 Second Stage, Computer Modeling

5.3.1 Refinement design
PART IV

Solution
CHAPTER VI
Concept

The automobile designed to be adaptable by this project is based on the gamma platform of General Motors. This platform is used currently in the Opel Corsa (sold with different names) known to be most successful global car ever constructed. (SAE)

6.1 Description

Keeping in mind that this automobile would be globally marketed, its aesthetics have been kept plain and simple. It is a car intended to look like a car, and it would be through the management of color or through the customization of the interior elements, that it could be localized to the preferences of particular regions. The surface language has been kept balanced between organic and edgy ensuring an image not so vulnerable to fashion.

Versa’s packaging is pretty much similar to that of a monovolume sedan (like the Corsa). It is expected to be built on a monocoque chassis, and is proposed to be powered by the same power plant currently used by the Opel Corsa.
The proportion is somewhat similar to that of a light pickup truck, but with a shorter bed and with the same wheel base as the Corsa. The doors are wide enough to allow an easy access to the interior, as well as the rear seats.

Two individual seats located in the front allocate the driver and the co-pilot, and a foldable bench seat is located behind to accommodate the occasional passengers. A drive-by-wire steering system allows more space inside the cabin and helps to make the instruments panel modular.

The rear of the car is integrated by two “core” modules that serve as a rail for the retractable canvas when the car is operated as a sedan. They also support a raised roof when the car is operated as a delivery van. These modules could also be used when the car is operated as a pick-up truck as additional points of support, and also to maintain structural strength in the frame.

The back of the car features a cargo area that can be accessed by lifting a retractable canvas that runs along two rails located in the detachable modules. This cargo space has an area of 1.5 square meters and a volume of 1.6 cubic meters when the canvas is closed. However, it could be opened to allow a larger volume capacity.
6.2 Adaptation

Whenever is necessary to adapt or transform the automobile into any of the conversions supported, the user will take the car to an authorized workshop to have it modified. This is done by replacing the modules located in the back of the car by the ones that will configure to the user requires. In the case a user requires a particular adaptation that is not supported by the concept, the car can be taken to the workshop of his preference to have it custom adapted.

The components taken off the car, would then enter the network of authorized dealers, and be refurbished if necessary. The components would then be re-used by another customer.

6.2.1 Pick-Up Transformation

When the car needs to be transformed into a pickup truck, the retractable canvas and rear windows are removed. The core modules could be detached or could be left depending on the user’s preferences.

Then the pickup module would be installed on the car. Although, for the scope of this project, the assembling mechanism have not been specified. These would be based on screws.
This module consists of a panel that closes the rear cabin, which is normally open when the car operates as a sedan. This panel incorporates a glass area to form a window like in a normal pick-up.

A secondary component of this module would be a gate or door of the bed, which would close the cargo area, so it can contain whatever the user is transporting.

With these modifications, the automobile can be operated with a functionality that is the same offered by an average “pick-up” truck.

6.2.2 Delivery Van transformation

When the automobile needs to be transformed into a delivery van, the procedure followed is similar to transforming it into a pick-up truck. The “core” modules of the sedan would remain in place. Only the retractable canvas and the rear windows would be dismounted.

A hard roof and a set of split doors replace the retractable canvas to make access to the cargo area more appropriate for heavy duty conditions. It is also important to mention that the design of these parts could vary from aftermarket manufacturer to aftermarket manufacturer. Finally, the rear windows are replaced by two panels that close the interior of the cargo area, making it invisible. These panels provide a good surface to put a logo or any other publicity graphics.

If an aftermarket manufacturer finds that there is a market for a different design of a delivery van, it could develop a whole camper for the rear part without using the core modules. This would allow even a greater cargo volume.

6.2.3 Custom transformation

In the case a customer requires a custom transformation that is not supported in the franchised modification workshops, he or she can take advantage of the benefits provided by the modular rear of the automobile.

Most emerging nations like Mexico have developed a vast network of workshops that operate in many categories, and can contribute to make custom transformations to cars.
The customer could go to one or various workshops to get the car modified in the way that it is needed. This would be particularly beneficial for old automobiles that the customer may have a very particular need for, and doesn’t possess the ability to buy a very specific type of car.

In this case, the procedure would be to remove whatever components are mounted on the car, and either keep them just in case the customer decides to reverse the transformation, or drop them at the authorized transformation dealer for some reimbursement.

Once all the modules have been removed, then the new components required by the customer would be built in whatever workshop that is appropriate. Then they are mounted on the car, using the same union spots used to attach the modules. This avoids the need to drill holes or weld on the sheet metal of the car, which is expensive and time consuming, and generally leads to the problems described in the first part of this document.
CHAPTER VII
Application

7.1 Overview
Currently large automotive manufacturers try to increase (or sustain) profit by selling more cars. This however, is not only unsustainable, but also ignores the importance of a growing market of second-hand cars users.

The solution proposed here on the contrary, proposes a new way to do business in the automobile industry. It entails a plan that profits are not entirely made by selling more cars, but rather by giving service to the cars already sold.

This business scheme includes local workshops and aftermarket manufacturers in the economies of scale of this automobile platform. This plan can be implemented in many of the emerging nations that share the same economic growth. This could be penetration strategy of a new company, or as a separate line of cars for any of the traditional big manufacturers.

7.2 Description

7.2.1 System Components
The components required to make this adaptation system able to successfully operate in emerging nations are:

The Stakeholders> Group of people who play a role and have a particular interest in the system.

The Knowledge Base> Set of information that guarantees that each of the stakeholder perform its job efficiently.

The Capital> Element that allows the system to start and keep operating.

The Hardware> Set of parts and tools required to perform the operations of modifying cars.
The Car> Raw material of the system that is transformed as a result of the activities of the rest of the components.

7.2.2 System Operation

Manufacturing & Global distribution> The first link in the system is constituted by the producer of the automobile. This, as previously mentioned, could be a new company that could use this system as a business strategy, or could also be a traditional large manufacturer which could establish this system as a separate line, and even a separate brand of cars.

These automobiles could be produced in the main regions of the world where they expect there to be a market, and then distributed to the surrounding countries, pretty much following the same scheme that the industry has already established.

National Distribution> Once the automobiles arrive to each of the countries where they are going to be sold, they are kept in stock and then re-distributed to the states.
Regional Distribution> In each state, automobiles arrive to the dealers located in most major cities and towns where they are marketed. This will use the same mechanisms that automotive companies already have in operation, or a similar one, if a new company is created.

Local Distribution and Sale> Finally, the customer purchases the car directly from the dealer, as any other car. Additionally, he gets information about the location of the franchised workshops that are authorized to perform modifications to the car.
Post Modification> Once the customer has bought the car, he can go to either any of the franchised workshops to perform the standard modifications supported by the automobile, or can go to a workshop of his preference to perform a custom modification, using the modular benefits offered by the car.
7.3 Scenarios of Application

The following examples, illustrate situations of real users, in which the solution developed in this project could enhance the overall experience of owning and using this vehicle.

7.3.1 Using the car as is Bought

Giovanni is an industrial design student, that drives 85% of the time alone. He drives with somebody else 10% of the time, and 5% travels with three or more persons in his car. As most university students, his back seat is full of stuff that he doesn’t really use, but carries in the car. Also, every time that he has to deliver a project to school, he needs to buy all kinds of materials, such as sheets of foam, stucco, and cans of paint.

He got this car brand new as a gift from his parents for finishing school. This car is appropriate for him because it allows him to:

- Use the space reserved for occasional passengers, carry all the stuff he uses whenever the need arises without the fear the items won’t fit, or that he might spoil the car’s carpet fabric.

- Have a wide cargo area with easy access that offers an option to protect the interior from the rain.

- Accommodate four passengers inside, and still have extra space for luggage like a normal sedan.

7.3.2 Making the car a Pick-up

Giovanni used the car for two years, but after graduating from school, he started to make a lot of money. When he decided to buy a Ferrari, he sold his car to a local dealer, where it was bought by Pablo.

Pablo was a research assistant at a local university when he bought the car. He eventually got fired for not achieving the expected results, and had to start working as an independent gardener. For his job as gardener, he needed a small truck to transport the cut bushes, as well as the equipment he uses for work.
This car is appropriate for him because it allows him to:

- Take the car to the authorized modification workshop to change the parts that will transform it from a sedan into a pick-up truck, providing him with the functionality he needs

- Save the time and resources that otherwise he would require to sell an average sedan and buy a truck.

- Keep a car for which he already knows specific information and which he knows how to maintain.

### 7.3.3 Making the car a Delivery van

Pablo used the car for three years, but after investing money he earned as a gardener in the stock market, he became rich. He placed an ad to announce the sale of his car in the newspaper, where he managed to sell it to Paul.

When Paul bought the car, he was working as a salesman for a company that builds milling machines. He needed a truck because he often needed to transport milled parts to make demonstrations for his potential clients. But eventually the company Paul represented went out of business, and he had to start selling Quickstar products to his friends and old customers. For his new activity, he needed something like a delivery van that could allow him the ability to transport the different products he sells in an enclosed and safe container.

This car is appropriate for him because it allows him to:

- Take the car to the authorized modification workshop to change the parts that will transform it from a pick-up truck into a delivery van, providing him with the functionality he needs

- Save time and resources that otherwise would require him to sell an average pickup truck and buy a delivery van.

### 7.3.4 Going Back

Paul used the car for four years, but eventually he made a lot of money selling Quickstar products, and decided to found his own company of milling services.
He bought a Porsche, then announced his car for sale on the internet, where he sold it to Aradhna.

Aradhna was a major dealer of art in the blackmarket. She needed a van, because very often she had to transport large paintings in a way they were protected from the environment, and not visible from the outside. Eventually, she got married and became pregnant. She then decided to get out the business, because it was too risky. For her new family, she needed a car with a capacity of at least four passengers.

This car is appropriate for her, because it allows her to:

- Take the car to the authorized modification workshop to change the parts that will transform it from a delivery van into a sedan, providing her with the functionality she needs.

- Save the time and resources that otherwise she would require to sell an average delivery van and buy a truck.

### 7.3.5 Custom Modifications

Aradhna used the car for three years, but eventually decided to buy a luxurious SUV with all the money she earned as an art dealer. So she decided to give her old car to charity at a church that helps poor people. Then this institution gave the car to Rene.

Rene is a mathematician recovering from problems associated with alcoholism. Currently, he is quite poor, and is making a living by collecting aluminum cans, then taking them to the foundry. He needs a car that can help him to move the cans easily. He knows that he could take the car to an authorized dealer to have it transformed into a pickup truck, but does not have the money necessary to pay for the transformation. However, there is a friend at the church who owns a metal workshop, and is willing to help him to transform the car for free.

This car is appropriate for him because it allows him to:

- Take the car to an average body-repair workshop to build the custom parts that will transform the car from a sedan into a pickup truck, providing him with the functionality he needs.

- Use the informal way the economy of emerging nations operates to achieve benefits.
7.4 Benefits

The Manufacturer> The industry is one of the stakeholders that would also benefit by the implementation of a concept like this because it:

- Supports economies of scale while outsourcing the need to makes change to the production line (and what this implies) necessary to build each variant.

- Satisfies the needs of second-hand users, which affects the value retained per vehicle, and affects sales of new cars.

The Aftermarket> Aftermarket producers would benefit, because this concept:

- Offers a good opportunity to expand their line of products or create a new ones.

The Franchised Workshops> Authorized workshops would benefit, because this concept:

- Offers a good opportunity to establish a safe business in a local context, since the number of vehicles would keep a constant flow of customers.

The Non-Franchised Workshops> Average body-repair workshops would benefit from concept because it:

- Represents a source of work.

- Offers a platform that can be easily adapted according to the specific requirements of their customers.

The Society> The society and government is benefited by this concept because it:

- Promotes the use of consumption patterns which are more sustainable

- Increases the efficiency of transportation for citizens

- Enhances the visual harmony of a city by preventing transformations from having a bad appearance
CHAPTER VIII
General Conclusions

On a macro level, today's sense of personal mobility problems are based on social, business, and life-style paradigms that may not necessarily project unalloyed into the future. The regular consumption of automobiles does not increase the quality of life of a customer, but is a symbol of status, and unfortunately, in the capitalist world, social status is everything. It may be unrealistic to think in terms of a solution to all the problems.

In the short term, better vehicle technology has been used as the most feasible approach to achieve better cars. For the long-term however, solutions that redefine the concepts used today to build, sell, use and dispose automobiles, can illuminate new solutions.

In our world, profitability drives development. We do not have better solutions today, because nobody is interested developing them, if there is no profit potential involved. It is almost certain that we could have better automobiles today, but the great past attempts have not found the necessary support to be fully implemented. It is crucial that any attempt towards changing an established paradigm is promoted and supported by all of the stakeholders.

New types of products that rely more on vehicle packaging and market positioning could play a fundamental role. Significantly smaller, lighter, more energy-efficient and electrically powered vehicles could help to open new markets in the process.

This project does not pretend to solve all the problems of the automobile, but simply attempts to make a better kind of car, which happens to also be more sustainable.
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