

AUTOMOTIVE ELECTRONICS IN BRAZIL: FACTS, TRENDS AND PROPOSALS

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Abstract. *The purpose of this paper is to discuss the status of the electronic applications in the Brazilian automotive market, showing a brief history about the automotive industry in Brazil, the applications that uses electronics or are just electronics at all, trends in the world wide automotive industry, and at the conclusion, there are some proposals showing the ways that could be followed in order to change the status seen today.*

Keywords: *automotive electronics, Brazilian automotive market,*

1. Introduction

Automotive electronics is understood as those applications where electronic components are used inside a vehicle, mainly semiconductors like diodes, transistors, ICs (Integrated Circuit) and other devices.

In the future, and already today, the main new innovations will be based on electronics. Indeed, today it is known that 90% of technological evolutions in vehicles are associated with electronics. This is a trend that can be observed worldwide. In Brazil there is also a similar behavior but we must be aware of a possible deviation from electronics, which could jeopardize Brazilian vehicles in different ways as will be discussed in this article.

In the beginning of the 90's a big challenge was promoted in the automotive market mainly due to its old technology, even already compared to chariots. The market was opened to the imported cars that brought a higher content of advanced technology and some features almost unknown by the consumers. Other car manufacturers decided to build their plants in Brazil. At the beginning local manufactures felt this sudden huge difference and applied policies to adapt themselves to these "new customers" that enjoyed the adequate changes, as well as the government increased the vehicles importation taxes to protect local industries.

Some of the enhancements done in the vehicles were based on electronics like immobilizers, door modules, electronic injection in all models, and many other applications not common in Brazilian cars.

After the situation begun to stabilize, a new phase started when the government promoted the "popular vehicle". The plan was to offer a car with lower content but lower price to enhance the automotive industry. Such car has a limited cylinder size engine and reduced IPI, industrial production tax, which increased their market share to about 60 - 70%.

The popular cars, as defined, is a very cheap one, and as a result the electronics inside them are very simple, basically ECU, cluster and timer for the window wiper.

It is true also that the higher the electronics content in a car, the higher the importation of semiconductors parts since they are not largely manufactured in Brazil.

This article intends to show these and other aspects of the automotive Brazilian market from the point of view of automotive electronics.

2. A brief about Brazilian automotive market

The automotive industry started decades ago when the government emphasized such production as a future strength to the development as well as the principal means of transport for people and goods. The effects can be seen everywhere as even with a high potential for ships, trains and even aircrafts, these means did not succeed so much as cars, trucks and buses.

During a long period this sector was protected by laws as it was forbidden to import vehicles; the consequences, from one hand, were that local companies had an easy growth because the lack of competition that enabled them to work almost without big efforts and, by the other hand, the same lack of competition drove the final products to be old fashioned (from the technical point of view) compared to equivalent cars in other countries.

August, the 8th 1990 was the day when the situation above was changed. The government authorized the importation of foreign cars and this policy was then responsible for great challenges in the Brazilian automotive market. The purpose of this paper is not going into details of all consequences that came afterwards but some of them will be mentioned here as they are of great importance in this discussion.

One of the results was the introduction of new features not only in high end cars but also in mid and low end ones such as ABS (Anti-locking Braking System), TCS, electronic injection, air bags, common rail, electro-hydraulic steering, high quality audio system, and others.

Another important change that was promoted by the government in 1993 was with the emphasis to 1000 cm³ engine car by reducing taxes, the IPI (Imposto sobre Produtos Industrializados), and later the II, importation tax, that drove the sales numbers to records never seen before. Of course it was not just the OEMs (Other Equipment Manufacturer) that increased, but all tiers 1 and tiers 2 followed the increasing demand. The idea of a such car was to offer to the population a product that could fit into their income; but, extra to a smaller engine, many other features were taken off, remaining the minimum quantity of parts on the vehicle. The option was always the most simple and cheap version. The result was a vehicle without comfort, weak performance but useful for city transportation and short trips; even though, the popular car enlarged its market share to about 60 to 70%.

Today some changes can be already seen as popular cars have a share of 55% and due to the recent emission legislation, diesel vehicles are forced to have engines with electronics.

3. Main topics of automotive electronics

Automotive electronics has grown very fast, mainly in recent years, as a result of the evolution in electronic components, increasing density (smaller devices for the same function), lower R_{DSon} lowering power dissipation for the current (and voltage), so enabling further shrinking, improvement of the working temperature range (very important in automotive applications) and many others. Below will be described the main issues of automotive electronics to provide a better understanding of its strengths, weaknesses, opportunities and threats.

3.1. Automotive systems

In order to have a better idea about the different applications existing in a vehicle, it is useful to classify them into different categories. These categories are not a rule and every company has its own internal division according to their necessities, but the differences are not so great.

3.1.1. Powertrain

Powertrain are the systems that deal directly with engine and transmission like Gasoline Engine Management, Diesel Engine Management, CVT (Continuously Variable Transmission), EVC (Electronic Valve Control), Hybrid and Fuel Cell Engines, Start Stop Alternator, EGR (Exhaust Gas Recirculation). These systems are heavily influenced by electronics mainly when it is considered the exhaust emission level laws, with less fuel consumption, through a precise reading of the necessary parameters, processing and control, usually done by sensors, microcontrollers and actuators.

3.1.2. Body and convenience

Body and convenience electronics are the applications related to door and seat modules, air conditioning systems (cooling and heating), light control, access and remote control, as well as security items (not safety). Sometimes this category, also known also as Comfort, is misunderstood with a luxury one. Such systems help the driver to keep his attention where it is necessary, so could be seen partially as a safety application.

3.1.3. Safety

Safety management systems are those that help to avoid or minimize an accident. Stopping the vehicle as fast as possible, keeping the driver's command, without worry about the fluid waste, lower fuel consumption and many other can be achieved with systems like ABS (Anti-locking Brake System), EHB (Electro Hydraulic Braking), EMB (Electromechanical Braking), ESP (Electronic Stability Program). They are tending to x-by-wire systems but fault tolerant system is a must to let these new technologies approvable. Airbags, TPMS (Tire Pressure Monitoring System), power steering EHPS (Electro Hydraulic Power Steering) electric motor drives the hydraulic pump, EPS (Electric Power Steering) the electric motor connected directly to the gearbox, with no hydraulics, which reduces about 0.4 l/100km the fuel consumption, EPA (Electro Parking Aid similar to EPS but working only at low speed), ACC (Adaptive Cruise Control), are the main examples of electronics in safety systems; however other innovative features will be added soon.

3.1.4. Infotainment

Infotainment is a joint of information and entertainment with applications like dashboard/instrument cluster, digital audio, mobile phones (hands free) and Internet.

3.1.5. Telematics

Telematics has many systems shared with Infotainment. The main difference is that the information is mainly used for orientation. In the future, it will be possible a vehicle to go from one place to another without a driver through Telematics applications. Until then, parts of such a system are used to help the driver. The main applications for this solution are navigation systems, multimedia systems (GPS, Bluetooth, and mobilephone) and in the future they will be connected to the x-by-wire systems from powertrain, safety and others, enabling this task.

3.2. Communication protocols

It is well known that electronics is increasing quite fast in all automotive applications leading to greater complexity and so demanding to a communication protocol. The first and more important protocol is CAN (Controlled Area Network) developed by Bosch. Today, there are many different protocols used inside the vehicles-- and some still in discussion--, to fulfill the demand for different applications. Some of them like LIN (Local Interconnect Network) fit better to low demanding requirements than CAN, and it is cheaper to fulfill its purpose. Automotive applications requiring high data flow should use MOST (Media Oriented System Transport) or Byteflight (a protocol developed by BMW) or D2B since there are more adequate due to its greater bandwidth. For applications X-by-Wire, mainly in safety applications like brakes and steering, a protocol must be fault tolerant and to attend this necessity the protocol needs to be time triggered and protocols like CAN and LIN are event triggered. TTCAN and Flexray are examples of such kind of protocol. MLI (Micro-Link-Interface), K-Line(ISO9141), MSB are another examples of protocols.

3.3. EMI – EMC – ESD

EMI (Electromagnetic Interference) or the effects that electromagnetic waves may cause in a circuit, with halting it or changing its behavior, EMC (Electromagnetic Compatibility) that brings into discussion how much a circuit can tolerate before jeopardizing its functionality and ESD (Electrostatic Discharge) a high voltage, up to 25kV, usually that the human body can discharge on an IC (Integrated Circuit) resulting in permanent damage, are issues that must not be forgotten during the conceal of a new system or application, or the development phase, production and mainly when the product is used by the end customer.

3.4. 42V power net

The increasing demand of electrical power has reached the limit that 14V power net can handle and as a solution increasing the power net voltage to 42V is the solution being adopted to overcome this problem. Today, some luxury cars needs up to 1,5 kW and in the future this value will grow to a range between 3 and 7 kW, not only for top class vehicles but for the low end versions as well, due to law restrictions to emissions and thus, demanding higher quantity of electric motors inside the cars as they are more energy efficient.

3.5. Reliability

The spread of electronics inside a vehicle has already reached the safety applications like breaks, steering and many others and the trend to x-by-wire systems, reliability becomes a key issue when electronics gets into the systems, sometimes without a mechanical backup, due to cost restrictions. Such subject is discussed in fault tolerant systems topics.

3.6. X-by-wire

Due to different reasons, like lighter systems, more efficient / low emissions, better performance and many others, x-by-wire has already started many decades ago (the first one known is the horn) and is continually growing, taking into the discussion issues like reliability, fault tolerant system, communication protocol, EMI among others topics. The “by-wire” has as applications examples like: gas-by-wire, power-by-wire, shift-by-wire, suspension-by-wire, steer-by-wire, brake-by-wire and many others.

3.7. Materials

Following the worldwide trend to preserve the environment the European Parliament adopted the following directives:

2002/95/EC on the Restriction of the use specific Hazardous Substances in electrical and electronic equipment known as RoHs.

2002/96/EC about Wasting Electrical and Electronic Equipment – WEEE

Some of the substances mentioned above can be found in components and their waste from production facility and enterprises are already taking care of these issues as it is planned to become law by 2006/2007 and the components compliant with them are known as “green products”. Components manufacturers have already started this process and the trend is that it will spread all over the world. .

3.8. Quality

This is not only an electronic specific issue but must not be forgotten that due to its high complexity and to the dependability of different components, it is highly important not to forget it during a quality analysis.

3.9. Autosar (OSEK/VDX), automotive architecture

Today a vehicle is assembled by the manufacturer but the parts are designed and developed by tier 1 suppliers; and , the interaction of electronic systems, is, often a problem since they are not made by the same supplier This means that although the systems are working perfectly, they do not have an efficient performance when working together and , for this reason and also to minimize development costs, a different kind of development must be done. The OSEK/VDX (in German “Offene Systeme und Schnittstellen für die Elektronik im Kraftfahrzeug” and VDX from France means “Vehicle Distributed eXecutive” recently joined Autosar, becoming a worldwide organization and although still in the beginning, the results are promising.

4. Electronics content in vehicles

Electricity is present in vehicles since their earlier times but its evolution was comparatively lower than other car applications. It was after the 60’s and mainly in the 80’s that electronics started and grew up inside the car, due to its own evolution like transistors and later on with applications that required such kind of solution like ABS.

In the recent years, the evolution was tremendous and we achieved the situation that 90% of all automotive innovations are driven by electronics, according to a study done by Strategy Analytics.

Also another interesting information is that, in 2002, 57 million light vehicles were produced from 20 OEMs, their electronic content was 22% (18% hardware + 4% software) and semiconductor per car about 200 € and the forecast for 2010 will be a production of 73 million vehicles from 8 OEMs, with 35% (22% hardware + 13% software) of electronic content and a rate of semiconductor per car of 300 €

In order to show the criteria used by Strategy Analytics INC., (INF 2004) , below are shown the applications and new technologies that are foreseen for the next years. Electronics is present in most of them. From these facts it is clear the importance that electronics has and will have inside the vehicle and the neglect it means a drawback with bad consequences. On the first column are the applications, the second one are year range when the application will probably be released and the third one is the field from the application.

4.1. Chassis

Ceramic Brakes	2000-2005	Others
Run-flat technology	2005-2010	Electronics
Active chassis	2005-2010	Electronics
Magnesium wheel suspension	2005-2010	Others
Plastic wheel suspension	2010-2015	Electronics
Steer by wire	2010-2015	Electronics

4.2. Drive train

CVT (Continuously Variable Transmission)	2000-2005	Electronics
AMT (Automated Manual Transmission)	2000-2005	Electronics
SWT sensor (Steering Wheel Torque)	2000-2005	Electronics
Magnesium gear box	2005-2010	Others
Starter generator	2005-2010	Electronics
Electromechanical breaks	2005-2010	Electronics
Infinitely variable transmission	2010-2015	Electronics
Dual clutch transmission	2010-2015	Others
Wheel hub drive	2015-	Electronics

4.3. Engine and auxiliaries

Ceramic heater plug	2000-2005	Others
Fully variable mechanical valve timing	2000-2005	Electronics
Diesel high pressure supercharger	2000-2005	Electronics
Gasoline DI (Direct Injection)	2005-2010	Electronics
Intermetallic materials	2005-2010	Others
Particulate filter	2005-2010	Others
Electrical Cooler + ventilation control / cooling	2005-2010	Electronics
Urea catalyst	2000-2005	Electronics
Denox storage catalyst	2000-2005	Electronics
Electro hybrid drive	2000-2005	Electronics
Fuel cell drive	2000-2005	Electronics
Electro hydraulic valve actuators	2010-2015	Electronics
Electromechanical valve actuators	2015-	Electronics
Hydrogen combustion engine	2015-	Others

4.4. Body shell structures

Alu	2000-2005	Others
Plastics	2000-2005	Others
Magnesium	2000-2005	Others
Metal foams	2000-2005	Electronics
Hydrophobic surfaces	2000-2005	Others
Steel space frame	2000-2005	Others
Sandwich structure	2000-2005	Others
Composite material	2005-2010	Others
Plastic body shell	2005-2010	Others
Object detection cameras	2005-2010	Electronics

4.5. Body / exterior

Active lighting	2000-2005	Electronics
Interior lighting with central light source	2005-2010	Electronics
Situation awareness radar system	2005-2010	Electronics
Pedestrian protection sensors	2005-2010	Electronics

4.6. Interior

Optical bus systems	2005-2010	Electronics
Intelligent airbags	2005-2010	Electronics
Soft-touch surfaces	2005-2010	Others
LED technology	2010-2015	Electronics
Night vision	2010-2015	Electronics
Fully variable interiors	2010-2015	Electronics

4.7. Standard operating system

Hybrid vehicle electronic systems	2000-2005	Electronics
42 V Power net	2000-2005	Electronics
Head-up display	2010-2015	Electronics
Driving with auto pilot	2010-2015	Electronics

5. Brazilian Automotive market

Although costs is one of the major factor that contributes to the final decision of a car and the lower the price the more competitive the vehicle will be, this fact can not be seen so simple.

One fact that happens usually when someone purchases a brand new car is to get a security policy that usually costs 15% to 20% or even more from car's price. Another expense that is usual to be done is sound equipment. Most of the times, the owner installs a high end equipment, adding some additional to the final expenses that the buyer have.

Some electronic equipments like ABS, air bag, or Electric Power Assisted Steering have an additional cost to the final vehicle value but sometimes is lower than the expenses that the customer is used to pay for the additional features.

6. Proposals to change

Below there are some proposals on how this trend can be shifted, one or more of them may result in an improvement of the situation seen today in the automobiles.

6.1. Information

Some of the electronic applications are not known by the customers, and beyond them, to know the advantages and benefits that he can get out of such features in a car.

6.2. Legislation

As some application gets into security and environment issues like emissions and waste of material (ex. brake fluid) and other inside security like ABS or airbags that contributes to save lives. Taxes reduction would be an incentive to improve vehicle quality.

6.3. Organization and other entities

Universities and other entities like SAE, ANFAVEA, AEA and SINDIPEÇAS should emphasize electronic features in their courses, seminars, congresses, articles, reports, press releases, and all the means of communication available.

6.4. Technology

As it was shown above, 90% of innovations will come from electronics, therefore without an appropriate empowerment of such industry, means a drawback in the competitiveness of Brazilian automotive industry. This fact can lead to a gap in the technology know-how and big investments in the future to update it.

6.5. Economy

Brazil, although is not a leading technology country for automotive industry, has the main electronics world wide suppliers, and it is quite easy to enhance electronics in Brazil and could be an add-on to become Brazilian vehicles more competitive. Searching for international new markets will help Brazilian economy, mainly the import/export trade balance.

Beyond this, electronics and their innovative features means more secure vehicles, so enabling lowering car accidents and then savings from insurance companies, hospital expenses, and many others that are due to an accident.

6.6. Insurance companies

With better safety systems, it is possible to reduce accidents and thus, it is possible that insurance companies can offer better quotes to their customer when some safety applications are inside the car.

6.7. Education

Increasing the knowledge of the people evolved is also important as the solutions presented here are quite complex demanding for dedicated trainings, workshops, seminars and post-graduation courses with the purpose of updating all persons about new technologies, and also, even at the graduation level, it is important that the new engineers start working with a background about these technologies.

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