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IMPRESSUM

Layout: Valentina Morianz

FH JOANNEUM Gesellschaft mbH Publishing
Alte Poststraße 149
A-8020 Graz
www.fh-joanneum.at

ISBN: 978-3-902103-95-6

Co-funded by the Erasmus+ Programme of the European Union

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1 CURRENT ISSUES IN AUTOMOTIVE ENGINEERING IN BRAZIL, ARGENTINA AND MEXICO

1. TRENDS & CHALLENGES IN AUTOMOTIVE ENGINEERING

BRAZIL

Historical Perspective, Trends and Challenges of the Automotive Industry in Brazil

The Brazilian automotive industry can be traced back to the 1920s when Ford (1919) and General Motors (1925) started their assembly lines in São Paulo. Vehicles and trucks came unassembled from the USA, and all parts were manufactured abroad. However, despite most vehicles being imported, local development was not dormant. For instance, alternative fuels such as Ethanol were researched, and a complete study, both theoretical and practical, was finished in 1925.
During World War II, with the short supply of auto-parts and vehicles, a local industry of parts started to develop. However, the supply of steel and other materials was not produced locally. This situation started to change with the opening of Companhia Siderúrgica Nacional (National Steel Industry) in 1945 and FNM (Fábrica Nacional de Motores). Their main goal was to produce heavy trucks and cars under license from Alfa-Romeo.

In 1956, the national government created a Work Group to define policies to attract foreign investment. This with the sole objective to create in Brazil an entire automotive industry with a chain of suppliers based locally to be able to replace imports slowly. In 1956, the first product to roll out of the assembly lines was the ROMI-Isetta, based on the BMW Isetta and manufactured by a local machine tools company; ROMI. Both companies that were already in Brazil, such as GM and Ford, and new entrants from Europe (Mercedez-Bens, VW, Simca, Renault, Auto-Union) and the USA (Willys-Overland and Chrysler), had their operations based in Brazil in an effort that changed the economic landscape in Brazil, being very important in the country industrialization.

The Brazilian market was closed to imported vehicles in 1974. The local industry went through a period of low investment that got worse due to economic turmoil. Product lines were outdated, and production numbers were stagnant for almost ten years at around 1 million vehicles per year. The number of companies was reduced to four (VW, Ford, GM, and FIAT) for cars and three for heavy trucks (Mercedes-Benz, Volvo, and Scania). Ethanol became the country's reply to the higher cost of imported oil, and the country managed to implement the first and, for many years, the only program of renewable fuel to be used on a large scale around the world. In 1985, more than 90% of the new cars sold in Brazil had Ethanol as fuel.

In 1990 Brazilian automotive market was deregulated, and imports were allowed. Economic stabilization was achieved in 1994, managing to control the inflation and bringing some predictability to investments; especially for new entrants such as Honda, Toyota, Peugeot-Citroen, Renault, and later on Hyundai. Product lifecycle and renewal time were reduced, and investment in new plants and facilities was present until 2015. A significant technological development is the "flex-fuel" vehicle, in which Ethanol and Gasoline can be mixed at the fuel tank at any proportion without a significant impact on performance. Brazil still has a successful bio-fuel program on bio-diesel, used exclusively for the transportation of goods.

However, the market is not fully opened to international competition, and only due to trade agreements with Argentina (Mercosur) and Mexico, Brazilian products are exported mostly to such markets that are also the leading suppliers of imported vehicles.

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Given the importance of the auto industry in Brazil, the national government had started several incentive programs either with tax rebates or financing opportunities from the national development bank. The most recent program is ROTA 2030. Since 2015 it established three cycles of five years in which the carmakers will have to invest about 1,2% of their revenue in local R&D in exchange for up to 10% of their due national taxes. The program also sets goals for energy efficiency for products and processes and other goals in emissions and vehicle safety.
Recession in the country since 2015 has put the Brazilian auto industry in a difficult situation. Ford has announced that it will cease its manufacturing operations in Brazil and new trends such as electrification still seem distant for the local market. Table 1 summarizes the current data on the Brazilian auto-industry

Manufacturers	26
Suppliers (1st and 2nd tier)	473
Assembly plants	65
Capacity (Cars, Trucks, Tractors, Buses)	5.05 Million vehicles
Revenue (2018)	US$61900 Million
Employment	1,3 Million Employees
Participation in the GDP (2017)	3%
Production (2019) (Cars, Trucks, Tractors, Buses)	2.944.988 units
Total Fleet (2019) (Cars, Trucks, Tractors, Buses)	45.478.649 units

Table 1: Summary data from Brazilian Auto Industry (ANFAVEA, 2020)

Motorcycle and scooter numbers are as per table 2

Manufacturers	14
Revenue (2019)	US$15100 Million
Production (2019)	1.107.758 units
Total Fleet (2019)	28.179.083 units

Table 2: Summary data from Brazilian Motorcycle Industry (ABRACICLO, 2020)

Relevance of the sector (ABRACICLO, 2020)

The last ten years can be divided into two different periods. The first one being of expansion of production and a second one of decline with a slow recovery. Errors in economic policy led to a substantial economic crisis, with the GPD falling for two consecutive years (2015 and 2015). Until today, only the recent COVID-19 crisis has represented a more negative impact on the Brazilian economy.

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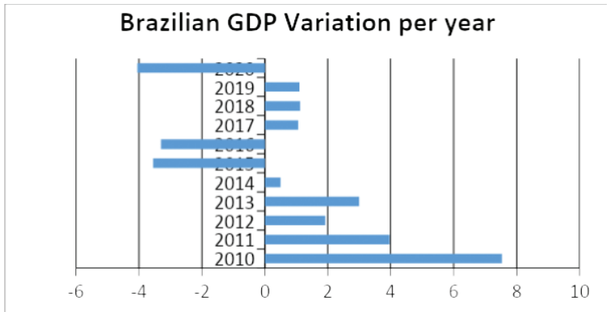

Figure 1: Brazilian GDP Variation per year (2010 – 2020). 2020 data is estimated

The economic downturn can be seen clearly on the production of vehicles during the same period (2010 – 2019)

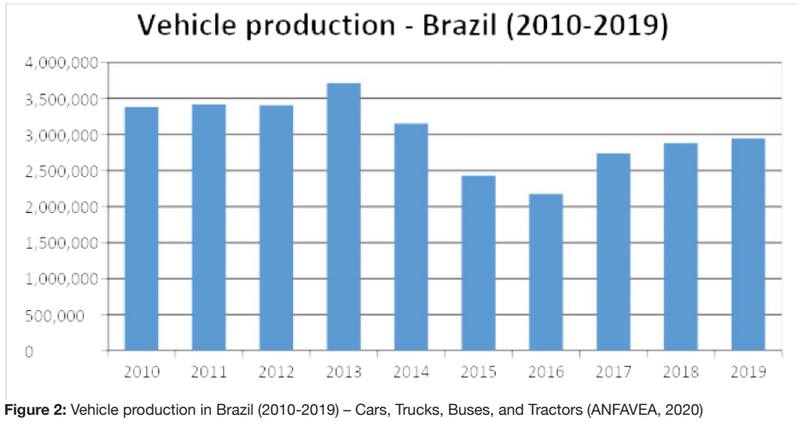

Figure 2: Vehicle production in Brazil (2010-2019) – Cars, Trucks, Buses, and Tractors (ANFAVEA, 2020)

Apart from the downturn, Brazil ranks as the world's 6th largest market for vehicles and the 8th biggest producer (ANFAVEA, 2020). The sector employs 1.3 million people and corresponds to 3% of the GDP of the country, according to 2017 data (ANFAVEA, 2020). It is feared that the numbers of 2013 will only be repeated by 2023. However, the COVID-19 crisis can impact this data even further. Idle capacity is still high since Brazil can produce 5.05 million vehicles per year. This excessive capacity is being eliminated by the cease of operation of some plants and the end of production of companies such as Ford and Audi that announced in early 2021 that they would cease their presence in Brazil with production units.

The announcement that Ford Motor Co. will close its three plants in the country (Camaçari, Taubaté and Belo Horizonte) represented the loss of 5000 employees. The company indicated that sales in Brazil fell 26% last year and are not expected to rebound to 2019 levels until 2023. The closing was part of a $11 billion global restructuring that also implied, among other cuts, the calling off of its auto joint venture in India. Ford's product development center in Bahia and its proving ground in Tatuí shall remain in operation, as well as its regional headquarters in São Paulo and the plants in neighboring Argentina and Uruguay. (Klayman & Alerigi, 2021)

On the other hand, the country is out of the electrification trend. Hybrid and Fully electric vehicles presence is minimal in Brazil since there is no local production of this kind of vehicle. In 2020, hybrid and electric sales reached 11.844 units sold (ANFAVEA, 2020). Availability of biofuels, oil reserves, economic crisis, and income reduction are some of the factors that hampered the adoption of fleet electrification in Brazil.

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Challenges (ABRACICLO, 2020)

The automotive sector in Brazil faces enormous challenges. New investments are suspended due to economic issues and overcapacity. Furthermore, to make matters worse, the country is not an exporter of vehicles, and the industry relies mostly on the local market. As a relatively closed economy, Brazil has not many trade agreements with other countries. Production costs are high (taxation, energy, logistics), and the limitation to import parts, even for vehicles that will be exported later, puts the country's industry away from the prominent global production chains.
The following points will have to be addressed by the industry, government, academia, and other stakeholders during the next few years

1. Recover from the economic downturn from 2015/2016
2. Integrate the Brazilian auto-industry into the global production chain.
3. Increase participation of Brazilian Engineering in technology and product development related to the automotive sector.
4. Keep in Brazil the central development related to Internal Combustion Engines. This item may sound controversial, but due to the local market and other regions' characteristics, internal combustion engines running on renewable bio-fuels can be a lower cost option to replace fossil fuels in short periods in locations where the production of biofuels is possible. Given the recent news that Europe and the USA may cease producing this sort of vehicles, a demand for engineering development may be transferred to Brazil.

Most challenges are related to the economic recovery of Brazil and changes in policy. This will depend on economic and tax reforms that will have to be negotiated at the political level. Without economic recovery, Brazil's automotive industry will be stagnant with very little investment and mostly with the production of vehicles engineered in other countries with little or no local technical input.

If Brazil starts to integrate its economy into the world's production chain, it will be possible to modernize the products and turn part of the local capacity for exports. Again, drastic economic reforms will be demanded to make this change happen.

Fiscal benefits for the industry such as the current ROTA 2030 initiative may be phased-out since it has become more difficult to politically sustain tax benefits to the industry with other pressing issues such as pensions, health, and education. On the other hand, simplification of taxes, deregulation, and reduction in energy and logistic cost may help to turn Brazil more attractive for investment from the automotive industry.

Despite the new opportunities, students and newly-graduates feel that there is a huge competition among highly-qualified workforce to occupy the available positions. The crisis left skilled professionals without an occupation and now the new job openings cannot absorb them. In order to get a job at an automotive company people have to have a previous specialization course and an extensive knowledge of the field. With this in mind, it is noticeable that the students have become more reluctant about the prospect of working in the automotive industry.

Brazil has no native car manufacturer. Apart from adaptation to local conditions, most of the R&D will be done outside Brazil unless the country can provide excellent engineering with a very competitive cost. If the current trend carries on, then the focus will be on manufacturing and assembly.
The general perception is that the engineers do not have the skills, especially in manufacturing and on topics related to industry 4.0. There is a need of more practical training related to industry requirements and more emphasis on soft skills, as well as establishing framework and formal structure for university-business cooperation.

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Regional challenges

The region around São Paulo is the main area for vehicle production and auto-parts. Regional development policies, increased labor costs near Sao Paulo, and tax incentives by other regions led to the opening of plants in other states of Brazil. Towards the South and North of the country, several plants were opened. However, given São Paulo being the main financial and services center of Brazil, several companies' headquarters and main engineering facilities are in São Paulo or in a radius of 100km from the city.

Rio de Janeiro holds the core of Brazil's oil industry, with the national oil company's headquarters, Petrobrás, being here. The largest oil fields of Brazil are also off-coast, in the northern part of Rio de Janeiro, and such industry has created a demand for engineering services that are available to other industries, such as the automotive. The main road linking São Paulo to Rio de Janeiro has the plants of several companies such as General Motors, MAN, JCB, Eaton, and other suppliers.

Given the availability of engineering services, suppliers, and good logistics, it is clear that the automotive industry will be concentrated in the areas around both cities. As mentioned before, the road between São Paulo to Rio as well as the roads to São Paulo to Campinas, São Paulo to Sorocaba, São Paulo to Curitiba, São Paulo to Belo Horizonte, and Rio to Belo Horizonte are the main axis where the industry has settled.

STRENGTHS	WEAKNESSES
Economic situation for the future is optimistic	Brazilian Market is overcoming a financial crisis. Automotive industry is still trying to recover. Therefore, the number of job positions is limited and skilled professionals are unemployed
OPPORTUNITIES	**THREATS**
Predictions say that economy will keep on growing. Companies have the opportunity to stand out of their competitors.	Predictions could be wrong and the economy will not recover as planned. More trained engineers and other professional will be unemployed or even lose their jobs.

Table 3: Brazilian Market SWOT analysis

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ARGENTINA

Historical Perspectives, Trends & Challenges in Argentina

The history of the Argentine automotive industry (Peyrú & Etcheber) dates back to the early 1950s when the industrial process was rethought. The production did not grow due to the lack of machines and the country did not generate the necessary foreign exchange to buy them, making the situation even worse due to the lack of external credit. It was then thought of encouraging the entry of transnational companies that were willing to contribute equipment in the form of direct investments and in sectors not yet exploited. Law 14122 was then signed in 1953, which tried to regulate the expected flows of funds and to grant legal guarantees to their owners. Its main objective was to attract companies to metalworking production in Córdoba in association with the Military Aircraft Factory (FMA). The privatization of the tractor factory that the FMA was installing at that time was achieved, being in charge of Fiat, a former supplier of the FMA and called Fiat Concord. Also in Córdoba, a car factory called IKA (Industrias Kaiser Argentina) was installed. These were the major fruits of manufacturing expansion associated with foreign capital, creating the first and largest metal-mechanical pole in the country. Legislative changes, market and political trends of the country made automobile production (counting in whole the automotive production and mounting of parts) to move from 33,000 units contributed by IKA in 1959 to 200,000 in 1965. Thus exceeding the broader expectations of its evolution. Decanting led to the survival of the three large companies in the United States (Ford, Chevrolet, Chrysler) and the largest European companies (Renault, Peugeot, Fiat). In addition, IKA passed into the hands of Renault. The SIAM company (Sociedad Industrial de Amasadoras Mecánicas, founded in 1911), which had only entered the automotive market at the end of the 1950s with great success (being the only local company that had faced a manufacturing program licensed by the English company Morris), decided to retire. Its assembly plant passed from hand to hand in the following years as part of the trials of the transnationals based in the country. The same happened with the production of tractors, in which four companies shared, once installed, a market of 12,000 units per year.

The automotive industry went through various periods of bonanzas and problems accompanying the evolution of national economic variables. Currently, an acute crisis derived from the general Argentine economic situation is currently observed, also enhanced by the COVID-19 pandemic. This has led the national government to close a large part of the economic and social activity of the country as of March 2020 and for the rest of the year. Year 2021 started with major uncertainties about the pandemic and possible future impacts on industry. The problem is further aggraviated by the national economic crisis. This, along with Ford's announcement of its closing of the operations in Brazil, has had a strong effect on Argentine's commercial balance since both countries are partners in MERCOSUR.

Relevance of the Sector (Sindicato de Mecánicos y Afines del Transporte Automotor, 2019).

In the last ten years, the number of inhabitants per vehicle has dropped from 4.1 to 2.8, showing that access to the purchase of vehicles has been facilitated. The growth potential in Argentina measured in inhabitants per vehicle cannot be compared with European indicators given the difference in surface area, population density, infrastructure, and gross domestic product between the country and the European countries. In any case, it is possible to think that this indicator could improve if an economic-social context were maintained that allows saving and investment in durable goods. Figure 1 shows this indicator.

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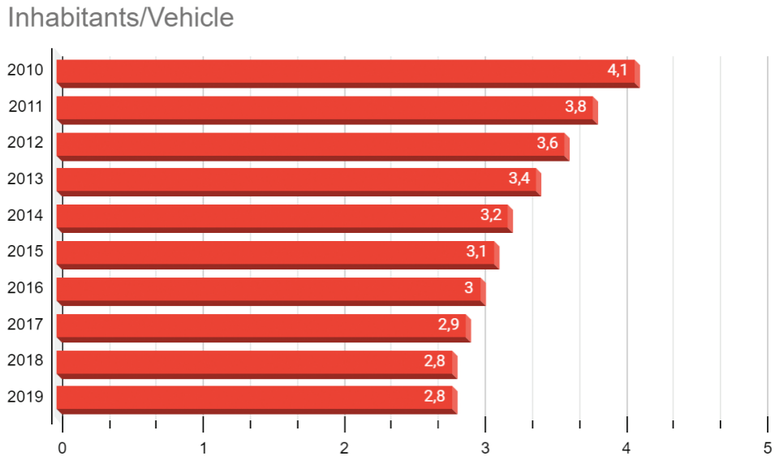

Figure 3: Indicator of inhabitants per vehicle in Argentina (data for 2019 is estimative) (Sindicato de Mecánicos y Afines del Transporte Automotor, 2019).

Argentina in 2018 was ranked 25th among the countries of the world producers of vehicles (it became the 18th in 2011), was the 6th global producer of Pick-ups and the 4th of medium sized Pick-ups. It ranked 19th in the world sales ranking and is the second most important market in Central, South America and the Caribbean. In the last decade, 6 million units have been produced, 7 million units have been sold in the local market and 3 million units were exported.

The market chain that makes up the Automotive sector employs 615.7 thousand workers directly and indirectly. Formal employment linked to automotive production is equivalent to 9% of industrial employment in Argentina. It represents 6.6% of the industrial GDP, considering only directly related productive chains. It has installed capacity to produce 1.2 million vehicles per year, although in the January / May 2019 period, it was only used by 33.4%. Its production takes place in almost all the provinces, although predominantly in Buenos Aires, the Autonomous City of Buenos Aires (CABA), Córdoba, Santa Fe and Tucumán.

In the country, there are installed only 30% of the top 100 global auto parts companies, while in Brazil and Mexico there are 79% and 97% respectively. These numbers have been reduced since 2020 in Argentina after the huge economic recession and negative prospects for the future that have led some companies to emigrate.

According to the survey of the Ministry of Labor, until 2019 there were 1,891 companies dedicated to the commercialization of vehicles (new and used) of which, only 40% would be associated with ACARA (Association of Automobile Dealers of the Argentine Republic). In Argentina, sales per dealership reach 842 units per year (year 2017) and in the American context this level of sales is higher than those of Brazil, similar to those of Mexico and lower than those of the United States (1,032 units per concessionaire in 2017).

The 2017-2020 investment, according to the estimate of the Automobile Manufacturers Association (ADEFA), would have been in the order of 4 billion dollars; much lower in relative terms than that of Mexico (100 billion between 2013 and 2018) and that of Brazil (25 billion between 2012 and 2017).
In Argentina the tax pressure is high and is equivalent to 11.6% of the vehicle's production cost (7% in Brazil and 0% in Mexico). As for the tax component in the commercial link of the chain, it is equivalent to 6% of the cost of the vehicle -without VAT- (9% in Brazil and 0% in Mexico). Consequently, the total tax burden with VAT and other fees paid by the consumer amounts to 50.1% of the value of the vehicle to the public, reaching 55% in imported vehicles.

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In Argentina, 14% of the FOB value of the vehicle exported are taxes. This is due to the almost doubling of export duties, the reduction of reimbursements, and the increase in the Statistical tax made by the government from 2018 approximately. These indicators show the high tax pressure, higher than that of the region's competitors, and which, in addition, has grown in the last 4 years.

In 2018, the Argentine automotive sector exported 58% of its units produced for a value of 8,331 million USD, which represented 13.5% of the total exported by the country, and 35.4% of the export of industrial manufactures. It is the industrial sector with high added value that exports the most.
The external trade deficit of the automotive chain would be much greater if there were no production in the country, since vehicles and their spare parts would have to be imported.
Vehicle production, after registering a growth of 420% between 2002 and 2011 -historical maximum of 829,000 units- remained somewhat below the 800 thousand units until 2013, and starting from that date a permanent decline has presented itself, thus reaching in 2018 a production 44% lower than that in 2011. In 2019, the estimate from the figures analyzed foretold that the deterioration would be even greater, and by 2020 the economic crisis collapsed indicators so that in the month of April 2020, practically zero vehicles were produced due to the industry being stopped during the preventive confinement (COVID-19) decided by the national government. During the rest of 2020 production increased again. Figure 2 shows these indicators up to 2019.

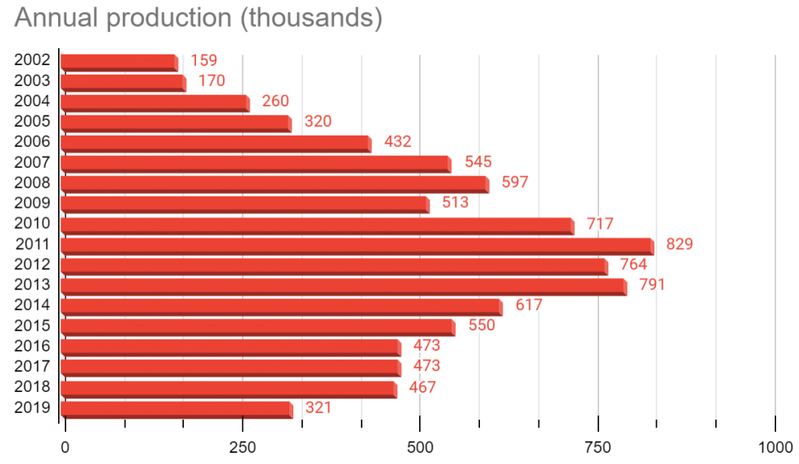

Figure 4: Annual automotive production in Argentina (data for 2019 is estimative) (Sindicato de Mecánicos y Afines del Transporte Automotor, 2019)

The systematic drop in production reflects the continuity of a state economic process that has not been able to reverse the situation. When comparing the graph with the one that indicates the number of inhabitants per vehicle, it is seen that the internal market has become saturated and the external market has been absorbing less and less production.

The low production scales per platform also affected the auto parts sector by dismantling its production chain, thus generating serious competitiveness problems in the chain of systemists -first ring- which in turn dragged the rest of the auto parts companies, and invalidated both the increase in content and the sustainability bases of the country as a future exporter of auto parts.

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Local auto parts companies have insufficient scales and capacities to face the challenge of global platforms, the adoption of Industry 4.0, the use of new materials, on-board electronics developments, new engines, among other aspects. The low presence of global systematists and auto parts companies, and also the lack of a State strategy for the consolidation of clusters (Poles) are limiting the competitiveness of the sector.

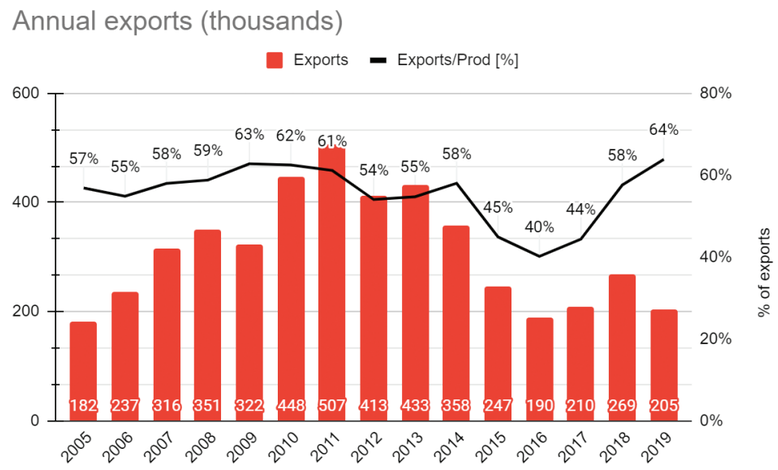

Figure 5: Annual vehicle exports (data for 2019 is estimative) (Sindicato de Mecánicos y Afines del Transporte Automotor, 2019)

In Mercosur, Argentina produces 12.5% of small / medium cars, 11% of SUVs (Sports Utility Vehicle), 14% of utility vehicles, 5% of trucks, and 47% of Pick-ups, these and utilities account for 61% of production.

The foregoing resulted in an excessive dependence of local production on exports to Brazil -40% of production-, which is aggravated by the sharp drop in export volumes in 2018 (47% less units than in 2011). That is due, in part, to the drop in demand in Brazil, but also, as mentioned, to the lack of "product". All this took place within the framework of a strong increase in imports to meet domestic demand. Figure 3 shows the Argentine automotive export indicators.

Patents registered a growth of 148% between 2005 and 2013 -a record high. During this period, imports maintained an approximate 60% market share, but as of 2016, they register a new impulse encouraged by the government, reaching levels higher than 70%, even when demand falls significantly as occurs in the first half of 2019.

Production estimates for 2019 and patenting reflected a drastic drop compared to 2018, 146,000 units and 309,000 units respectively, reaching the levels of 2005 and 2006. In 2020 this indicator decreased.

In the aspects of active and passive safety, and in the environmental issue (sound and gaseous emissions), locally there is no active guidance strategy, although the industry is gradually adopting increasingly demanding standards in accordance with international trends. It should not be forgotten that this is a condition for exporting and/or avoiding external unfair competition of vehicles and their parts. These issues were established in the National Traffic and Road Safety Law and were subsequently modified by the intervention of the Ministry of the Environment, with regard to emissions, and by the National Road Safety Agency and the Ministry of Production in what it does to active and passive safety. Through successive agreements, implementation schedules were established for a growing number of requirements in terms of active and passive safety, which somehow tried

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to follow the productive trends in the region, but with delays and temporary mismatches, which have been accentuated in recent years.

The automotive sector showed signs of reactivation since the last months of 2020. In January 2021, 24,308 vehicles were assembled, 19.4% less than in December, but 17.5% more than in the same month of 2020. 47% of vehicles sold were of national industry, surpassing the peak of 45% in 2015, and car imports increased in 68% compared to January 2020. However, the industry is still lagging in terms of technological innovation for production, incorporating greater added value and the advent of electric cars.

The Argentinian government is aware of the relevance of the automotive industry for the economic reactivation of 2021. In order to boost recovery, authorities are implementing policies that benefit production, such as waiving export duties for companies that exceed 2020 foreign sales and keeping the currency quota from last year, as well as bills establishing tax benefits that allow for further investment. (Maza, 2021)

Challenges (Sindicato de Mecánicos y Afines del Transporte Automotor, 2019)

The current situation in the country leads to the need to analyze ways to achieve a substantial improvement in the situation of the sector. Challenges arise, that must be faced. These challenges of the value chain have the temporal sequence of their objectives, and require the improvement of the general socioeconomic conditions of the country. They are, in principle, according to the view of SMATA (The Union of Mechanics and Related workers of Automotive Transport of Argentina):

1. Reverse the decline in employment and production.
2. Increase investment in terminals and auto parts companies.
3. Improve the supply of inputs (availability, quality -new materials- and price) for the automotive industry and its productive ecosystem.
4. Develop a system of continuous technical professional training for the automotive sector and deepen the implementation of public policy programs related to strengthening training actions in the automotive sector. In this framework, it is proposed to design training courses that include employed workers and unemployed young people who seek to find employment in the activity. The paths must articulate basic traditional training, with complex training in the different processes of technological and organizational innovation expressed by industries 4.0. In this process, university degrees or higher technical degrees related to these innovations are to be integrated. To guarantee the sustainability of the system, it is essential to create an R&D Center in which an area of technical professional training is consolidated. In this space, in addition to SMATA, should converge the business chambers linked to industry and service - ADEFA, AFAC (and representatives of second and third ring auto parts), ACARA, FAATRA (Argentine Federation of Association of Automotive Repair Workshops and Related). And the Universities that are working on issues related to the sector, and the public areas of the scientific and technological system such as INTI and CONICET.
5. Terminals:
   a. Increased investment in the local market with minimum competitive scales, exclusive to Latin America (modular global platforms),
   b. Deepen the specialization in Pick-ups, expanding to light and heavy models.
   c. Develop the SUV and light utility segment (urban distribution, logistics for SMEs, etc.) destined for the local market but mainly for export. The international insertion requires to expand the range of products in the context of specialization. This is evident when analyzing the EU market.

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6. Auto parts:
    a. Strengthening of local auto parts and attracting investments in global auto parts companies of the first ring (auto parts companies that supply systems to the terminals),
    b. Fill vacant spaces with new products at the same time that suppliers begin to develop for the new demands of vehicles (connectivity, safety, new engines, axles, transmissions, etc.).
    c. Massive incorporation of manufacturing 4.0 and Lean manufacturing in coordination with the terminals.
    d. Promote from the State the formation of clusters: complementarity, shared R&D, greater logistics efficiency, application of new technologies; and productive poles.
7. Trading system. The digital formats and new roles of the commercial network: Sales and post-sale services; customer and terminal services.
8. New engines, opportunities and challenges for the manufacture of engines and their parts: hybrids, electric, hydrogen cells, LPG, LNG, CNG and bioethanol - flex engines.
9. Redefinition of regulations for foreign trade regulation and customs controls.
10. Technical standards.
    a. Approach to the standards required in developed countries, following WP29 (Regulatory Framework of standards, United Nations, for environmental protection and safety, annual forums for issuing and evaluating standards, Argentina does not belong to the Forum).
    b. Energy efficiency and vehicle labelling.
    c. Expand the requirements for active and passive safety.
11. International insertion:
    a. Protection of the local market from unfair practices. Replacement of market assurance.
    b. Evaluation and proposals for a strategic alliance with Brazil within the framework of the MS EU, MX Brazil, and US-MX FTA agreement. Redefinition, additional protocols etc., of the agreements signed and in progress.

It is worth to mention the strong decision taken by Ford at the beginning of year 2020 about closing its Brazilian facilities where light vehicles were produced. This is aligned with challenges 5.b and 5.c mentioned above, and embedded in an international context where there is abundance of lightweight vehicle producers and at the same time the sustainable mobility trends in big cities are pushing away private mobility while incentivizing public mobility services. This scenario will lead to a reduction of demand for this lightweight segment, pushing an aggressive cost and market competence between producers, which may move the weaker actors away of the market, or even make the big actors to take strategic decisions. This scenario might become a reality in medium term.

Regional challenges

The regions surrounding Bahía Blanca and La Plata contains a significant number of technology-based companies oriented to the metalworking and electronics area. In addition to petrochemical centers oriented to the processing of petroleum derivatives both to create fuels and lubricants and plastics, as well as other products for the agro-industry. Very close to La Plata is located the main petroleum refinery of Argentina belonging to YPF, the national petroleum company.

The development of technological products based on electronics and software is actually not substantially affected by the relative geographical location between the producer and the customer, so the development of technology and the supply of product for the automotive productive chain is perfectly feasible. The main challenge is to be able to meet delivery volumes according to need, the adaptation of production to the regulations required by the client, and achieve a competitive price, and time-to-market for the global economy. The capacity in human resources and know-how is adequate to face challenges of this magnitude.

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The local initiative derived from the TEAC project (Ministerio de Ciencia, Tecnología e Innovación, 2019) in Bahía Blanca has consolidated a cluster of technology-based companies associated with researchers and institutions that allows the development of technological projects and collaborative business ventures oriented to the local market and the global market. The approach of these companies towards the automotive area is perfectly feasible based on exploring opportunities and linking the parties.

Contrasting with the previous paragraph, La Plata and its area of influence used to have up to the end of the eighties local industry devoted to automotive parts like Albano Cozzuol (plastic parts); SIAP (panel instruments); INDECO Mogul (main and rod bearings); SAFRAR Peugeot, then SEVEL (cars mounting); Citroen, then PSA Peugeot and the Jeppener plant. All of them started with the development of the automotive industry in Argentina in the sixties and began to decline with the economic model of military government of 1976. It can be said that with ups and downs, most of them were disappearing or remaining reduced to a minor scale than they were in the past. In the last decade YPF has installed its research center YTEC next to the refinery. Thus maintaining scientific relationships with the universities of the area. One of them also offers services of tests under standards for the automotive industry although the plants are located very far from La Plata.

In Argentina the focus is mainly oriented to production of Pickups, utility and SUV vehicles. However, a tendency to include new hybrid high end vehicles, electric and hybrid vehicles including new technologies in batteries, electronics, etc., is foreseen.

The automotive industry is considered an attractive industry to work in given the attractiveness of its areas of expertise, its respected position of vanguard in the production industry, its continuous improvement and advances, and its significance in Argentine culture.

There is a general opinion that the number of engineers necessary for this industry will increase. However, it is needed more training on reasoning for applying technical knowledge, as well as soft skills (conflict management, foreign languages, teamwork, etc.) and understanding of the chain of value (production systems, lean manufacturing, costs, etc.). Business-university collaboration has been evaluated as poor, with further need to develop agreements for internships and workshops where both parties understand each other's working schemes and strive to facilitate the student's transition from the academic to the industrial sector.

STRENGTHS	WEAKNESSES
1. Long tradition of car manufacturing in the country 2. Number and versatility of companies in the market represents an important offer of products 3. Number of suppliers available in the sector 4. MERCOSUR- Efficiency of the workforce. Good offer of trained professionals	1. High gas prices 2. Argentina is not a technologically leading country in this industry 3. High state taxes on the car prices 4. Average salaries of the population are low related to car prices (cars cost twice as in Europe and salaries are 1/3)
OPPORTUNITIES	**THREATS**
1. Latin American market is one of those greatest growth in the world (OICA) 2. Sustained economic growth of most countries in the region 3. Expected growth of exports	1. Industry and products depends principally on fossil fuels 2. New technologies are adopted after a great lag from their popularization in the world 3. Fluctuacting exchange rates 4. Inflation, that generates loss of 5. regional competitiveness and uncertainty

Table 4: Argentinian Market SWOT analysis

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Historical Perspective, Trends and Challenges of the Automotive Industry in Mexico

The automotive industry and, therefore automotive engineering, have a long history in Mexico. It can be dated back to 1921, when Buick established the first assembly plant in the country, followed by Ford in 1925, with the first assembly-line factory, capable of producing up to 100 vehicles per day (Ruiz-Durán, 2016). Later on, in the 1930's arrived General Motors and Chrysler, reflecting the great influence of the US automotive industry in its southern neighbor from its very beginning. Although focused in satisfying the local demand for vehicles, the automotive industry quickly became one of the most important modern industries in the country, a key player in the industrialization of Mexico (Ruiz-Durán, 2016) (Vicencio-Miranda, 2007).

Consequently, it rapidly attracted the attention of the Mexican government, which from the 1940's started to regulate it, making it an example of its policy of industrialization by substitution of imports (Ruiz-Durán, 2016) (García-Echeverría, 2020). In the 1960's, the continuing expansion of the operations of the American carmakers led to the arrival of Volkswagen, Nissan and Renault, and an explosive increment in the manufacturing of vehicles in the second half of the decade, from 96,781 in 1965 to 250,000 in 1970 (Ruiz-Durán, 2016). During the 1970's, important economic crises led the government to rethink its strategies and policies, opening the economy to world and promoting a new model of manufacturing for export (García-Echeverría, 2020). This led the carmakers to increment considerably their exports, ending up in the 1980's in a fresh wave of investment in new manufacturing facilities in central and northern Mexico. By the end of the 1980´s and the beginning of the 1990's, Mexico exported up to 2.5 million vehicle engines per year (Ruiz-Durán, 2016). Finally, in the 1990's, the North American Free Trade Agreement (NAFTA) with the US and Canada gave further impulse to the automotive industry, particularly through a substantial increment in the exports (Vicencio-Miranda, 2007). In 1994, Mexico produced roughly the same amount of vehicles for export and for the national market, while by 2000 the proportion was three times more for export and by 2015 4.3 times more. (Ruiz-Durán, 2016).

As the automotive industry continued to grow and expand, in the 21st century Mexico became a major player in the automotive industry at the international level. In 2017, it ranked as the 4th largest exporter of automotive industry-related products in the world, with 83% of its light vehicle output destined for the international markets. The automotive industry became clearly one of the main engines of the economy, representing 3.7% of the national GDP (Gross Domestic Product) and 20.2% of the manufacturing GDP, generating more than 800 thousand direct jobs, and accounting for 1 of every 5 jobs in the manufacturing industries (AMIA - INEGI, 2018). At that time, 25 of the world's most important manufacturers of cars, light vehicles, buses, and heavy commercial vehicles had operations in Mexico, supported by a strong and diverse army of car part manufacturers.

However, in the midst of this success story, the Mexican automotive industry faces a big challenge in its big dependency on the United States market. This dependency has been fueled by the two free trade agreements signed with that country and Canada, NAFTA in 1994 and UMSCA in 2018. In 2019, for example, Mexico exported 3.33 million vehicles in five different categories and in each one of them the US was by far the leading destination: 74% of 1.49 million SUV´s, 84% of 0.77 million compact cars, 92% of 0.74 million pickup trucks, 58% of 0.27 million subcompact cars, and 73% of 0.05 million luxury cars. (Zaga, Reza, Montero, & Pantoja, 2020). Such a high dependency on a single market poses obvious risks, as any problem in it, such as a recession, leaves little margin for compensating reduced demand, for example.

Also and unfortunately, Mexico's great manufacturing success did not replicate in other areas of the automotive industry, particularly having little impact in design, research, and development. This was due mainly to the fact that the manufacturers of car and other vehicles are mostly part of foreign-based conglomerates that appreciated the relatively inexpensive but high-quality Mexican labor force, but had little interest in its engineering and design capabilities. Nonetheless, with time, several of those companies developed design and/or engineering centers in Mexico. Initially limited to redesigns and adaptations of parts and vehicles for the local market, they have recently started to shift their scope to make them part of their global engineering pipelines. Additionally, within the vehicle parts area, which is also very large and diverse, some Mexican companies slowly but firmly became relevant players by themselves, prompting the development of local engineering and design prowess. Finally, local engineering and design abilities also found a niche within the small but relevant group of local bus and truck manufacturers, and some boutique car companies that are very low volume but highly specialized.

This trend towards more design and engineering work being done locally is now another of the important challenges of the automotive industry in Mexico, requiring both more well-prepared human resources and collaboration with organizations that con support them with knowledge and specialized infrastructure. Local universities can certainly have a relevant role in both aspects.

The COVID-19 pandemic represents the most recent and biggest challenge for the Mexican automotive industry. From January to July 2020 only 1,274,517 vehicles were exported, compared to 2,017,717 for the same period in 2019, a reduction of 36.8%. During that same period, the production suffered significant reductions, particularly in April (98.8%) and May (93.7%), as most of the industrial and commercial operations in the country were shut down. By mid-year, however, this industry was classified as essential, and allowed to operate permanently, considering not only its importance for the Mexican economy, but also its key role in the manufacturing chain of the automotive industry in the whole of the North American region. However, big challenges and uncertainty loom in the future, as the pandemic evolves and it continues to have significant economic and social consequences. As stated before, in this context relying so much on the United States market, which received 81.7% of the Mexican vehicle exports from January to July 2020, poses particular concerns (Carbajal-Suárez & Carbajal-Suárez, 2020).

STRENGTHS	WEAKNESSES
1. Infrastructure 2. Manufacturing costs 3. Low duties 4. Manufacturing Experience	1. Lack of national providers 2. Missing of R&D centers 3. Missing of design centers 4. Missing of educational centers
OPPORTUNITIES	**THREATS**
1. A lot international companies, OEMs with financial opportunities 2. Already some cooperation of university and industry which need to be enlarged and specialized 3. Need for engineers in the automotive industry is increasing (advantage of lower wages and still relatively high qualification)	1. NAFTA agreement elimination 2. NAFTA agreement reduction 3. Development of automotive industry as well political decisions of participating countries

Table 5: Mexican Market SWOT analysis

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2. QUALITY MANAGEMENT FOR AUTOMOTIVE ENGINEERS

Implementation of quality management systems

When we talk about high or low quality, we predominantly talk about fulfilling customer requirements to a certain degree. Installing a quality management system can help an organization set itself apart from competitors and it provides additional security for management and staff. Within organizations general quality standards can be influenced on different levels, such as available boundary conditions (e.g. equipment, facilities, infrastructure), workflow (processes, collaboration, time management) and results (product, outcome). A well-established quality management system ensures according planning, checking and enhancing along all these levels to accomplish sustainable improvement in the organization's performance.

A quality management system includes written information about the scope of validity and orderly work processes (A process is a regularly occurring activity with time and content limit.). It defines responsibilities and decision making competences at management and employee level, elaborates on effective flow of information within the organization, identifies main contact persons for specific areas of expertise and general collaboration between departments and people.

The descriptions of the boundary conditions, the work processes, the outcomes, the responsibilities and the flow of information provide an important overview for all employees, provide the basis for regular analysis, improvement and fault management and provide a valuable source of information for new employees and employee trainings, making them also a source of knowledge management.
The aim of a so-called quality management handbook is to give a comprehensive overview of all these processes and their interaction. Each process is continuously assessed by analyzing it in alignment with previously defined key figures and is accompanied by standard operating procedures, which also account for applicable legal requirements and regulations.

Composing and updating these quality management documents proves to be a continuous challenge for organizations and companies. Documents mentioned in the quality management handbook must be current and readily available. Any modifications made to them have to be documented and released.

In order to determine the effectiveness of an implemented quality management system, internal and external audits are the main means of inspection. While an internal audit will usually be done by a member of the organization's quality management team, an external audit is commissioned to a certifying institution (Haidenberger, 2017).

Quality management in automotive engineering

Over the last years the threats of climate change and its effects on civilization and species have led to a raised awareness of the need to take up on the environmental challenges of the future. When the European Union agreed on the targets set in the Green Deal this commitment was determined and also gained more significance on an international level.

The automotive industry has faced the effects of these challenges and is in a state of continuous development and change. Innovative new technologies contribute to the reduction of greenhouse gas emissions and provide alternative options to fossil fuels. The electrification of road transport is enabled by major developments in the battery technology sector. Hydrogen solutions become viable for the long-distance freight sector and groundbreaking strides have been made in autonomous driving.

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These technological changes enable customers to choose from a range of different vehicles with different powertrains and have influences customer demands. Customers' raised awareness towards environmental protection, information security, high quality products and manufacturing, ethics and health have a direct effect on manufacturers, suppliers and developers all over the world.

Already as early as 1970 and 1980 many large-scale companies decided to get ahead of potentially new, costly and changing environmental regulations und started implementing voluntary anti-pollution practices into their processes. Soon it was evident to international organizations, governments and industry associations that setting standards to be used as guidelines for companies had many advantages (Morrow & Rondinelli, 2002)

The International Organization for Standardization develops and publishes international standards, which can be taken on and implemented by companies in order to ensure their customers the latest standards are being applied and followed.

- Quality management support companies to work efficiently and reduce product failures and defects.
- Environmental management standards help reduce the environmental impact.
- Health and safety standards contribute to the reduction of accidents in the workplace.
- Energy management standards help to reduce energy consumption.
- Information security standards protect sensitive information.

ISO 9001: Quality management systems

The benefits of implementing a certified quality management system as in ISO 9001 are the increased customer value, satisfaction and following loyalty. The implementation contributes to the positive reputation of the organization and helps stabilize the customer base, while increasing effectiveness by better coordination of processes and improving the overall communication structures. It is based on seven management principles (International Organization for Standardization, 2015):

- Customer focus
- Leadership
- Engagement of people
- Process approach
- Improvement
- Evidence-based decision making
- Relationship management

Mandatory Requirements — Documents and Records (Keen, 2021)

- Monitoring and measuring equipment calibration records
- Records of training, skills, experience and qualifications
- Product/service requirements review records
- Record about design and development outputs review
- Record about design and development inputs
- Records of design and development controls
- Records of design and development outputs
- Design and development changes records
- Characteristics of product to be produced and service to be provided
- Records about customer property

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- Production/service provision change control records
- Record of conformity of product/service with acceptance criteria
- Record of nonconforming outputs
- Monitoring measurement results
- Internal audit program
- Results of internal audits
- Results of the management review
- Results of corrective actions

ISO 14001: Environmental management systems

The ISO 14001 standard is meant for organizations aiming to manage their environmental responsibilities systematically. The intended outcomes of the environmental management system include the improvement of environmental performance and compliance with set obligations (International Organization for Standardization, 2021)

By implementing ISO 14001 organizations define standards for their environmental policy and environmental aspects of their processes. They set down clear definitions and goals, assign roles of responsibility for the environmental management, establish training programs accordingly and by continuous and transparent flow of information ensure awareness in all employees as well. A system of environmental management documentation is established and emergency plans are developed. (Morrow & Rondinelli, 2002)

ISO14001 was introduced in 1996 and has since attracted an ever higher number of interested organizations. (Balzarova & Castka, 2008)

ISO 27001: Information security management systems

Since the General Data Protection Regulation came into effect in the European Union and the development of automated vehicles required gathering, storing and using huge amounts of data, the protection of personal and sensitive data has become even more important.

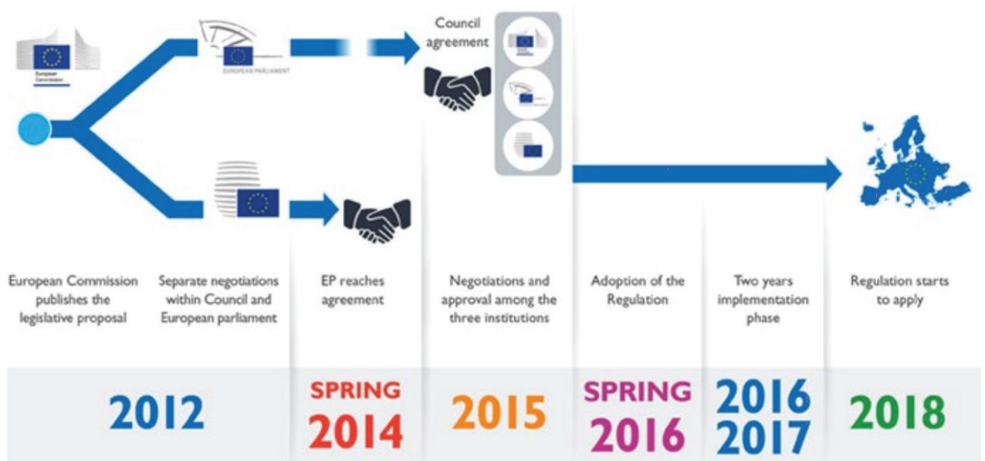

Figure 6: Stages of GDPR (Lopes et. al., 2019)

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People, processes and technology are the three pillars upon which the ISO 27001 standards are based. The implementation of the standards helps identifying potential threats and vulnerabilities, raises awareness for security aspects and the need for data protection and it enables companies to prepare for emergency scenarios. Following these measures consistently throughout the organization stakeholder's trust rises significantly as it implies high commitment to customer data and information protection (Lopes et. al., 2019)

ISO 45001: Occupational health and safety management systems

Ensuring a healthy and safe workplace for their employees is one of a company's main concerns. Nowadays and in light of the Covid-19 pandemic, this requirement receives new and additional attention. Further emerging risks can be related to digitalization, new technologies and the psychosocial health of workers. ISO 45001 enables organizations to proactively improve their occupational health and safety performance. To correctly adopt the ISO 45001 measures a risk assessment needs to made and exact knowledge of the legal framework conditions is necessary (Darabont et al, 2017)

3. SOFT SKILLS FOR ENGINEERS

Since the turn of the century, competencies have become a key tool to describe, evaluate, analyze, and assess both professional profiles in general, and in particular plans developed in the context of the university. Bozu and Canto (2009, pág. 33) defined competencies as "the set of knowledge that identifies the extent of a person's training for taking on—in optimal conditions—the responsibilities associated with the development of the functions and tasks of a given profession." Competencies represent a training modality that helps structure all the phases of the formal training (education at the secondary, technical, higher, and doctoral levels), non-formal training (lifelong and continuing education), and professional development (access, promotion, career planning, etc.) of each individual. They can be used as a modality of cross-sectional improvement in the active working life of people.

In the current university context (Castro & Ion, Changes in the University Research Approach: Challenges for Academics' Scientific Productivity., 2019), there is a clear transition from academic approaches to others more market-oriented ones. Under this new framework of the so-called market-oriented model, the competency-based model of organizing and planning university teaching and learning processes presents very distinct characteristics from the discipline-based models widely used until just a few years ago. Comparatively, we could say that competency-based models are distinguished from discipline-based models as described in the following table:

Discipline-based models are oriented towards...	Competency-based models are oriented towards...
• the academic world • the epistemological context • the curriculum design (policy) • the needs of the teaching staff and the university • the end goals	• the world of work • professional performance • market demands • adapting to the needs at hand • more emphasis on people development (training and work)

Table 6: Comparison Between Discipline-Based and Competency-Based Models

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A person is competent when they show that they are capable of solving a series of complex and clearly contextualized challenges in a professional setting. Castro and Navío (2002) argue that at the university level, competencies allow for a person to effectively demonstrate their ability to solve specific and complex situations through the interaction of different bodies of knowledge (formal, procedural, and axiological), skills, informal knowledge, self-reflection, personal experiences, attitudes , capacities, practices, etc. It is clear that the competency-based approach is better aligned than the academic curriculum, which is organized by subjects that set educational end goals. Hence, the great profusion and widespread use of the competency-based model worldwide.

At this point, it is necessary to define what competencies are. Although the literature on the matter is very verbose, they can be defined as the set of theoretical and procedural components, regulations, values, skills, abilities, informal knowledge, self-reflection, experiences, attitudes, capacities, practices, etc. that allow a person to successfully perform the obligations pertinent to a particular situation, context, or job. Competencies are contextual and involve a subject's demonstration of how to solve complex specific situations specific to their job. Figure 7 illustrates this definition as follows:

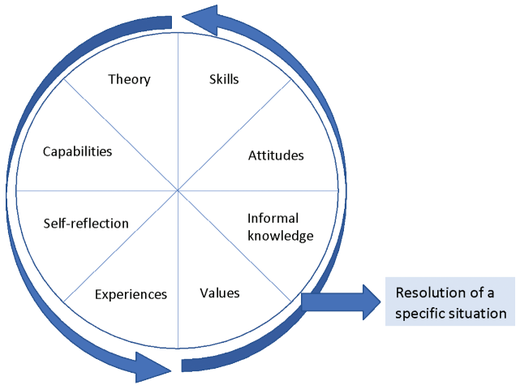

Figure 7: Components of Competencies

Teachers, rather than simply transmitting an abundance of information, are expected to promote the development of competencies as a guarantee for the lifelong learning of their students and so that these students can carry out their responsibilities in a relevant and satisfactory manner in this ever-changing and complex world. There is therefore a need to define a new teaching profile that guarantees efficient, effective, and satisfactory professional performance. The main reasons for choosing a competency-based profile are:

1. It focuses on the development of capacities in the participants, promoting the training of critical and reflective professionals who are autonomous and responsible in their professional performance; and who, in addition, demonstrate the ability to propose pedagogical alternatives and participate in decision-making concerning education, at the levels and in the areas in which they act.
2. It redirects us to the need for a type of lifelong learning that seeks to continuously deepen and develop new capacities.
3. It opens up interrelated spaces of different types of capacities and knowledge, thus strengthening comprehensive personal and professional development.
4. Since it is contextualized, it is flexible and able to adapt to social demands, to the needs of students' comprehensive development, to lifelong learning, and to paying attention to cultural diversity and the conditions in which teaching is carried out.
5. It provides versatility to the teaching/learning process and, therefore, is more capable of adapting to the current rate of change.

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A competency-based approach—the result of dialogue and consensus—can fulfill two important functions in the continuous improvement of any profile: a structural function between the initial training and lifelong learning and a dynamizing function in terms of professional development throughout one's career, as well as in one's profession itself.

Nevertheless, designing and planning a competency-oriented teaching-learning process comes with its difficulties. We turn to Van-der Hofstadt (2006) who warns us of some of its problems:

- There is little agreement on the definition of the term competency, which is why there is often a lack of shared vision on the achievement of competency-oriented teaching.
- A basic condition for building competency-oriented teaching is to have a professional and educational profile with which the demands placed on the degree holders coincide with the competencies required in the labor market.
- There is much confusion about the form and methodology with which competency-oriented teaching should be designed and built.

In the words of Castro and Navío (2002) education has been concerned with providing people with the aforementioned ingredients. The curriculum thus consists largely of content, but also stresses students' capacities. However, we cannot conceive that a competency-based training is limited only to transmitting, administering, facilitating, and guiding a series of types of knowledge and/or capacities to and in a group of students. There is something more to competencies, given that they are individual touchstones; each person combines the basic ingredients according to their personal characteristics, experiences, interests, contextual conditions, etc. Therefore, in addition to having available to them a series of resources, the person must combine their own characteristics with what the context provides them in order to be able to present themselves in society as competent.

To better understand this, let's take a simple example: communication is a very important competency in the performance of many professionals, but it is not carried out, applied, nor put into practice in the same way for, let's say, an engineer, a journalist, or a philosopher. Simply defining and contextualizing competencies does not suffice; rather, an achievement level must be established for each one.

In other words, if we determine a professional profile with a series of competencies, we cannot expect a maximum level of mastery to be demonstrated in each one of them. First because it is surely unnecessary, and second because it would be impossible to find a professional with the highest degree of expertise in all areas of competency; this would be like saying that there was no room for improvement or further learning.
Competency-based training breaks—or at least should—with the goal-centered curriculum and with academic content and its traditional concept of education. The following figures (Castro & Navío, 2002) show us the differences between a training design based on objectives and one based on competencies.

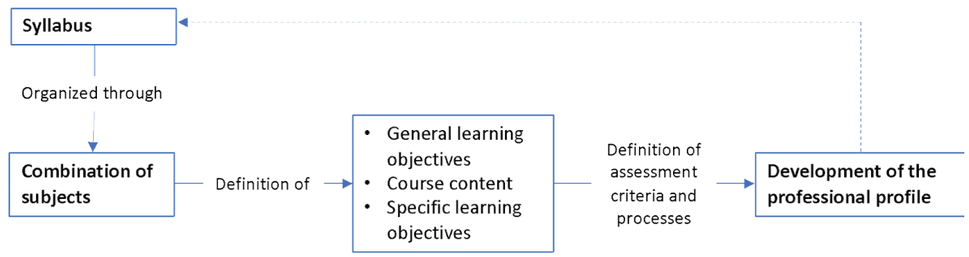

Figure 8: Curriculum Design Based on Objectives

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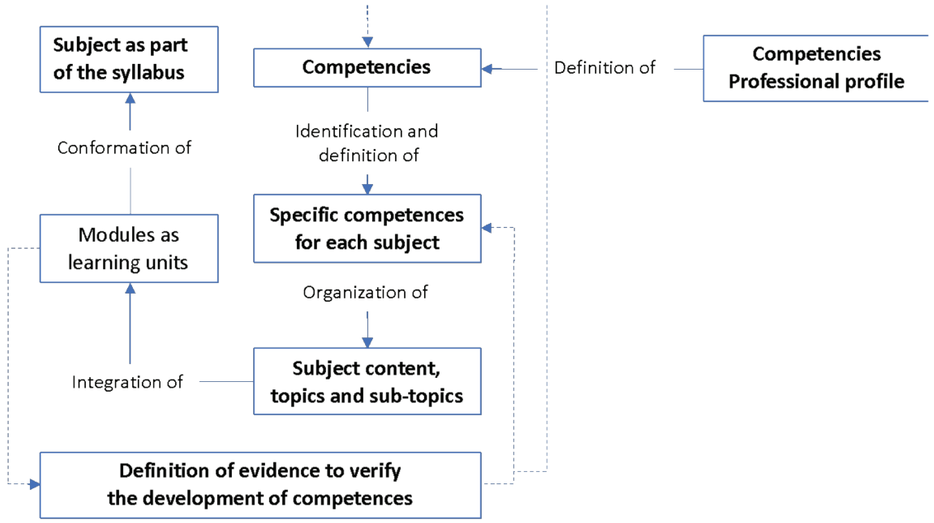

Figure 9: Curriculum Design on Competencies

Thus, it seems that it is just as important for a person to have resources as it is for them to learn to combine them and apply them in professional situations. There is no doubt that if our aim is to train professionals in the business and industrial context, something must be done to activate their different types of knowledge; in other words, they must be able to adequately combine their knowledge to be able to solve complex professional situations. A "professional" is not simply someone who holds a degree that demonstrates their mastery of knowledge, but also someone who knows what to do with that knowledge.

Competency is demonstrated within a context; the demonstration of competency is what shows that certain knowledge has been combined and integrated in a way that is relevant to competently carrying out one's responsibilities. If we also understand competency as being a constant work in progress, the key to its success is in distinguishing what constitutes a professional's basic training (key, basic, and generic competencies), and what is considered specific training (professional, technical, and profile-specific competencies) in order to be able to continue building on the competency according to the demands of each moment of one's professional trajectory.

Therefore, competency implies not only initial or basic training, but also continuing education, lifelong learning, and professional development, all of which will allow for continuous improvement. Higher education is therefore nothing more than a prelude to competently exercising one's profession. It is the invitation to a lifelong education that must begin with initial training. We embrace the words of Lévy-Leboyer (1997) who proposes that there are three ways to develop one's competencies:

- in previous training, before active working life;
- through training courses for adults, during active working life; and
- through the practice itself of the professional activity, through one's active working life

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The competency-based perspective in training and talent development in organizations allows competencies to be directly linked to the workplace context: to roles, responsibilities and other aspects directly related to the job. The following modalities shall serve to illustrate the possibilities of competency-based training (Navío, 2001):

- **Instructional modality:**
  The training is subject to prescribed standards (competencies); in this sense, training is limited to the requirements of the job. This type of training is usually given when the competency is considered to be based on a set of static elements that evolve slowly and always based on strict prescriptions proposed by the company.
- **Development modality:**
  This type of training using two reference points: the individual and the requirements of the job. Even though there is a prescription derived from the job requirements, the training addresses the needs, interests, experiences, capacities, and characteristics of those involved.
- **Educational modality:**
  The main reference point of this type of training is the context and the people within that context. The context defines the competency and gives it specificity and complexity, therefore also granting freedom to how the training is carried out. The workplace or context is given more consideration than the job position itself. Competency, and by extension competency-based training, is understood as a process and not as a static list of different elements.

But there are different types of competencies. According to Mertens (1996), competencies are divided into basically two main typologies, depending on their nature. Hard-skill or technical competencies (hard skills), that could be defined as those that resolve specific technical-professional issues thanks to specialized training; and, on the other hand, the soft-skill, social, cross-disciplinary competencies (soft skills) which are those that are linked to the interpersonal capacities that a professional possesses regarding their work attitude. As it can be noticed, sometimes the authors only refer to some of their components (skills) when they talk about competencies.

These days, employers not only value the intellectual skills of their employees, but also increasingly value their soft skills—that is, skills that are transferable and more linked to experience (Markes, 2006). Soft skills focus on the person and include: leadership, ethics, collaborative work, entrepreneurship, the use of information and communication technologies, innovation, global perspective, mastery of foreign languages, critical thinking, intellectual curiosity, communication, problem solving, and a passion for self-directed learning.

Also known as "people skills" or "interpersonal skills," soft skills describe how a person relates to and interacts with other people. These skills are much more subjective than technical competencies and are therefore much more difficult to measure quantitatively. If an employer is looking for someone who knows a programming language, the candidate can share his marks from a particular course or point to a program he created using that language; but it is much more difficult for him to demonstrate to what extent he is creative or innovative.

In the field of engineering, the general consensus among experts is that professionals need both good technical training and soft skills. In a recent and interesting study on soft skills in the engineering sector developed in Mexico by Neri and Hernández (2019) the authors argue that, although the labor market and society at large demand soft skills—which has an impact on young job-seeking engineers—current university programs do not guarantee the development of these types of competencies. In a more recent publication, Neri and Hernández point out that:

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> *In engineering schools, students spend more time honing their technical skills and sometimes neglect competencies that allow them to solve other problems. Given this, we must find out the ways of learning that students most appreciate and that generate the most enthusiasm among them. Social skills are crucial for engineers, given that their work environment is increasingly interdisciplinary and requires more collaborative work. (Hernández Herrera & Neri Torres, 2020, pág. 4)*

Neri and Hernández ((2019), citing Deveci and Nunn, 2018; Meissner & Shmatko, 2018; Ureña & Martínez, 2017) add, that because not all young people who graduate from university courses achieve the level of competencies required by certain sectors of society, they are forced to take skill-building and development courses to improve their areas of weaknesses. They note that "research reveals that engineering students have a positive view concerning the acquisition of soft skills, since they consider themselves capable of strengthening those competencies that they perceive as weak" (pág. 5). Neri and Hernández (2019) therefore consider the modification of engineering study plans to be of top priority because it would promote a better development and understanding of the importance of soft skills with respect to technical knowledge. The authors add that "a change in the accreditation criteria in the fabric of the traditional engineering curriculum will provide a broader and more solid overview to achieve the desired objectives or competencies (Byrne, Weston & Cave, 2018; Bastarrica, Perovich & Sama, 2017; Veraldo et al., 2017)" (2019, pág. 5)

The lists that bring together the definitions of soft skills are diverse given that—as we have pointed out—competencies are contextual; although each scenario therefore ends up defining and giving these types of competencies a specific shape and form, the following is a proposal for their definition, in broad and specific terms (Castro R., 2020)

- **"Communication and active listening.** A leader is more productive when he or she knows how to communicate with his or her peers. Having good communication with your work team is essential; knowing how to communicate your ideas and receive those of the collaborators is a key part of this.
- **Leadership.** Leading is not an easy task; it goes beyond simply giving instructions. It's about knowing how to motivate the team and maximize their skills.
- **Planning and time management.** Good planning of daily tasks and optimal organization will help make sure that the team can take full advantage of the time it has to perform its activities.
- **Teamwork.** "Unity leads to success." These days, knowing how to work as a team is an indispensable skill for everyone. If your team members are individualistic, working as a team will not be easy.
- **Flexibility.** Work teams require employees who are flexible: who can adapt to change and keep the organization up to date.
- **Decision-making.** Decision-making is something that we all do in our daily lives, whether on a professional or personal level. Within the context of work, professionals who are "problem solvers"—those who know how to make the right decision even in difficult situations—are much needed.
- **Outcome-oriented.** Being outcome-oriented means directing all the actions of a company towards achieving a goal. Employees must know the goals and objectives that their organization wants to reach; this will boost their commitment.
- **Negotiation.** This is the ability to reach an agreement between two or more parties. Leaders must know that there are always options that benefit both parties."

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The American Society for Engineering Education [ASEE] (2003, cited by (Palma, Miñán, & Ríos, 2010, pág. 2556)) proposes that every engineering graduate should possess the following five hard skills and six soft skills, as described below in Table 7:

Technical skills (hard)	Professional skills (soft)
• An ability to apply knowledge of mathematics, science, and engineering • An ability to design and conduct experiments, as well as to analyze and interpret data • An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability • An ability to identify, formulate, and solve engineering problems • An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	• An ability to function on multidisciplinary teams • An understanding of professional and ethical responsibility • An ability to communicate effectively • The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context • A recognition of the need for, and an ability to engage in life-long learning • A knowledge of contemporary issues

Table 7: Hard and Soft Skills of Engineering Graduates (ASEE) based on ABET criteria (Palma, Miñán, & Ríos, 2010, pág. 2556).

In their (1996) study, Shea and West point out the relative importance of 10 skills for engineers using a rating scale of one (low) to five (high). They demonstrate that communication (with an average of 4.60) is considered to be one of the most important soft skills, followed by problem solving and people skills (4.45), commitment to objectives (4.13), and continuous development (4.12).

More recent research by Colman and Willmot (2016) in the United Kingdom indicates that the most important soft skills for both students and teachers are: communication (oral, written, active listening, and gesturing), teamwork, and time management.

Within the Mexican context, Portero (2016) groups soft skills according to the order of importance determined by employers in the automotive sector:

- Most important: the ability to sell and negotiate a service, management of marketing techniques, knowing how to communicate and establish a good relationship with clients and colleagues, cost accounting and finances, and labor legislation.
- Of high importance: leadership, supervision and conflict resolution, polite interaction with everyone in the workplace, and teamwork and socialization.
- Of some importance: knowledge of foreign languages (especially English), mastery of general and specific computer programs, and problem solving.

Although the engineering study programs in general—and those of the automotive sector in particular—include work on some of the aforementioned soft skills, data shows that graduates do not sufficiently develop these skills during their education. In Central and South America, engineering students recognize the need to strengthen their oral and written communication, leadership, and financial competencies (Hernández Rangel, Santana, Hernández Vargas, & Mancera, 2017). For all these reasons, it is essential that study plans in the field of engineering in tertiary education firmly reinforce the development of soft skills with the aim of training young people in the competencies demanded by both society and their own field of employment.

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4. TRAIN THE TRAINERS

The development of test benches that help bring university-level education more in line with the competency needs demanded by companies makes it necessary to consider a change in the processes of planning, implementing, and evaluating training programs. The ultimate goal of this reorientation of processes should be that of bringing academia closer to the industry, thereby fostering among recent graduates a greater capacity to adapt to the business context. In turn, this process must also allow for the design of ad hoc training activities that help recycle active professionals through the test benches generated within the framework of the ASCENT project.

This section summarizes the main aspects related to the planning and organization of training activities, including aspects concerning the detection and analysis of training needs, methodological strategies (problem-based learning, case studies, and project-based work), and the evaluation of training programs in order to enhance autonomous and team learning.

Planning and Organizing the Training Activity

Planning training activities means focusing the attention on what the participant in the training program should learn, considering their personal, academic, and professional traits. The work and/or socioeconomic environment in which the competencies developed in the training will be put into practice must also be considered in order for the training processes to be focused on the application of the learned materials and linked to the demands of the world of work.

In the training process, several elements converge at a given time and space. The didactic communication between the teacher and the students can therefore be either strengthened or limited by the level of motivation of the teachers, the characteristics of the classroom, the type of content, the quality of the teaching material, and the characteristics of the participants, among other factors.

A distinction has traditionally been made between the basic elements and those that intervene in training. The basic elements include the teacher, the participants, the subject, and the methodological strategies; the intervening elements are specific to each situation and take into account the characteristics of each person (motivation, attitude, maturity, etc.) or of each learning situation (learning spaces and times, work environment, and available resources).

The interaction that occurs between each of the described elements, as well as the priority that we give to one over the other demarcates four training approaches. An academic-humanistic model (in which the learner must submit to the elements in order to internalize them, giving greater importance to social needs than to their own individual ones); a technological model (focused on knowledge and how it should be used); a humanist model (focused on the particular needs and interests of the learner); or a critical model (focused on how people use knowledge in order to change their current reality) (Gairín & Navío, 2006)

The development of the training activity relies on three key moments:

- The initial stage, which prepares the participants using a motivating activity that generates curiosity and questions regarding the content to be discussed.
- The intermediate stage, which focuses on the learning process and is based on the transmission of information, the search for answers, comparing and contrasting ideas, etc.
- The final stage, which is focused on reviewing and verifying the learning acquired by the participants, as well as providing a preview of what will be worked on in the next sessions.

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In each of these stages, the trainer and the participants take on different roles:

- The trainer can act as a facilitator, strengthening the learning capacity of the participants and helping them to autonomously solve problems that arise. Later on, the trainer can present him or herself as a role model and an observer by modeling the same behavior that he or she intends to develop in the participants, monitoring the learning process, and providing support in solving doubts or problems. Finally, as an evaluator, the trainer offers feedback to the participants about the activities they have performed.
- The participants may first have an active-listening and note-taking role; subsequently, they may take on an active role in implementing what they have learned; and, at the same time and at certain stages, they can act as observers, offering peer feedback on the activities performed.
- The organization of the training process must also take into account the resources and the setting available for carrying out the teaching-learning process, since the arrangement of resources in the classroom space predetermines the type of activities that we wish to perform (Miguel, 2005)

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Detecting Training Needs

Developing training programs that are adapted to the reality of the industry forces us to become familiar with the current reality of the sector, to determine what future scenarios are foreseen for it and, from this information, to design and implement concrete actions in order to achieve the desired situation. The gap between the current reality and the desired one makes it possible to brainstorm the changes that would ideally be made in and employment settings—specifically those linked to promoting training and outreach actions that facilitate progress towards the desired scenario.

Identifying the deficiencies of training programs at the institutional level and within the local context involves compiling and analyzing existing training proposals and organizing the information according to the type of needs taken into account. The analysis must reckon with not only the broad content of the training programs (objectives, methodology, resources, and the evaluation system), but also with the frame of reference and the type of needs that must be identified (see Figure 10).

EXISTING SITUATION	DEFICIENCIES (Concerning...)	DESIRED SITUATION
How do trainers carry out their activities in relation to the established standards?	*Trainers' knowledge and mastery of standards (number of regulations)*	How should trainers develop their activities in relation to the established standards?
What problems arise in the teaching of standards?	*The demands of trainers (number of demands expressed)*	How should they deal with the problems of teaching standards?
What is it? how does the professional behave in practice?	*Carrying out the professional activity (number of implicit activities)*	How should they behave as professionals?
What is it? How does the professional behave with respect to what professionals from other external contexts do and who they are?	*Imitable situations (number of comparative situations)*	How should professionals act in order to achieve the same level of the best professionals from other contexts?

Figure 10: Operational Scheme for Taking Action

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The steps to carry out for good detection of training needs include:

- Outlining, in a functional way and according to the results of the analysis of the environment, which competencies of the different existing or expected professional profiles will be covered.
- Establishing a map of the existing training offerings at the institutional level in relation to the needs of the automotive sector.
- Analyzing the gap between the training offerings and the training needs of the existing human resources.
- Determining the training spaces and settings in which to implement the response to the detected training needs (existing undergraduate degrees, master's degrees, specific training course, workshops, etc.)

Methodological Strategies

An action-oriented approach and the professional context typical of competency-based training requires active methods, since it is through taking action that one learns to act. We therefore examine problem-based learning, case studies, and project-based learning. These implement an interdisciplinary approach (they require adeptness in more than one area of knowledge to guarantee good outcomes), linking learning to practice (by focusing on professional issues), and integration of theory and practice (practical problems guide the choice of pertinent theories).

These proposals should be combined with other work procedures that, even though they are not considered methods, make sense in conjunction with or as complements to the aforementioned methodological strategies: among others, group and cooperative teamwork based on specific needs and in flexible grouping modalities. In fact, the work methods explained here involve these proposals if we consider that they often require collaboration among peers, between the teacher and the student, or other relationship formulas.

Problem-Based Learning

The problem-solving strategy involves giving a coherent explanation to a set of related data within a given context; it is different from performing an "exercise." There is usually only one answer to the problem, but the strategies used to get to the resolution can be quite diverse, since they are determined by maturity factors or others.

The **problem-solving guidelines**, although diverse, coincide on the following points:

1. UNDERSTANDING THE PROBLEM: What is the data (what we know)? What are the questions (what we are looking for)? What relationship exists between these two aspects?
2. DRAWING UP A PLAN TO SOLVE IT: Is this problem similar to others we are already familiar with? Can it be framed in another way? Would there be other simpler, but similar problems? What could lead us to the final outcome? What pieces of information fit and what is superfluous?
3. PUTTING THE PLAN INTO PRACTICE: Are the steps correct? Are the deductions made defensible? Are alternatives possible? Is the plan carried out in an orderly fashion?
4. CHECK THE RESULTS: Is the solution logical? Is it useful for other cases? Are there other solutions? Are the solution trajectories the most appropriate ones? Does the solution remain strong in symmetry tests, dimensional analyses, or changes of scale?

Some relevant **teaching strategies** are:

- Solving problems from lowest to highest level of complexity; using simpler formulations or equivalent or partially modified problems; breaking the situation down into smaller problems; simplifying the data, etc.
- Using inductive, logical, or related processes (reductio ad absurdum), analyzing realities, experimenting with alternatives, solving analogous problems, making schemes, establishing conjectures, etc.
- Establishing problem-solving guidelines through diagrams, established processes, etc. The V technique proposed by Bob Gowin (1989) can be a suitable teaching tool in this regard to support the conceptual plot that is constructed during the problem-solving process (Figure 12).

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- Asking students to formulate new problems related to the problem that has already been solved or to formulate data-based problems.

The Case Study

The case study "is an examination of an instance in action" (Macdonald & Walker, 1975, pág. 2). The examination refers to the analysis of something in a systematic and detailed way in order to understand it; here an instance refers to the behavior of a person, an organization, a program, a particular situation, analyzed within its context; and action denotes the dynamic meaning of the case study itself.
Its use in training processes can be carried out using different models depending on the intended methodological purposes (Martínez & Musitu, 1995):

- Model focused on the analysis of cases presented and resolved by specialists. Its purpose is for students to understand, analyze, and assess the intervention processes and procedures presented, offering up alternative solutions if they can find them.
- Model focused on the application of principles and regulations. In this approach, the students are active in the selection and application of the most appropriate procedures for each situation. Deductive thinking and application skills are therefore developed.
- Model focused on training in resolution of situations. With theoretical framework and practical prescriptions as its basis, this model is about resolving situations according to the uniqueness and complexity of specific contexts. The most important part of this approach is the process, and less so the correct solution (which can usually vary).

Some general didactic guidelines that could be considered include:

- The best cases studies are those that present real situations (with detailed descriptions of data, processes, the implicated parties, thoughts, and actions), are clear and understandable, and can be characterized as plausible, provocative, concise, familiar, and not ambiguous.
- In order for them to serve as training objectives, when writing case studies, it is crucial to clarify, in the wording and terminology used, the objectives and the information that is required and desired; it's also essential to bring out some appeal in the situation.
- The proposal must be validated with an experimental application that reveals: if important information has been left out, if unnecessary data that distorts the discussion has been included, if the information is redundant, if there are errors or limitations in the description, what the degree of difficulty is, what the intended system of resolution is, and more.
- Teacher and student intervention in case studies may vary depending on the nature and content of the studies (López, 1997). A well-planned and developed case study promotes the following in students: cognitive skills (critical thinking, analysis, synthesis, and evaluation of situations); social skills (teamwork, active communication); personality skills (autonomy, identifying and solving problems, creative development, decision-making, motivation, easing insecurities, etc.), among others.

The Case Study

TheProjects can be used on specific occasions or as the centerpiece of the training activity, even if they are intertwined with other types of activities, including: triggering experiences, which are broadly based activities that can be a bit informal and which are intended to familiarize students with situations related to the subject material or the degree; short assignments (more time-limited and structured tasks, although students may also participate in establishing the limits and structure); and self-correcting worksheets (which strive to facilitate students' self-monitoring of their learning progress), among others.

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Although each type of project has its own particular stages in its planning and development, we can identify some generic phases that are usually present:

- The preparation phase consists of the first conversations and exchanges that attempt to delineate the topic to be addressed and its development. The realization of this phase consists of the formalization of the project with explicit purposes, the activities to be carried out, those involved, the distribution of responsibilities, timing, etc.
- The development phase involves the effective implementation of the project and requires resources (spaces, times, material, etc.) and orientating the teaching staff. It seems that, in this phase, it is important to foster contact between different groups of students, in an attempt to thereby generate synergies and debates among the different participants, as well as to establish mechanisms for following up on and monitoring processes.
- We believe the communication phase, which includes handing the project in to the teacher, to be important; it encompasses communication among the students in each group (with the goal of learning from others) and/or external communication (aimed at motivating students and disseminating their work).

The work of the teaching staff in the promotion and development of projects on the one hand must clarify the meaning and content of the projects, and on the other hand must guarantee with their actions that they meet the established objectives. Project-based work values the knowledge and experiences of students, opening new horizons and setting new demands for them. In addition to developing less common modes of learning (locating information sources, drawing up plans, monitoring progress, collaborative work, etc.), it also encourages positive attitudes and values, such as: responsibility, reflexivity, a spirit of critical thinking, and rigor at work.

Evaluating the Training

In the field of training, the evaluation must involve assessing the different elements and variables that intervene in the process of carrying out any training activity and that, in one way or another, may be acting as conditioning factors for the outcomes obtained.

The evaluation cannot and should not consist of a specific activity but is instead a complex and dynamic process that must be carried out taking into account the context in which it is applied and the technical measures that it requires. Likewise, it must contribute to the generation of knowledge that facilitates the understanding and analysis of that which is being evaluated; thus making way for an approach that leads to the value judgments and subsequent decision-making that are necessary for improving and promoting change for success (Barrera-Corominas, 2018).

According to Gairín (1996) with this perspective in mind, the evaluation turns into an intervention process characterized by:

- **Systematization:** It presupposes a planned action that includes, at minimum, a prior delimitation of the purpose and the methodology to be used.
- **Contextualization and implicit dimensions:** The analysis must include elements that surround the process being evaluated, as well as implicit and internal aspects and side effects.
- **Globality:** It must include different spheres in addition to the student body, such as the educational center, the programs, the teaching staff, etc.
- **Rigor and utility:** There must be rigor not only in the design and planning of the evaluation activities, but also in the aspiration of objectivity, which requires special attention to the technical aspects.
- **Reflective attitude:** It requires a positive attitude towards reflection; an inquisitive spirit that seeks to maintain the quality of the actions, even prioritizing it over the technical configuration.
- **Ongoing process:** Proposed as a process of continuous support for educational planning and intervention.
- **Intersubjectivity:** Collective intersubjectivity is understood as a way of counteracting the effects that subjectivity may have on the evaluation results, given the relative nature of the selection and application of measurement instruments and the importance granted to certain evaluation criteria.
- **Participation:** In terms of evaluation, participation has an ideological character; framed in a democratic context and guaranteeing the necessary intersubjectivity, participation must accompany any evaluation process.
- **Ethical and evaluative process:** This includes the consideration of the existing limits on access, treatment and diffusion of information, and the results of the evaluation.
- **Evaluation as a proposal for change:** Evaluation reveals the mechanisms of power and the existing dominant values within a context. It reflects what the institution considers to be important and can therefore divert conflict.

In this section we will analyze, from previous reviews ((Gairín, 2010); (Barrera-Corominas, 2018)), the most important aspects to take into account in the evaluation of training programs.

The Evaluation of Training Programs

The holistic model (Pineda, 2000) is based on the model developed by Kirkpatrick (1976), and aims to be systematic, rigorous, and consistent, overcoming the limitations of preexisting evaluation practices and offering a proposal for global and systematic evaluation. The model implements five basic questions from which the evaluation process is defined (see Figure 5).

Each one of the questions groups a set of elements to be taken into consideration in the process of designing the evaluation. Below, we pose the questions and present the intended answers:

- For whom do I evaluate? The purpose of the evaluation, as well as its focus and design, will change depending on the recipient of the evaluation. The recipient can be the university itself, a particular department, the business sector that has financed the program, the trainer, or even the participants themselves.
- What do I evaluate? This depends on the objectives of the evaluation. The holistic model identifies six levels of objectives: participant satisfaction, level of learning acquired, pedagogical coherence of the training action, transfer of learning to the context of application, impact on the context, and return on investment made.
- Who evaluates? The evaluation agents must be known; they are the ones who will make judgments about the training in which they have participated, whether more or less directly. A myriad of different actors can be evaluators, from the trainer, to the managers of the institution, to the participants themselves, to external agents.

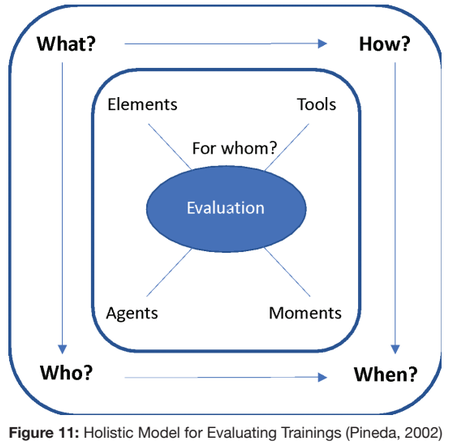

Figure 11: Holistic Model for Evaluating Trainings (Pineda, 2002)

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- When do I evaluate? This question is based on the four basic times at which the evaluation may be conducted, which in turn correspond to the evaluation modalities:
  - Initial or diagnostic evaluation. Conducted before the training begins, it reveals the students' situations prior to the activity.
  - Procedural or formative evaluation. During the training, this type of evaluation helps bring to light how the participants' learning is progressing and how to introduce changes in order to resolves gaps in the process.
  - Final or summative evaluation. At the end of the training, this is used to check the competency level acquired by the participants.
  - Deferred or transfer and impact evaluation. Conducted after a period of time after the training has ended has passed, this evaluation demonstrates the acquired competencies that have endured and that have been transferred to the job.
- How do I evaluate? This section indicates which methodology and instrumentation will be used to obtain the necessary information to measure and quantify the level of learning and to expose the weak points of the training process.

All evaluations must bear in mind the set of different types of information related to the aspects that intervene in the design and development of the training activity: the detected needs, the training objectives, the contents studied, the characteristics of the participants and the trainers, the didactic resources, the space in which the training takes place, and the connection of the training activity with other activities that take place in the same organization—all this must be taken into account without disregarding the evaluation process itself.

Kirkpatrick's classic model (2004) helps us identify different levels of evaluation:

Level 1: Evaluation of Satisfaction:
The objective is to understand the perceptions of the participants, such as whether they liked the training program, whether the material used was relevant, whether the method was appropriate, etc. The instruments used in this phase of the evaluation are usually questionnaires that are easy to carry out and analyze and that serve to improve the training activity itself. This phase of the evaluation serves to predict the extent to which learning has occurred among the participants, since a positive assessment of the training activity is favorably related to the learning achieved, while a negative assessment of the training proposal is usually linked to a lower level of acquired knowledge.

Level 2: Learning Achieved
The objective is to evaluate the differences between participants' knowledge prior to and after the training activity. In order to do so, a pretraining evaluation and post-training evaluation must be carried out in order to clearly identify the differences. The instruments in this phase of the evaluation can be diverse; in addition to pretests and post-tests, evaluators can also carry out simulation tests, observations during the practical sessions, or interviews with different stakeholders.

Level 3: Transfer of Training
At this level, changes in the behavior of the participants in the training activities and as a consequence of the training activity are evaluated. The most important aspect of this phase is to assess whether the new skills, knowledge, and attitudes that have been acquired during the training are used by the participants in the industrial context. If it is not possible to assess this aspect in the company itself, simulated scenarios can be generated—with the collaboration of the company—that facilitate the assessment of the applicability, or lack thereof, of the new competencies acquired.

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Level 4: Training Impact
This stage is about evaluating how the training has contributed to generating change in the reality of the industry or the specific organization. For example, measuring whether the training has been able to obtain more investment, improve employability, improve innovation processes, reduce adaptation time on the job, etc. This is the final proof that the training has been successful and is the type of evaluation most valued by organization managers, who believe that this level is the one that allows them to really assess the training outcomes; it may, however, be difficult to measure this level if the training has influenced some of these outcomes. It is of utmost importance to determine, from the very beginning, the indicators that will allow evaluators to accurately measure the training impact once the activity has ended. If this previous step is not carried out (determination of the factors that may change as a consequence of the training), it will later be impossible to determine the training's impact on the outcomes.

Conclusions

If we consider learning to be a continuous process of acquiring knowledge and constructing meaning, those responsible for developing training activities linked to test benches must have the competencies to identify the training needs of the productive sector in which they are working, to design training activities that respond to these needs based on the entry profile of their students, and at the same time to evaluate the level of learning acquired. It is also essential to have the necessary capacity for dialogue with the productive sector to jointly identify new needs, as well as to recruit students who take advantage of the new training programs to improve their competency profiles and thus contribute to an improvement in their country's labor market.
The design of the training activity must always stem from the desired learning outcomes and from the subsequent analysis of the most appropriate resources and strategies for achieving these outcomes. Therefore, the trainer must be constantly reflecting on his or her educational practices in order to plan and adjust the training process according to the characteristics of the participants and the contextual variables of the setting.

5. UNIVERSITY-BUSINESS COOPERATION

Here, the university and business cooperation in general as well as the status quo and current developments in Brazil, Mexico and Argentina regarding that matter are taken into consideration. However, to start with, we will take a general look at success factors of university-business cooperation and possible differences in industry, country and universities, which influence the outcome of such a cooperation. Bodas Freitags et al. (2013) point out that depending on if the industry is either mature or emerging, a cooperation can be more or less intensive and the initiative to start one can always come from another participant. Further differences between mature or emerging industries can be seen in the role of networking, extent of market turbulences and the competitions rate in technology and product development in a country. (DAAD, 2017)

Further distinctive features such as the number and type of organizations involved, the financing, the cooperation area, the geographical impact and target area need to be analyzed (Viktorova, 2017).

Collaborations can be the result of a strategic partnership or a single new product development project and therefore consist of a one-to-one university-business cooperation or involve more universities and industry partners, even the state as a public financier can be a part of it. The research itself can deal with basic research or specific contract research.

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The goal of a cooperation can have several benefits, such as:

- an increase in the business competitiveness;
- growth of the relevance and innovations of scientific research in universities;
- joint educational programs;
- an increase in labor productivity in business;
- creation of new jobs and PHD-positions;
- stimulation of economic growth;
- access to (worldwide) researcher network and knowledge;
- training of students on real business problems;
- strengthening of social cohesion. (Viktorova, 2017), (Zashchitina, Bondarev, Pavlov, & Pavlov, 2017), (DAAD, 2017)

To sum up, the formation of university and business cooperation shapes the development of innovations, economic growths, resource and educational potential for both business communities and higher education establishments and therefore is often of high interest for the state. (Baskakova, Belash, Ryzhov, Ryaskov, & Shestopalov, 2016) Taking a strategic view on this, it can help to pursue the economic interests of a country by strengthening its authoritative, geopolitical and economic positions in the world; especially by training the intellectual elites, national culture, scientific achievements, as well as by promoting the development of the entire national education system. (Zashchitina, Bondarev, Pavlov, & Pavlov, 2017) The primary task of the state therefore is to establish a framework of funding, tax benefits and a diverse education infrastructure to support sustainable university and business cooperation.

At the next step, the current status quo of the educational structure as well as the university and business cooperation in Argentina, Brazil and Mexico are taken into consideration. Every country will be viewed individually, trying to summarize this chapter with a common outlook. Data will mostly be collected from secondary sources such as scientific publications, country analysis, policy reports and statistics.

BRAZIL

Brazil is the fifth largest country in the world with a land area of around 8.5 million square kilometers. The population of Brazil is estimated to be around 210 million people in 2019, with a high percentage of young people (more than 40% under 24 years). (Statista, s.f.)

In an analysis conducted by the German Academic Exchange Service (DAAD) in 2017, the following data regarding the higher education and research structure was generated:

- There are 2364 universities in Brazil, of which 295 are public (107 federal, 120 state and 68 municipal universities). 2069 higher education institutions are private. This means that 87.5% of the universities are profit-oriented or non-profit private educational institutions (Data from 2015)
- Didactic autonomy for universities by the Brazilian Constitution.
- Public universities are funded either by the federal government, a state or a community.
- National Ministry of Education (MEC) evaluates and controls the quality of the educational offers. (Faculdades, universities and Centros Universitários can set up courses independently)

Money generated from research and cooperation between university and industry exists but has been rather reluctant in the past.

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For instance, 5.1% of the research budget of the Universidad de São Paulo (USP) is said to have been privately funded, and Times Higher Education ranked the Catholic University of Rio de Janeiro (PUC Rio) number 8 among the universities that receive the most money from the economic system per professor. Bodas Freitas et all. explain that in the past a stagnation in Brazils export structure was caused by poor university and industry cooperation, also leading to lower patent registrations and scientific publications. Cooperation mainly took place in R&D (Research & Development) and product testing and for the coal, oil, metals, electronic equipment, instrument, machinery, chemical, pharmaceutical and printing industries. In the 21st century the public support for university and industry cooperation in the high-technology sector was further encouraged, because its focus lies on the company's value chain. (DAAD, 2017)

Overall, however, the state is the most important source of funding for research and development in Brazil. Only 36.4% of the expenditure in this area was made by commercial enterprises (compared to 65.8% in Germany). Brazil sees a great challenge in promoting technology and development and therefore wants to bring business and research closer together. The laws Innovation Act from 2004 and "Lei do Bem" from 2005, provide support measures for productive research and innovation and gives legal persons, who are active in the area of research and development of innovative technologies, tax benefits. (DAAD, 2017)

MEXICO

Mexico is the 14th largest country by area (Statista, s.f.) and the most populous Spanish speaking nation in the world. (Worldometer, 2020) Mexico is a developing country, ranking 76th on the Human Development Index, (UNPD, 2019) but is considered a newly industrialized state by several analysts. It has the world's 15th largest economy by nominal gross domestic product (Statisticstimes, s.f.) and the 11th largest by purchasing power parity (Globalfirepower, 2020), with the United States being its largest economic partner. (United States Census Bureau, 2020)

Mexican higher education has experienced an explosive development due to the country's demographic development. From 1940 to 2017, the population grew from 19.6 million to just under 129 million. Today about 23 million Mexicans are between 14 and 24 years old. With this rapid population growth, a corresponding range of academic training and professional qualifications had to be built up. Mexico now has over 4,200 universities of various types. (DAAD, s.f.)

The most powerful research institutions are primarily the autonomous universities of the individual states and the Institutos Tecnológicos, where intensive basic research or applied research is carried out. The almost 30 federal research institutions (Centros de Investigación), which are sponsored by the Consejo Nacional de Ciencia y Tecnología (CONACyT), have a special position. Due to their research capacity in the field of basic research and applied research, they are very interesting cooperation partners for scientists from abroad. (DAAD, s.f.)

The interaction between industrial firms and academia has long been extremely weak in Mexico in spite of the manufacturing revival sparked by the North American Free Trade Agreement (NAFTA) since 1994. This situation is paradoxical given the persistent efforts from the Mexican State to encourage university-industry linkages. Over the years, this uncoupling has produced two effects: on the one hand, university research has followed its own agenda, mainly driven by scientists' interests based on their career tracks, and on the other hand, most firms lack research and development capabilities because they have preferred to seek abroad for technological advice.

Analyses carried out on a survey of 39,336 enterprises, which were collected by the National Institute of Statistics and Geography (INEGI), showed differences between smaller and bigger companies. The outcome was that larger firms are more capable of absorbing the knowledge generated by universities thanks to their higher level of human capital, whereas smaller firms face harder challenges to harness academic knowledge because of their lack of

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qualified engineers and technicians that can help them to address their innovative endeavors. The implication of these results for public policy is that collaboration between industry and universities in Mexico can be encouraged by selectively supporting the hiring of relatively low-trained engineering graduates and technicians, whereas universities should also be able to promote key programming skills, technical training, infrastructure skills and even sales training and negotiation skills, much earlier in the academic process (Merritt, 2015).

ARGENTINA

Argentina is a developing country and ranks 48th on the Human Development Index, the second highest in Latin America after Chile (UNPD, 2019). It is a regional power in Latin America and retains its historic status as a middle power in international affairs. Argentina maintains the second largest economy in South America, the third-largest in Latin America, (Statisticstimes, s.f.) and is a member of G-15 and G-20.

After the 2001 state bankruptcy, the debt cut led to a recovery in the economy from 2003, which enabled a drastic reduction in the remaining debt and led to high growth rates of 8 to 9% from 2004 onwards. The last two governments had made education and science the focus of their work, by spending from 4 to up to 6% of their gross domestic product on the education sector. For the reasons mentioned above, it could be assumed until now that Argentina will remain interesting or become increasingly interesting not only as a partner in business and culture, but especially also in the field of higher education and research. Since the inauguration of Macri in December 2015 this development has stood again in question: Education and science are definitely not among the priorities of the current administration and the weakening economy is exacerbating the conditions for the education sector. Sticking to the Minister of Science of the previous government has so far signaled the will to guarantee continuity in the areas of education, science and research. (DAAD, s.f.)

In recent years, S&T (Science & Technology) policies in Argentina put a strong emphasis on creating knowledge networks. Several support PRO (Public-Research-Organizations) industry schemes have been developed under the premise that these are key instruments for strengthening innovation, both by increasing knowledge exchange among different actors in the NIS (National Innovation System) and by stimulating further R&D investments in the private sector. More interaction can lead to more and better research projects while enhancing the use of scientific knowledge by the private sector. However, private investments in innovation have remained very low by international standards. Furthermore, the NIS is fairly poorly articulated; there are wide geographical asymmetries and although PROs-industry interactions have increased, they are still fairly local, short-term and rare for the vast proportion of private actors. (Arza & Carattoli, 2016) The current economic crisis in Argentina, along with a struggling currency, also makes it very difficult to foster (international) research projects. (Gillespie, 2019)

Summary

What can be noted is that universities all over the world try to be more entrepreneurial, motivating students to work closely with industry or even to start their own businesses. The idea of university and business cooperation should be beneficial to national economic growth and foster the technical capabilities of a country. On the one hand, the state itself plays a major role by determining the success factor of setting up the right national institutional environment for innovation, cooperation and guaranteeing stable economic conditions. Universities on the other hand need to establish a structure with Technology Transfer Centers, advisory on the possibility of spin-offs and founding possibilities to support university and business cooperation. (DAAD, 2017)

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2 THE ASCENT PROJECT

1. OVERVIEW, OBJECTIVES AND MAIN TARGET GROUPS OF THE ASCENT PROJECT

Overview

The ASCENT project refers to the realization of a group of activities to contribute to the improvement of automotive engineering capabilities in Argentina, Brazil and Mexico. All ASCENT partners are globally seen very strong and important markets of the automotive industry. Their participation and development in this sector does therefore influence regional economic stability. ASCENT project was financed by the European Union. Specifics data are the following:

Formal Name: ASCENT - COMPETENCE CENTERS FOR AUTOMOTIVE ENGINEERING TO INCREASE THE POSITIVE IMPACT ON REGIONAL ECONOMIC DEVELOPMENT IN ARGENTINA, BRAZIL AND MEXICO
Program.Erasmus + Capacity Building in Higher Education Joint Project
Coordinating Institution: FH JOANNEUM Gesellschaft mbH (Austria**)**
Project Duration: 15.10.2017-14.10.2020 - 36 months (extended 6 months due pandemics)
Target countries: Argentina, Brazil and Mexico

Members:

1. FH JOANNEUM (FHJ). Austria
2. Hochschule Dusseldorf (HSD). Germany
3. Universitat Autonoma de Barcelona (UAB). Spain
4. Universidad Nacional del Sur (UNS). Argentina
5. Universidad Nacional de La Plata (UNLP). Argentina
6. Universidade de Sao Paulo (USP). Brazil
7. Universidade Federal do Rio de Janeiro (UFRJ). Brazil
8. Instituto Tecnologico y de Estudios Superiores de Monterrey (ITESM). México
9. Universidad Iberoamericana A.C. (IBERO). México
10. AVL List GmbH (AVL). Austria

Objectives

- To spread knowledge during the coaching sessions within the competence centres
- To increase the number of projects in AE
- To enlarge university-business cooperation
- To contribute to increase employability of engineering graduates

Main Target Groups of the ASCENT Project

The main target groups within the ASCENT project are as following:

- HEIs leaders and managers of the areas of automotive engineering and sales management for engineers
- Academic staff focusing automotive engineering and sales management for engineers
- Students and student associations studying automotive or mechanical degree programs who aiming to improve the automotive industry in the participating countries
- Companies operating in the automotive industry
- Automotive associations and political partners

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2. MAIN OUTPUTS OF THE ASCENT PROJECT

The three main outputs of the ASCENT project are Capacity Building, Competence Centers and the Network, which are described below.

Capacity Building

ASCENT builds up capacity on automotive engineering sales management strategies and soft skills for engineers at higher education institutions in Argentina, Brazil and Mexico through international expert training to create awareness and spread the idea of these topics on academic but also industry level to ensure future growth of university-business cooperation.

Competence Centres

ASCENT implements six competence centres focusing on automotive engineering, sales management strategies and soft skills for engineers at partner higher education institutions to establish a knowledge hub for the core topics. The six competence centers are described in next section.

Network

ASCENT builds up a global network and a knowledge exchange platform for international exchange on automotive engineering and sales management for engineers. ASCENT NETWORK is described in next section.

Other outputs

Among the additional results of the project were the following:

- Internal workshops: trainings for university professors.
- Student workshops (previously mobilities): trainings for students from the six Latin American universities.
- Conferences: two international conferences, one in Sao Paulo with physical assistance and the other in Mexico City with remote assistance.
- Visits: to universities and companies with relevant equipment to know

3. SIX COMPETENCE CENTERS OF THE ASCENT PROJECT

During the execution of the ASCENT project, six competence centers were designed in the Latin American universities participating in the consortium. These universities were closed due to the COVID-19 pandemic, so these centers could serve users mostly online only. Below are the six designed centers.

Universidade Federal Do Rio de Janeiro

The ASCENT competence center at the Polytechnic School of the Federal University of Rio de Janeiro is part of the laboratory infrastructure of the Mechanical Engineering Department and was inaugurated on 30th of August 2019.

The center is located at installations used by the student competition teams, FORMULA-SAE, FORMULA-SAE electric and SAE-MiniBaja on the Technology Center. One of the main strengths of the Competence Center is to rely on the long-lasting experience and infrastructure of the university.

Another very important asset is the number of professors and researchers, as well as graduate and undergraduate students, in different areas that can join development and consultancy projects.

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Concerning the uniqueness of this competence center the availability of multi-channel data acquisition systems and skilled personal to operate them and perform dynamic data analysis in different areas of the automotive industry are just two of many remarkable characteristics of the center in view of the Brazilian market. The mission is to bring state of the art and state of the technique subjects to a strong formation of engineers in different areas related to the mobility! We desire to establish the Federal University of Rio de Janeiro as a reference school for engineers regarding cooperation with the automotive and mobility industry.

Objectives:

- Execute trainings and projects together with the industry
- Development of technology in NVH
- Development of electrification strategies for vehicles and infra-structure
- Study autonomous and semi-autonomous driving issues

Universidade de Sao Paulo

The Automotive Engineering Center at the mechanical engineering department will run the competence Center. The location will be at the building where the Formula Student is currently hosted, inside the mechanical engineering building at the University Campus. This building is under the responsibility of the faculty involved with the project and has all condition to support the new equipment and the people that will make use of them.

The main costumers are the car industries in São Paulo and the suppliers of auto parts and systems, São Paulo hosts the HQ of companies such as VW, General Motors, Ford and PSA. Other companies are located at about one hour from town, such as Toyota, Honda and Hyundai. From the last five years racing car teams have contacted the university to have some engineering development and have collaborated with the students in teams such as the Formula Student and SAE Baja. The Center will also focus on this growing demand.

The mission is to provide technical background to graduates and engineers working in areas related to mobility. We desire to link the University of Sao Paulo with the automotive industry and its suppliers most of them located at the same geographic area.

Objectives:

- Cooperation with the industry
- Work in experimental methods to validate simulations
- Train and evaluate personnel that will work at the automotive industry and its suppliers
- Develop new bussinesses in mobility

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Universidad Nacional del Sur (UNS)

The Competence Center is located in the Universidad Nacional del Sur, Bahía Blanca, Argentina. The laboratory is equipped with specific technology used in modern vehicles for control purposes: ECU's, actuators and sensors, and specific software for measurement, calibration and control. In addition, experimental setups including specific parts of vehicles have been installed for academic purposes, to train professionals in the design, setup, calibration and operation of mechatronic systems for automotive technology. The Competence Center takes advantage of existing instruments, devices, tools and components, which already exist in the abovementioned facilities in order to increase the range of offered services.

Universidad Nacional de la Plata (UNLP)

The ASCENT IAME Center of Competences belongs to the Mechanics Department of the Faculty of Engineering of the National University of La Plata (UNLP). The UNLP has a president and two vice-presidents, one institutional and the other academic. The Faculty of Engineering has a dean, a vice-dean and an academic secretary. The Mechanics Department has an executive director, while the mechanical engineering career has a career director. The UIDET IAME depends on the Mechanics Department and has a coordinator. The equipment purchased with the ASCENT resources will allow to wider the range of measurements to be offered by the Center of competences. It includes: particular determinations like compression ratio of engines in direct way; breath capacity or air flow of engines; weight of a racing car through the individual weight in each wheel; hardness of the rubber of the tires; camber angle and caster angle; engine valves springs rate; ignition angle adjustment of engines.

Instituto Tecnológico y de Estudios Superiores de Monterrey (Saltillo)

The Competence Center for the Automotive Industry is part of the School of Engineering, at Tecnológico de Monterrey Campus Saltillo, located in the Northeast Region of Mexico. Focused on Industry 4.0, the center aims to foster and enhance the collaboration between the different campuses of the Tecnológico de Monterrey System, and the Automotive Industry Cluster located in Saltillo, México.
The Center offers training for students, faculty, and industry; continuing education service to the local industry; tech transfer activities between industry and academia; Industry 4.0 initiatives; and funding for projects that improve the capabilities of the automotive sector in the region. Initial capacities of the Center include Collaborative Robotics and Vision Systems.

Universidad Iberoamericana (Ciudad de México)

The Centro de Diseño y Prototipado Rápido – CEDPRA (center for design and rapid prototyping) belongs to the Universidad Iberoamericana Ciudad de México, is part of the university´s department of engineering studies for innovation and is run by the mechanical and electrical engineering program.
This competence center is hosted within its center of advanced mechanical/electrical engineering (cima - Centro de Ingeniería Mecánica/Eléctrica Avanzada). It takes advantage of all its infrastructure and human resources (including professors, technicians and students) in order to offer a wide range of prototyping, engineering, testing and training services that can be offered independently or integrated, according to the client´s needs.
Through our participation in the ascent project, already existing facilities, technical needs and human capacity have been upgraded since October 2017 in order to improve cooperation with the regional and international automotive industry.

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4. ASCENT NETWORK

One of the most relevant results of the ASCENT project is the establishment of the ASCENT NETWORK through which the six designed centers as well as the rest of the member members will continue to operate.

Mission of Network

The ASCENT Network aims to become a strategic partner of the automotive industry in order to be able to fulfill market needs by equipping future engineers with the right skills and competences, and supporting their development. All partners and network members will also benefit from increasing international collaboration. An impact on all other target groups such as associations related to the automotive industry and/or universities and students will be reached through the network activities.

Vision of the ASCENT Network

The vision of the ASCENT Network is to become a sustainable reference for education and training to overcome challenges of the automotive industry in the Latin American Region through collaborating with the industry.

Objectives of the ASCENT Network

1. Exchange of knowledge: Establish international exchange of knowledge on automotive engineering and sales management
2 Enhance collaboration: Enhance collaboration between companies and universities in the field of mechanical and automotive engineering.
3. Promote the centers: Promote the competence centers that have been established at the partner countries higher education institutions
4. Creation of regional boards: Foster the creation of a regional board of policy makers, educators and employers to annually evaluate the status, threats and opportunities for the industry.
5. Develop and offer services: Adapt, develop and offer services in form of workshops (previously called counselling sessions) to companies and other external stakeholders.
6. Develop a joint publication: Develop a joint publication, as well as offer documentation and material to disseminate and communicate findings and news within the network of experts.
7. Bring the industry closer: Enhance the possibility of bringing industry and HEIs closer together. Increase university-business cooperation through the knowledge-transfer platform.
8. Be a contact for the industry: Be a constant contact for the industry, thereby increasing collaboration and facilitating easy and regular communication of needs.

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5. RELEVANCE OF THE ASCENT PROJECT

This section presents the relevance of the ASCENT Project for each of the three Latin American countries as of today. Certainly, over time and as the operation of the competence centers progresses, new ways will be identified to increase the relevance of the project for each country.

BRAZIL

For Brazil's case, the ASCENT Competence Centers will provide a competitive edge in terms of collaboration with industry in the two main initiatives that exist in Brazil and other areas such as personnel training.

The ASCENT project's impact has to be evaluated considering the size of the Brazilian automotive market and the amount of investment that the automotive industry does in Brazil. According to the National Association of Automakers (ANFAVEA), Brazil can produce 2.8 million vehicles per year (this number excludes two-wheelers) (ANFAVEA, 2020). Although Brazil's economic downturns are known to be lasting since 2014, the country still sees news of investment from companies and the government. For instance, Bosch transferred diesel parts manufacturing from the USA to Brazil (Silva, 2021), and General Motors has announced that will invest R$10 Billion in its Brazilian operation (Elias, 2021). The automotive sector is one of Brazil's largest employers and has approximately 8700 engineers currently employed (Ribeiro de Castro, Chiari Barros, & Hupsel Vaz, 2013). Taken as a whole, the automotive sector was responsible for 5% of Brazilian GDP (Daudt & Wilcox, 2018).

With the context and comparative size, we must understand ASCENT as an opportunity for institutions from Argentina, Brazil, and Mexico to foster ties and collaboration and work-out ways to contribute locally to better collaborate with the local industries.

Another outcome of ASCENT is to equip the institutions with the competence center so that the institutions may become more competitive to participate in local initiatives of academia-industry collaboration. In the particular case of Brazil, two initiatives must be mentioned. One is the program ROTA 2030, and the other one is EMBRAPII.

ROTA2030

Rota 2030 is a program established by the national government in 2018 with the following directives:

- Establish mandatory requirements for the sale of vehicles in Brazil;
- Increase energy efficiency, structural performance, and the availability of assistive technologies;
- Increase investments in R&D in the country;
- Stimulate the production of new technologies and innovations;
- Automate the manufacturing process and increase productivity;
- Promote the use of biofuels and alternative forms of propulsion and enhance the Brazilian energy matrix;
- Guarantee of technical training and professional qualification in the mobility and logistics sector;
- Guarantee of expansion or maintenance of employment in the mobility and logistics sector.
- The initiative compensates investment in R&D by the automotive industry with fiscal benefits, i.e., tax reduction. There are three main lines of actions:
- Basic or fundamental research: Experimental or theoretical research developed mainly to acquire knowledge of the automotive industry's fundamental sciences.
- Applied research: Innovative development mostly to solve a specific problem or practical development.
- Experimental development: Application of current technology to solve problems in different areas. (manufacturing, new processes, and new products). Improvements in processes and systems already in use are another possible line of development.

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EMBRAPII

EMBRAPII is an acronym for BRAZILIAN COMPANY FOR RESEARCH AND INDUSTRIAL INNOVATION (EMPRESA BRASILEIRA DE PESQUISA E INOVAÇÃO INDUSTRIAL), and the national government created it in 2013 to foster research and development in the Brazilian industry. It supports academia, research institutes, and private companies in the development of new industrial technology. It funds projects to reduce financial risks of more significant investments in new products and technologies until they can be turned into new products capable of generating revenue.

For the academic institution, EMBRAPII works with creating "Units" in which groups of researchers can support companies to develop new technology for a specific line of products or technologies.
In March 2021, USP was awarded the creation of an EMBRAPII Unit dedicated to automotive powertrain R&D. The objective of this unit is to support companies in the development of technological projects with several aspects related to the automotive powertrain (Alternative fuels, Tribology, Electrification of vehicle, powertrain automation). The ASCENT Competence Center at USP was included as one of the laboratories to participate in this unit.

UFRJ has a long history of cooperation with the oil & gas industry for the research center from PETROBRAS is located inside the university campus. Therefore, an EMBRAPII unit related to oil & gas is already operating for 5 years. Currently UFRJ is in a bid to build a second EMBRAPII unit to work together with the automotive industry, using funds from ROTA2030 program. The ASCENT CC is an important part of this initiative.
Since EMBRAPII funds up to 1/3 of the projects' investment, it will help considerably on the sustainability and maintenance of the laboratory for at least five years. The other 2/3 are split between the company that hires EMBRAPII as a development partner and the research institution. The investment from the university is mostly in person-hours and equipment-hours made available to each project.
One of the aims of EMBRAPII is to work with new companies that have new products but have difficulties establishing a research and development group, buying research equipment, and hiring more skilled professionals. This kind of resource is available at the universities, but academia is typically focused on more extensive research projects that are generally not available to small to medium-sized companies. From its inception in 2013 to the end of 2020, EMBRAPII had a total of 200 million Euros committed to R&D projects.

Other Initiatives in Research and Education

Both USP and UFRJ are among Brazil's leading academic institutions with a history of research and education activities that can be traced to 150 years. The two universities have graduate programs in engineering that rank among the best in attracting students from both Brazil and neighboring countries. Academic cooperation with outstanding academic institutions in the USA, EUROPE, and ASIA is well established, and the two universities have a crucial role in cooperation with companies such as Petrobras (Oil and Gas) and Embraer (Aeronautics) in research and scientific projects.

Scientific research in Brazil is funded by the national government that acts through the National Research Council (CNPq) – Ministry of Technology and Industry and by the Ministry of Education. There are also research agencies from the federal states, such as FAPESP (São Paulo) and FAPERJ (Rio de Janeiro).

Another form of research is by cooperation with the local industry, typically in projects also supported by the government organisms mentioned before. This kind of research project is mandatory for faculty members of both universities. As part of the daily activities of a faculty member of both USP and UFRJ are the development of research at the Ph.D. level with the publication of research papers in renowned academic journals.

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Engineering Education and training are also part of the activities that the competence centers will impact. Both centers will interact with an average of 100 engineering students per year either in laboratory classes or support engineering students' teams.

An example of support to engineering developed by the students is the Formula SAE and Baja SAE Projects in which the students have to develop, build and test a race car (Formula) and an off-road vehicle (Baja). The two competence centers can train and provide technical support in measuring engineering data in vehicles both onboard and off-board. The students will have access to state-of-the-art equipment and software, similar to what is used in R&D in the industry. This will help them to be familiarized with experimental engineering at a level that is not normally possible in undergraduate school due to time and resource limitations.

ARGENTINA

In order to describe the importance of the project at national level, the consistency with public strategic plans, detected needs from the industry, and opportunities and strategies that the university can capitalize on in this context are analyzed. In this environment of plans, needs and possibilities described below, ASCENT project provides the tools and capacities required to alleviate weaknesses and enhance strengths, based on the activities carried out within the framework of the project, as well as its effects on spillovers from people and organizations involved.

(1) From the state

The national strategic plans for the development of science, technology and innovation in the last decade in Argentina highlight the efforts to promote inclusive development and the generation of value in the country's production. Within the plan entitled Argentina Innovadora 2020, and among the 4 Strategic Socio-Productive Nuclei that are identified within the industrial sector, is that of auto parts. Its objective is to promote innovations in the field of metallurgy and metalworking in general and in aluminum and magnesium in particular, to develop auto parts based on nanocomposite materials of lower weight and better mechanical characteristics. It is indicated that the focus is on the incorporation of new technologies for foundry and material shaping and support is given to the development of nanostructured magnetic materials in electric motors.

The Strategic Socio-Productive Nuclei for auto parts encompasses innovations in parts, not only for automobiles, but also motor vehicles and agricultural machinery. In this sense, the actions are aimed at the technological development necessary to achieve a competitive auto parts industry and in a position to meet the demands of a highly internationalized automotive industry.

In particular, the national government plan established the following topics for the development of projects and/ or interventions: (1) Auto parts: biodegradable compounds; casting of magnesium parts; semi-solid and fast set technologies; new lighter and more resistant nanotechnology materials; composite materials (carbon fibers, ceramics, etc.); and new stamping and painting technologies. Electronics development: safety and comfort. Pilot plants that make it possible to fine-tune the scaling of the different technologies and adjust the basic engineering. (2) Parts for the agricultural sector: development of new manufacturing and riveting processes; processes of forming new composite materials; new anticorrosive paints and coatings; and hard coatings resistant to abrasion. Pilot plants to implement advanced design technologies, virtual simulators, advanced metal parts manufacturing technologies, improvements in the development of ICT components (automation, electronic intelligence), online connection to the web. (3) Engine parts: soft technologies to improve production processes (numerical control software for assemblies' processes for the traceability of parts and pieces), materials with lower weight and greater resistance (flexible resins, coatings).

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(2) From the industry

Based on surveys of entrepreneurs from the private sector and a focus group with automotive specialists, some needs are detected. It is an important step because they could be met from the progress and spill-over effects caused by the project. The main needs that emerged from the survey are discussed below.

On the one hand, the fact that Argentina is not a technologically leading country in this industry. Despite the innovation plans, the auto parts and automotive industry incorporates new advances with a certain time lag, with little local R&D development from the business sphere. Likewise, as mentioned in the preceding chapter, local auto parts companies have insufficient scales and capacities to face the challenge of global platforms, the adoption of Industry 4.0, the use of new materials, developments in on-board electronics, new engines, among others aspects.

On the other hand, the contacted entrepreneurs of the industry require from the universities a greater practical training of their students, who then are hired by the sector as professionals with little experience in the labor and applied field. Local automotive specialists from private sector declare that the demand for highly trained and specialized human resources in the industry will increase, with a very broad and diverse skill set. These skills include up-to-date technical knowledge on digital electronics, power electronics, mechanics, IoT, Industry 4.0, communications, programming, electrical energy storage, energy management systems for electric and hybrid vehicles, power drives for electric motors, and many other areas as well as transversal skills to communicate, manage personnel, know models to assist in decision-making, logistics, quality management, negotiation, language skills, among others.

In relation to the contribution between private and academic sector, all the local industry professionals consulted consider that the current business-university collaboration is poor.

(3) From the university

The university has the opportunity to train students with the skills required by the industry. For this, it must address a strategy to adapt the study plans of the careers according to the detected needs, an update and specialization of involved teachers, and an investment in equipment and laboratories to increase the practical activities that students can develop in the academic field.

The university can facilitate the relationship between students, graduates, and companies. To do this, it can sign collaboration and professional internship agreements to increase cooperation in this relationship and encourage student internships in the potential labor field.

Through its training function in the environment in which it operates, the university can address strategies to attend to the training demands of companies, as well as develop specific postgraduate careers for training in the automotive industry.

Finally, in terms of R&D developments, the university has the human resources, infrastructure, and capacities required to generate new technology that improves the efficiency and competitiveness of the private auto parts producers and automotive sector in Argentina.

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Triangle of relevance

In this triangle of plans, needs and opportunities, the ASCENT project through its member universities promotes the training of human resources specialized in mobility under its different modalities, the transfer of knowledge to the environment and the production of new technologies, considering the contribution to sustainable development, the alignment with the strategic plans of the country and the strengthening of the university-business relationship.

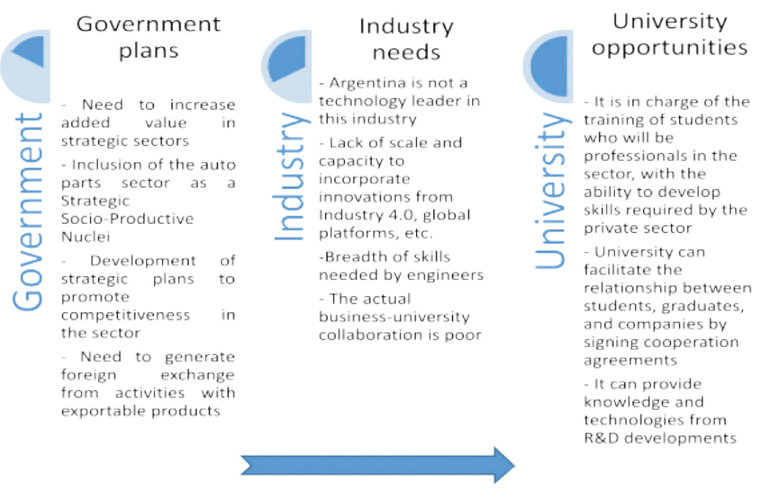

Figure 12: Plans, needs and opportunities in the automotive sector in Argentina. **Source:** own elaboration.

Additionally, when reviewing the Strategic plan developed by SMATA in coordination with the main automotive actors in Argentina, one of the main Challenges to be addressed by the industry is the development of a system of continuous technical professional training for the automotive sector. This is exactly the main objective of ASCENT, and the creation of the Competence Centers in the partner universities is perfectly aligned with that objective.

In particular, added values can also be analyzed at partner level. The added value for UNS is resumed as follows:

The creation of the CC on sustainable mobility will group technical and non-technical specialists working on the areas related to automotive production and development: engineering, soft skills, administration policies, humanistic, teaching, and legal aspects. All this taskforce can be oriented towards solving the challenges proposed by the automotive industry, though local and regional efforts for developing technologies and solutions for the sector.

The global effort will be a motor for incentivizing students to capacitate in all the related areas. Joint projects with automotive companies, agricultural machine producers, government, etc. will help to increase know how and capacities of the human group, and eventually can provide resources for increasing laboratory capacities.

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The added value of UNLP CC is supported by giving technical advice to low budget racing teams located in La Plata City and its surroundings. The racing car activity in the La Plata area is very intensive in promotional categories which develop their competences in the main circuit located 20 km from downtown and other circuits with basic infrastructure. Previous contacts with racing teams' owners and individual pilots who manage their own team and have the necessity of technical help make the target group. Training for them beside the laboratory tests and technical support compose the original offer of the UNLP CC.

MEXICO

The ASCENT project has the potential to be highly relevant for Mexico considering that the automotive industry is a very important industrial sector in the country. The training of engineers and other human resources can help the automotive industry continue to advance as a tractor of the Mexican economy. The following indicators show the importance of the automotive industry for Mexico (Zozaya Delano, 2021)

- 1st Currency Attractor. Trade balance surplus of 78 billion dollars (2020). Automotive Industry is the country's main currency attractor. 33 out of 100 dollars of total exports comes from Automotive Industry.
- 4th World exporter of light vehicles (2019)
- 6th Vehicle manufacturer in the world (2019). 3.8 millions of units (2019)
- 1st Vehicle manufacturer in Latin America
- 5th World exporter of auto parts (2019)
- 1st supplier to the United States market
- 18.9% Its contribution to manufacturing GDP in Mexico (2020)
- 3.5% of total national GDP
- 954,042 total direct employees
- 26 assembly plants, 14 brands and presence en 14 Mexican States

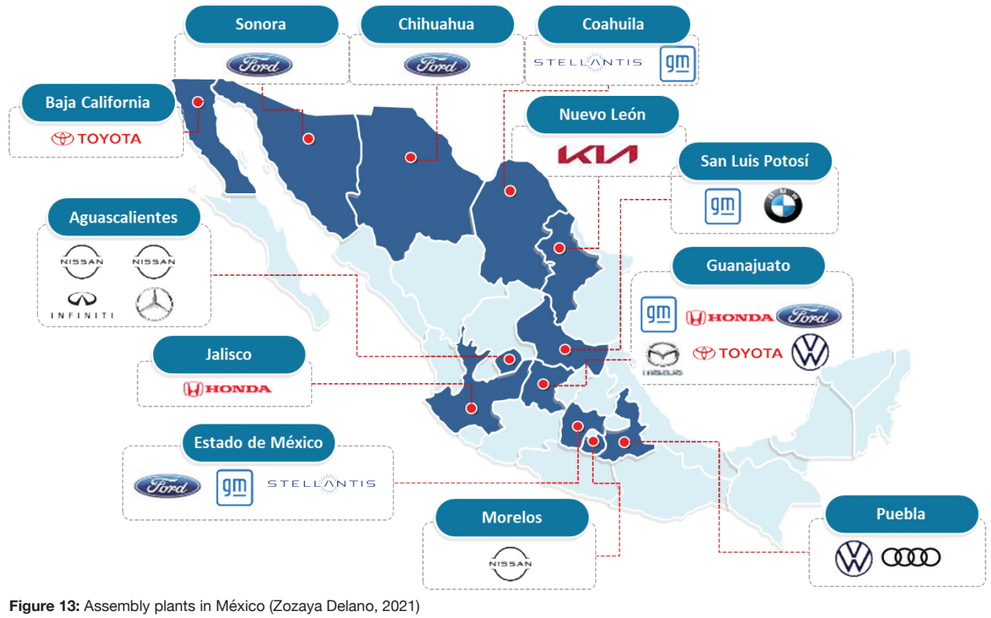

Figure 13: Assembly plants in México (Zozaya Delano, 2021)

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The opportunity, NAFTA (now UMSCA)

The free trade agreement for the North American NAFTA region was transformed into the UMSCA agreement with some changes. USMCA Rules of Origin are a challenge for OEMs plants established in Mexico. Regional Value Content (RVC) must be achieved within a 3-year transition period and a 2-year extension for specific models if Alternative Staging Regime applied is approved.

Specifically, the regional value content (RVC) must go from 62.5% to 75% in a period that goes from the present to the year 2023 and the value of labor content (LVC) must go from 30% to 40% in the same period.

This creates new opportunities for the automotive industry in Mexico as a reconfiguration of the current value chain to meet the increase in national content proposed by UMSCA (Zozaya Delano, 2021). New investments are expected to go into auto parts that had been imported from outside the North American region under NAFTA. Relocation, nearshoring and Decoupling are some of the possible consequences of the change in the value chain.

New R&D Centers

Another potential benefit is the establishment of research and development centers in Mexico to meet the new requirements for national content in parts and labor, according to UMSCA. The ASCENT project can help provide support in solving this potential need.

There is currently a registry of 29 research and development centers in Mexico. The establishment of R&D centers has helped shore up existing capacities in the sector and improved the quality of the products manufactured in Mexico. However, this capacity can be increased with the support of the ASCENT project, which has the appropriate infrastructure and the support of the universities participating in the network.

Specialized labor in Mexico

Mexico has a qualified labor force for the automotive industry due in large part to the demands of the “maquiladora” program, which forced the opening of specialized training programs. Mexican government and firms have invested in higher education and specialized training for advanced, technical industries. Over 100,000 engineering graduates enter the workforce every year. A robust labor force means Mexico can remain competitive, while keeping wages cost-friendly for investors (Zozaya Delano, 2021).

The role of the ASCENT network can be very important for the training of new engineers that will be needed in the coming years in the face of the changes posed by UMSCA and in the face of new challenges in the global automotive industry.

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3 IMPACT AND GOOD PRACTICES OF THE ASCENT COMPETENCE CENTERS

The impact of the six ASCENT competence centers on diverse target groups as well as environments and good practices in the competence centers are described in the following

1. ARGENTINA

THE COMPETENCE CENTER AT UNIVERSIDAD NACIONAL DEL SUR, UNS

UNS can create Laboratories, Departments, Centers and Institutes. Laboratories are entities where a group of teachers and researchers do practical and experimental activities on a specific area of knowledge. Have a space, infrastructure, and equipment and are able to offer services to industry. Departments integrate and organize academic offers on specific areas of knowledge. They have space, infrastructure, Laboratories, administrative and academic staff oriented to offer undergraduate and graduate programs to students. They also can offer services to industry though their laboratories and research groups. Centers group more than a single laboratory and more than a single research group, oriented to do projects with industry. They can join together groups and laboratories from different Departments. Institutes are oriented to research, include many laboratories and research groups and cover a wider area of knowledge. They also can do projects with industry and technology transfer. Although for ASCENT purposes it would have been enough and much simpler to create a Laboratory, the stated name “Competence Center” was incompatible with that possibility. So after analysis of the local context where the sustainable mobility is starting to be considered and required for urban planning, being that the UNS did not have previous entities oriented to that big topic, seen that several Departments and Institutes have research interests related to the topic, ASCENT team considered the possibility of creating a Center oriented to sustainable mobility, where the ASCENT new capacities could be contained and developed accordingly. Clearly, the creation of a Center is a much more ambitious and bigger challenge than the original objective stated by project ASCENT.

The project of creation of the ASCENT Competence Center on Sustainable Mobility was elaborated and presented in February 2020 by ASCENT team at UNS simultaneously at each of the three Departments where ASCENT team belongs, and later presented to the Supreme University Council (CSU). After endorsement of the initiative, the CSU elevated the project to the University Assembly, the maximum government entity of UNS. On November 25, 2020, after intensive work performed by ASCENT team and the Assambly members, the Assembly of UNS voted unanimously approving (Res AU13/2020) the creation of the Competence Center on Sustainable Mobility at UNS (Centro de Competencias en Movilidad Sustentable). Later and the Supreme University Council approved the operational rules in December 23/2020 (Res CSU 625/2020). So, the main action towards the existence of the CC has already been completed after almost one year of work due to COVID delays.
The staff for the CCMS will be UNS personnel. It is not necessary, nor possible, at this stage to make any contract for new staff. The CCMS will be open for participation to students willing to do their final graduation project, MSc and/or PhD thesis. Also will be open for academic staff with interests in sustainable mobility willing to integrate it in the future. Directive Res CSU 625/2020 states the mechanism for incorporating members and all relevant operative aspects.

It is ruled to have a director, vice-director, and a council of six to govern the Center. There will be as much members as people willing, and in condition, to participate, and the condition of membership is to be in a project on related topics in automotive or mobility areas. The Center will have elections every 2 years for director and will

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have to write annually a report of activity and results, to be presented and archived at UNS. So, administratively it depends on UNS in general and under direct observation and dependence on the constitutive Departments of Engineering, of Electrical Eng. and Computers, and of Administration Sciences. Technically, the production of results is on the members‘ hand, but the need of annual reporting results and the fact that the report is going to be analyzed and observed by the main authorities, is a push- forward on each member, on the council, and on the director’s head. Any earned money has to be used for improvements and expenses of the Center.

So, the created CCMS is now part of the formal structure of UNS. Any other future action affecting the CCMS would have to be discussed and voted by the Assembly under justified reasons. It is worth to mention that the creation of Centers at UNS is not frequent, and unanimity approval is still less frequent.

Objectives

Once fully operative, not online only, the ASCENT UNS CCMS will contact companies to seek for opportunities for joint projects for technology development and transfer. Students will be invited to participate in technologic projects, where they will be able to prepare their final graduation thesis, or work on MSc or PhD thesis.
Agreements with companies, other academic institutions, and government entities will be done, and projects will start in the framework of such agreements. As seen in next figure, the internal and external possible stakeholders are diverse, all having their particular interests and requirements. The CCMS will be able to address such diverse needs.

Figure 14: Internal and external stakeholders

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Impact on Regional Development

With reference to UNS CCMS, the impact on regional development it is still a forecast. The first impact will involve the students and their new skills obtained at the CCMS. This will increase employability and will offer them also the possibility of start their own business on certain topics.

CCMS will offer to industry the possibility of helping in the development of new products, processes, or solutions in the related areas. This will also increase the capacity and image of the UNS from the social-productive media.

Involvement of and Benefits for Students in the Project

From the first workshop up to now, students were always very interested in ASCENT. They followed the three workshops organized at UNS and were very interested in the possibility of going to Saltillo for training. The selection process at UNS included personal interviews to 17 students and the selection of five students for the training in Mexico. Unfortunately, COVID changed all plans and the visit could not be done, neither was possible to receive the students from San Pablo. But even in quarantine, the interest of the students was still high. During April to July 2020 the course “Technologies for electric and hybrid vehicles” was lectured for the first time where ASCENT training material was partially also used for lecturing. Some of the students selected to integrate ASCENT were also interested in the new course, which now is part of the optional curricula of the Electronic Engineering program at UNS. It is planned for the future to set a collaboration agreement with the CCMS for the students to receive practical training on the new ASCENT equipment in the framework of the new course. During the second semester of 2020, ASCENT produced a series of seminars oriented to students to cover somehow the loss of training possibilities in presence due to the pandemic. The interest on these seminars was also very high.

In 2021 the UNS ASCENT team is organizing a new series of seminars in soft skills and technological topics. Up to this moment, the first one was already lectured and there were many interested students. According to the plans, there will be four seminars in April and other four in May. The continuity of the offer during the following months will be dependent on the existence of new lecturers or new topics to disseminate.

As UNS has still to se-up the new equipment, the students did not have yet the possibility to be trained and/or work on it. Plans for the future include also offer to students the possibility of being involved in CCMS projects.

The benefits already perceived are related to the extra knowledge added to the participants on the seminars and trainings. That was very appreciated by the students. Other benefits will appear when students could get their hands on the equipment for training, use or projects. The students who get trained on this topics will be able to offer extra capacities to possible employers, and/or will be in condition to start their own technological offer to specific clients. Those are clear benefits for local students.

Good practices

Regarding previous experience UNS in joint projects with industry, the best results were obtained when the industry-academy collaboration was oriented towards obtaining new or better solutions to industry problems which do not have standard solutions, or where the standard solutions are not good enough. The academy is best prepared to analyse and select solutions and technologies if time is not a critical issue. So, the problems that are in the middle of a critical path, where any delays represent a loss of market, money or position of the industry respect to their competitors, if possible have to be solved by private solution providers or commercial companies prepared for fast response. But other problems which can be scheduled to be solved without a
hurry, can perfectly match the possibilities of academy. New solutions can be proposed and tested, seeking for better, cheaper, newer solutions and results.UNS team has previous experience from project TEAC that involves

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academy and technological based companies seeking for solutions and alternatives to solve their problems in better or cheaper way.

Major force difficulties

UNS faced two types of difficulties during ASCENT execution. One is COVID, impacting on the possibility of accessing facilities, and on extra delays on administrative procedures. The other is economic and political uncertainty after the election of the actual government. The problem arose in august 2019 when the possibility of political change got enhanced, and increased when the new government started (December 2019). There was a direct impact on the value of the local Peso, which was devaluated considerably, and perspectives of more devaluation and commercial restrictions appeared. UNS at that moment was executing the first purchasing procedure and it was necessary to analyze the situation and take hard decisions regarding the start of new tender for the rest of the equipment. The perspective at that moment (February 2020) indicated that it was too risky for UNS to receive a money transfer from Europe, which was going to be immediately converted to pesos, and then to start a new tendering process which could take several months, expecting to buy equipment valuated in Euros, since the risk of devaluation could lead UNS to need extra inexistent money to pay the invoices. So it was decided to wait a little more to reevaluate the situation again later. At that moment, the project was still defined to finish in October 2020, and the last deadline for paying invoices for equipment was defined to be June 2020. The risk of not finishing on time was high, even starting a new tender in February. Local quarantine due to COVID started in march 2020, making even more difficult to attain the deadlines. Later, a six-month extension was confirmed, but still the COVID restrictions (which were active until march 2021) and economic uncertainties still shown a very difficult scenario for starting new tenders. Finally, it was decided not to do more purchases to preserve UNS from troubles, and that affected considerably the original plans of creating a mechatronics lab with several models of ECU's and associated devices since it was finally only possible to buy just a single unit of ECU and a single unit of display, which enable a very basic setup for the laboratory. Also, due to COVID restrictions, considerable delay has altered the original plans for installing and start-up the purchased equipment. Nowadays, the equipment is not yet operative and it is expected to do the first tests and training at the end of April 2021, if COVID does not force new extra restrictions. In the meantime, if other funding becomes available, additional devices should be purchased or recycled form somewhere to setup some mechatronic structure able to be controlled by the ECU.

Clearly the delays affected the possibility of preparing counseling sessions with industry using and showing the capacities obtained with the new equipment.

Alternative activities and plans for 2021

So, to fill somehow the gap, ASCENT UNS has started offering a series of online seminars for academic staff, students and industrial partners, focusing on diverse areas of knowledge, and promoting the ASCENT network. The effort has been coordinated with other two Erasmus projects which have their main focus on complementary areas such as Internet of Things, and smart and sustainable cities. The collaboration arose naturally since IoT (project NEON) is a natural tool necessary to create infrastructure for smart cities (where the mobility has also to be defined smart and sustainable) and for connected, autonomous and smart vehicles. The smart cities are addressed by CAP4CITY, and the sustainable, smart mobility by ASCENT. So an incipient collaboration has started, where ASCENT CCMS and the others can gain expertise in complementary areas. The joint initiative is to create local synergy on the intersection topic, advancing even out of the original projects, but focusing on local capacities derived from the original projects.

The joint seminars are organized around a main keynote speaker invited for each event. At the beginning, brief descriptions of the three project illustrate the context where the topic is immersed. ASCENT Competence Center is also presented. At the end, The Network event of ASCENT is done, inviting people to join the network, and also showing the CCMS capacities. The Network event will be repeated at each new seminar. The series started on march 23, addressing strategies for negotiation, which is a soft skill topic very important for human relations, business and project development, economic definitions, etc. which all impact on any human activity, including academy, industry etc.

During the series there will be technical and non-technical dissertations. Four other events are scheduled in April, and during May, we expect to do other four events.
Technical counselling sessions are planned as separate events to be done when the equipment becomes operative and it could be shown working, but unfortunately this will happen after the project end. Actual plans are scheduled to start on May 2021.

Nevertheless, it is worth to mention that a preliminary counseling session was already made in 2019, quite before creating the CCMS, but within the timeframe of ASCENT. It was scheduled within an event where ASCENT team was invited to participate. Was a whole day activity where company Knorr-Bremse presented in Bahía Blanca their products for stabilization and safe braking of trucks. The event was done in the main racetrack of Bahía Blanca, showing the performance of their equipment on real truks running and maneuvering over wet and dry floor. At that time UNS ASCENT team in presence of Knorr-Bremse personnel, and representatives of local and national companies involved with trucks, tires and trailers presented the project, the local capabilities and examples of previous successful results obtained in joint projects with industry. It is expected to participate and/or organize events of this type with selected industrial partners in the future.

Sustainability of the CC

Academic sustainability
The academic sustainability depends on the member´s abilities and the result of their work. This is a standard situation for any researcher. As membership is open to interested staff with minimum requirements of being working on areas related to sustainable mobility, academic and technologic results will be available every year.

Administrative and functional sustainability
The structural, functional and administrative basis are already defined by UNS. This guarantees stability in time under normal conditions (regular operation, no major force situations).

Economic sustainability
Part of the CC's equipment has been acquired with funds from the ASCENT Erasmus+ project. In addition, purchases of subsequent equipment may be financed from the application in the call of the General Secretariat of Science and Technology for the acquisition of large equipment for common use to various research groups, departments or areas of UNS. In addition, opportunities will be explored for obtaining funds from national and international funding entities.

Based on the participation of the laboratories and the academic staff of UNS, purchases or activities in scientific-technological events may also be financed from the subsidies of the research projects impulse by members of the CC.

Externally, income may eventually arise from work to third parties that the institution may provide with companies or organizations linked to the automotive industry. All surpluses caused by this type of activity will be reinvested in the Competence Center.

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THE COMPETENCE CENTER AT UNIVERSIDAD NACIONAL DE LA PLATA UNLP

On October 28th 2019 Architect Fernando Tauber president of UNLP signed the letter announcing that the

ASCENT Competence Center is an integral part of the Faculty at the National University of La Plata. It is part of the university's structure and entitled to use its infrastructure as well as basic equipment for its operations. The ASCENT Competence Center is further integrated into internal and external communication channels and structures. With the operation of the ASCENT Competence Center, the Faculty + the National University of La Plata emphasize the importance of offering high quality and international education on automotive engineering and sales management (soft skills for engineers) and highlights its efforts of ongoing improvements in university-business cooperation. The following picture shows the organization structure of the CC

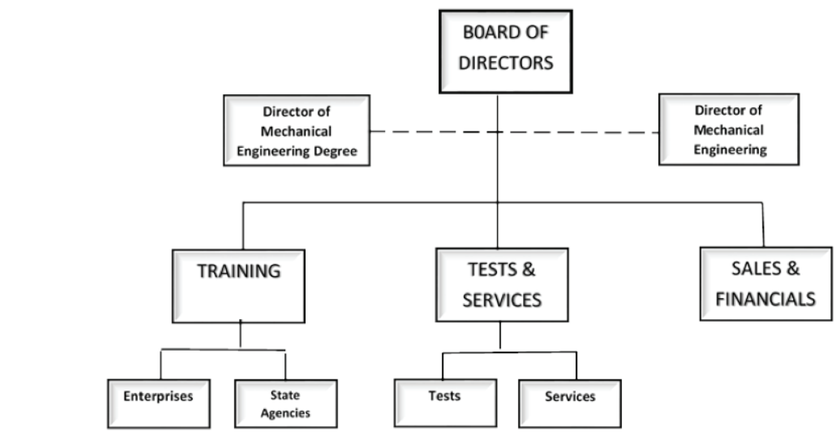

Figure 15: Structure of UNLP Competence Center

The ASCENT UNLP CC has identified the client as small entrepreneurs of the motorsports, pilots and team owners which have economics and logistics difficulties to access to certified tests of their engines and vehicles because the high costs and for not existing near the city of La Plata laboratories duly equipped to offer measurement services valid for the development of vehicles of competition. The ASCENT IAME Center of Competences aims to provide consulting services and performance measurements on motors and racing cars, at low cost and certificated results. The service that the ASCENT IAME Center of Competences intends to offer stands out because it is supported by a university in which mechanical engineers are trained. The future engineers will participate in the Competence Center in conjunction with professors in charge. These students are characterized by being, in a large percentage, lovers of cars and engines, fans of racing cars. It is common that those who have the possibility participate in some automotive activity related to competitions. They guide their academic expectations, within what the curriculum allows them, to be trained with an orientation toward the automotive. Unlike similar services offered by other companies, the ASCENT IAME Center of Competences will be operated by teachers and students specialized on the services to be provided. Training for the topics will be taken from the four training activities of the ASCENT project. Two workshops have already been held, one on automotive technologies and the other on soft skills and marketing. In the future, there are other kinds of customers that may be considered, as sectors of the industry and government offices, could be potential clients of the ASCENT IAME Center of Competences. At the same time, it is important to highlight that our Center of Competences has the support of the image that the UNLP represents for the society, regarding professional excellence. A course package is also planned for third parties (including the racing teams which are the main target group of this plan) and for enterprises people.

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Impact on Regional Development

Regarding UNLP, faculties are closed since the third week of March 2020 because of pandemic restrictions which are deeply modifying the regular commercial, industrial, educative and social activities. So, it is very difficult to imagine a regional impact on a scenery that will probably be very different to those known in the past once the activities return to reasonable levels. Despite that, there are some reasons to be optimistic since the links between the CC and the target group (which clearly belong to La Plata City and surroundings and have expectations about the services from the CC) is already established. From the point of view of student´s training, the equipment financially supported by ASCENT project will be immediately available once the activities are restarted to implement measures and technical determinations on engines and cars.

Involvement of and Benefits for Students

The Faculty of Engineering of the National University of La Plata offers, through its Mechanical Department, the Mechanical Engineering degree. Surveys carried out each year among students who apply to Mechanical Engineering show that they do so because of a strong vocation to know and train in the subject of engines and automotive in general. Many of them have a technical background prior to the initiation of university studies and several of them have ventured into racing cars or wish to do so. There is a local racing automotive activity that takes place in the vicinity of the city of La Plata in regional categories in which amateurs with scarce or limited economic resources participate. They are a strong attraction for students and every year a meeting about this subject is carried out, with participation of invited engineers and technicians and exposition of cars. Regarding the young graduates, the Faculty monitors their professional career and this has shown that many of them find jobs in the automotive industry. Their experiences are a very valuable feedback for the revision of the plan of studies and as reference for the students. For this reason they are invited to tell their working experience for those who are by the middle of the degree. The new activity established from the CC, will be a very important complement of the automotive profile that already has the Mechanical Engineering Degree at La Plata UNLP specially if it is considered that a smaller portion of students that would be interested in venturing into the automotive field abroad, so the link with other universities and companies through the ASCENT Network could allow their participation in academic circles through postgraduate courses and working in the industry of countries of other ASCENT partners.

Sustainability of the CC

Regarding the UNLP CC the equipment financed from ASCENT conform a unit itself and at the same time make possible complement an offer of services previously available at the Mechanical Department, Faculty of Engineering, devoted to determining engines and cars performance and the training of students, technicians and engineers around automotive subjects.

The president of the university has also signed the compromise of keeping the operation of the UNLP CC at least two years after the end of the project. This means more specifically that the competence Center will be running until October 14, 2022 at least. Since the point of view of the resources needed for the operation of the ASCENT UNLP CC it is guaranteed considering that the facilities that compose it are also of use for the laboratory practices of the degree students. Therefore, they should always be operative in the future to carry out tests for didactic purposes. Tests for third parts will be optimum opportunities to involve students in the operation of the test facilities as part of the training keeping strictly security conditions in order to avoid accidents. Additionally, the provision of services to the target group (car competition teams) will allow the incoming of sufficient economic resources to ensure its economic sustainability over time. Since the service that will be provided from the CC, serves a market in which no other bidder exists, it is believed that being pioneers in this segment greater recognition will be acquired and will ensure continuity over time. Additionally, the prestige and recognition that the UNLP and the Engineering Faculty possess in the city and in the region would cooperate with the continuity. The expenses of the ASCENT UNLP CC will be supported by the UNLP: salaries of the teachers, students and contracted staff; energy costs and maintenance of the building; taxes, etc. It is expected that the business profits after paying operating costs and other expenses can be reinvested in additional equipment to improve the capacity of the CC. No partners are considered but, in case of need support of any of advisors, professional fees will be paid. Costs of fuel, if needed are to the charge of the owner of the engine or the car. Fees of services and counselling should be realistic with the budget of the target group of customers, defined as low cost competition teams.

2. BRAZIL

COVID – 19 pandemic impacted the implementation of the Competence Centers at both USP and UFRJ. Classes and laboratory activities were cancelled from March 2020, and until one year after this suspension, there was no total return to the activities. Company visits were also limited by the companies themselves, and the university following restrictions to avoid non-essential meetings. With all such restrictions, several activities had to be suspended or reformatted to videoconferencing.
With the delays due to the pandemic, it is still challenging to measure Brazilian competence Centers' impact. One of the purchased equipment's intended uses is by the students' team – Formula SAE and Baja SAE. So far, it was not possible to provide hands-on training using the equipment. What is expected to achieve is that the students will improve their vehicles using accurate engineering data gathered when the vehicles are in use.

COMPETENCE CENTER USP

The competence Center at USP is aimed to the development of a laboratory dedicates to Experimental Engineering applied to Automotive Engineering. This new laboratory is linked to a group of researchers that have a lasting collaboration with the local industry in research projects and educational projects at graduate level.

Good Practices

The collaboration between the University of São Paulo with Industry, particularly the automotive, has a history that dates back to developing the first experiments of Ethanol as fuel to recent research-based collaboration to develop new materials and methods for application in the automotive industry. The aforementioned granting of a new EMBRAPII unit to the University of São Paulo comes from this collaboration.

The University of São Paulo has its policies for collaboration with the local industry. Its main administrative unit the handles this collaboration is the Innovation Agency (AUSPIN – Agência USP de Inovação) that handles the writing of agreements, patents, and financial administration of the agreements with the corporative world. The ASCENT competence center, as part of the University, will connect with every administrative unit that has a stake in the center's activities. This connection will be helpful for the competence center since most of the bureaucratic tasks will be done in connection with the Innovation agency.

As mentioned before, as part of the new EMBRAPII unit, the center will interact with the projects that will be assigned to this unit. In particular, this unit will work with companies that do not have a structure to develop research and have constraints to develop new products. The unit has to promote itself, organize workshops and meetings in a similar way to what ASCENT developed during its implementation.

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Major force difficulties

Brazil was among the most affected countries during the COVID-19 pandemic in 2020/21. This fact led to the suspension of most activities at the University of São Paulo with a substantial reduction on every administrative action that was not related to the essential maintenance of the institution. The pandemic also affected the automotive sector. Lockdowns and reduction of economic activity impacted the industry, with new projects being halted or delayed. Even visits to companies were suspended due to social distancing measures that were put in place.

The center implementation suffered delays, and the equipment commissioning had to be postponed and delayed from its original schedule. The commissioning is a critical phase in which the members of the ASCENT Competence Center will get familiar with the new equipment to use their full capability.

Even with all the difficulties, the ASCENT Center started to prospect new projects with companies associated with powertrain components and equipment to be used as accessories linked to agricultural machines.

It is expected to have by the second semester of 2021 a gradual return to complete normality given the vaccination campaign against COVID-19. It is expected that a substantial amount of the population will receive the vaccine. With this return to normality, it is expected to have the equipment fully commissioned, and the center is starting to have its projects implemented.

Involvement of the students

The ASCENT Competence Center at USP will have an impact on students' activities at different levels. At first, it will be integrated into the student teams involved in automotive projects. The teams are the Formula Student and the SAE Baja. The first one has the task of developing a race vehicle fully, and the other team develops an off-road vehicle. Both projects are competitive at the local competitions, and the center will collaborate by providing experimental engineering capabilities to the teams.

Both teams have an enrolment of about 80 students with different degrees in Engineering. The projects need experimental data to improve their designs and engineering models. As a collaboration method, students will be trained to use the equipment and the theory in their activities. It is expected that this group of students will be qualified to work with experimental engineering later on in the professional careers.

Another possible way of involving students is by what is known in Brazil as "Scientific training" (Iniciação científica). In this modality, students are trained to work in a research laboratory to collaborate on scientific research. Typically students are granted a scholarship and stay in this capacity for up to two years.

The University of São Paulo also has a well-established graduate program focused on research-based activities for students seeking a doctoral degree. Those students will benefit from the ASCENT Competence Center in their research activities that need experimentation to be carried out. The national and state funding agencies sponsor the research activities, and private sponsored research is done in collaboration with the industry.

Sustainability for the Competence Center

USP Competence Center will be part of the new EMBRAPII unit at the University of São Paulo. EMBRAPII is a public company that is aimed to fund the development of new technologies and industrial products. This new unit was granted to the University of São Paulo in March 2021. The unit aims to develop Powertrain systems and parts,

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including electrification and automation of such systems. The competence Center is one of the labs that will form the unit, providing experimental engineering and signal processing capability.

The University of São Paulo is a public institution that is fully funded by the federal state of São Paulo. Every faculty member is a full-time public employee, and the university can form a partnership with companies to develop research. As one of the faculty's mandatory activities is to develop research, the continuation of the Center activities will be part of its coordinator's mandatory activities. The university has full research support, it has an agency for innovation and from this perspective, the Competence Center's sustainability is assured.
Another activity is teaching, and in this category, we may have an impact to report since every year, about one hundred students will attend classes in experimental engineering that will have use and demonstration of the purchased equipment. Experimental engineering is a fundamental part of the engineering course. This impact is expected to last for at least the next 15 years, even if we consider the purchased equipment's obsolescence.

COMPETENCE CENTER AT UFRJ

UFRJ Competence Center is intended to congregate different activities related to the automotive industry. The beginning of operation is Centerd on the prototypes built for different student competitions such as Formula student and Mini-Baja. These activities congregate different groups, from mechanical engineering, through electrical engineering, control, design, etc. The formation of skilled personnel, technicians, students, engineers is the key aspect for developing joint projects with the industry.

Sustainability of the Competence Center

The Competence Center's sustainability is simplified by the fact that most of the fixed costs, rent, salaries, facilities, etc. are regular costs assumed by the university for the involved personnel is the normal staff of the UFRJ. Nevertheless, specific projects will involve specific costs that the contractors may cover. The major problem involved is the availability of funding for these projects since the automotive industry is currently facing a crisis due to the COVID pandemic. The future development of the electromobility poses interesting challenges for the industry and may create R&D opportunities to be explored.

In order to facilitate the funding of the R&D projects, UFRJ CC is pursuing three different strategies. First is the accreditation as part of an EMBRAPII unit, of the UFRJ, in the area of mobility. This will enable the CC to offer co-financing possibilities, which shall ease the industry's participation in such projects. A second strategy is a common development with the Technology Park of the University of dedicated vehicles for the Park's electromobility and later for the whole university campus. Such development will open opportunities to cooperate with the industry and even create start-up companies in the Technology Park. The third activity is the active contact with the surrounding automotive companies in order to offer joint research projects.

Presently the CC is working on the development of an H2 powered small hybrid vehicle to operate in the Technology Park. Another development is a hybrid vehicle project for eight passengers to be used for transportation by the Technology Park. It will also be used as a test bench for different control techniques, interfaces, energy charging and control systems, assisted driving algorithms, etc. The use of acoustic emission effects to assess truck chassis damage is ongoing research, and the use of cameras to allow stereoscopic vision and uncertainty determination to be incorporated in drive assistance. This is part of the university staff's main activities, along with undergraduate courses, Master of Science and Doctor of Science programs which will profit from the infrastructure of the CC.

Therefore, the sustainability of the Competence Center is expected to be assured for the following years.

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3. MEXICO

COMPETENCE CENTER AT TECNOLÓGICO DE MONTERREY – SALTILLO

The Saltillo Competence Center was inaugurated in March 2020, in the same month that the stoppage of activities in Mexico due to the Pandemic was decreed. The face-to-face activities were canceled, so after a transition period, work sessions with companies and external parties were designed in a digital format, remotely.

Good Practices

To carry out the counseling sessions, an alliance was made with the CIAC (Cluster of the Automotive Industry in Coahuila), who facilitated contact with companies and external parties. Some sessions were designed to show the capacities of the CC, others to ask the needs of a company and others with a mixture of both activities. The following figure shows the typical agenda of one of the counseling sessions.

COUNSELING SESSION

Date: TBD, 2020 **Place:** Virtual Meeting trough Zoom / Microsoft Teams / Google Meet

Session Objectives:

1. Receive input for Industry 4.0 Training Needs (in collaboration with CIAC)
2. Get to know the Competence Center @ Tec de Monterrey Campus Saltillo
3. Explore future collaboration with Tecnologico de Monterrey

Time Frame	Activity
5 min	Welcome
5 min	Confidentiality Agreement (optional, depending on Company's needs)
5 min	ASCENT Competence Center / ASCENT Network
30 min	Guided questions* for the current and future company's Training Needs
10 min	Tec de Monterrey Collaboration Options for Companies.
5 min	End of counselling session

Figure 16: Agenda of a typical counseling session

As an example, below it is presented a set of 10 sessions held between the CC, the CIAC and different organizations of the automotive industry in the region. All the sessions executed in coordination with were Cluster of Automotive Industry in the Saltillo Region (CIAC).

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No.	Focus of Session	Date of Implementation	No. of Participants and their origin (company/institution)	Training Material (Doc.name)
1	Presentation of ASCENT Competence Center @ ITESM	Nov 9, 2020	Contact person (Tupy) Contact person (CIAC)	ASCENT - ITESM - CIAC - Counselling Session.pptx
2	Training Needs Detection Session (DNC)	Nov 9, 2020	Contact person (Tupy) Contact person (CIAC)	ASCENT - ITESM - CIAC - Counselling Session.pptx
3	Presentation of ASCENT Competence Center @ ITESM	Nov 10, 2020	Contact person (Caterpillar) Contact person (CIAC)	ASCENT - ITESM - CIAC - Counselling Session.pptx
4	Training Needs Detection Session (DNC)	Nov 10, 2020	Contact person (Caterpillar) Contact person (CIAC)	ASCENT - ITESM - CIAC - Counselling Session.pptx
5	Presentation of ASCENT Competence Center @ ITESM	Nov 12, 2020	Contact person (Questum) Contact person (CIAC)	ASCENT - ITESM - CIAC - Counselling Session.pptx
6	Training Needs Detection Session (DNC)	Nov 12, 2020	Contact person (Questum) Contact person (CIAC)	ASCENT - ITESM - CIAC - Counselling Session.pptx
7	Presentation of ASCENT Competence Center @ ITESM	Jan 12, 2021	Contact person (Magna CIMS) Contact person (CIAC)	ASCENT - ITESM - CIAC - Counselling Session.pptx
8	Training Needs Detection Session (DNC)	Jan 12, 2021	Contact person (Magna CIMS) Contact person (CIAC)	ASCENT - ITESM - CIAC - Counselling Session.pptx
9	Presentation of ASCENT Competence Center @ ITESM	Jan 28, 2021	Contact person (Metalsa) Contact person (CIAC)	ASCENT - ITESM - CIAC - Counselling Session.pptx
10	Training Needs Detection Session (DNC)	Jan 28, 2021	Contact person (Metalsa) Contact person (CIAC)	ASCENT - ITESM - CIAC - Counselling Session.pptx

Table 8: A set of ten counselling sessions

Session No.	Short Statement
1 & 2	In this sessions, possible future collaboration with ITESM were discussed. Also, Tupy shared their specific areas of interest for training in specific topics regarding Industry 4.0.
3 & 4	In this sessions, possible future collaboration with ITESM were discussed. Also, Caterpillar shared their specific areas of interest for training in specific topics regarding Industry 4.0.
5 & 6	In this sessions, possible future collaboration with ITESM were discussed. Also, Questum shared their specific areas of interest for training in specific topics regarding Industry 4.0.
7 & 8	In this sessions, possible future collaboration with ITESM were discussed. Also, Magna CIMS shared their specific areas of interest for training in specific topics regarding Industry 4.0.
9 & 10	In this sessions, possible future collaboration with ITESM were discussed. Also, Metalsa shared their specific areas of interest for training in specific topics regarding Industry 4.0.

Table 9: Short statements of a set of ten counselling sessions

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The following figure shows the results of the set of counseling sessions. The “X” axis shows the topics of interest where companies most need to receive training from the ASCENT Saltillo Competence Center. This includes process, asset utilization, labor, inventories, quality, supply-demand match, time to market, service after sales. The “Y” axis indicates the scale of interest in a range from 1 to 4.

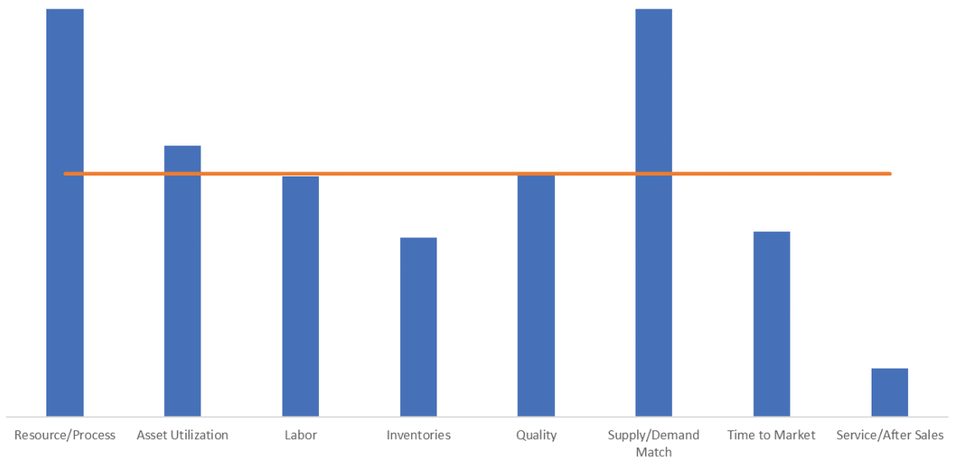

Figure 17: Outcomes of a counselling session

As an initial result of the sessions, areas were identified where a first university-industry collaboration project for training can be carried out. As can be seen, the industry 4.0 topics were of greatest interest to the set of companies are the following:

1) Process
2) Match supply demand

This means that companies want to receive training in 4.0 technologies that impact the reduction of process costs and the reduction of costs in the supply-demand match.

Impact on regional development

The competence Center in Saltillo will impact Professionals and students of automotive industry from the productive sector in the Saltillo and Monterrey Region of Mexico, mainly those involved or interested in training in Industry 4.0 technologies like virtual Reality, simulation, robotics and internet of things. Specifically, the existing automotive companies in the 18 industrial parks of Saltillo like General Motors- Ramos Arizpe, Fiat- Chrysler Derramadero and Daimler Derramadero.

Industrial projects will be training but additionally consulting and cooperation will be included according to the need of companies in the region on these issues.

One of the main reasons for the installation of an automotive competence center at the Tecnológico de Monterrey Campus Saltillo is the strong link with the three main assemblers in the region, such as General Motors, Fiat Chrysler and Daimler. This link is reflected in various activities such as the participation of students and teachers in internships projects and programs. Another reason is the existence of the mechatronics program and the industrial engineering program that have prestige in the region for the quality of our graduates who are hired by the automotive industry. These programs have solid laboratories and equipment that automotive companies require.

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Involvement of and Benefits for Students in the Project

From the beginning of the project, a call was made for university students to join a support group for the operation of the Competence Center. These students participated in some design activities of the center, in follow-up activities to the operation of the ASCENT project. They also participated in the student training seminars together with the students from Argentina and Brazil. From the above activities, students have benefited from the knowledge acquired in automotive engineering and soft skills, as well as from the experience of the ASCENT project activities.

Sustainability of the CC

From the beginning, the center will operate through the income that will be obtained from a mixture of five types of services, which will mainly serve to cover variable expenses. Additionally, five-year contracts with 3 large companies will be signed to cover fixed operating costs. At the end of the five-year period, another 3 large companies will be sought to add to the initials.

The Competence Center will be oriented to develop both technical and soft skills in automotive professionals in the region. In the initial stage the technical competences of industry 4.0 chosen are robotics, augmented reality, simulation and internet of things and soft skills are critical thinking, communication, negotiation.
The competence center will try to bridge the gap between industry and academia by creating a common place to share knowledge and to create links of cooperation. The focused field is Industry 4.0 in the automotive sector.

The main activities in the competence center will be:

- Training of students from Tec de Monterrey
- Training of faculty
- Training of workers from the automotive industry
- Project cooperation between industry and academia

COMPETENCE CENTER AT UNIVERSIDAD IBEROAMERICANA (UIA)

IBERO´s competence centre, the Centro de Diseño y Prototipado Rápido – CEDPRA (Center for Design and Rapid Prototyping) is part of the Departmento de Estudios en Ingeniería para la Innovación (Department of Engineering Studies for Innovation) and run by the Mechanical and Electrical Engineering Program. It is hosted within the program’s Centro de Ingeniería Mecánica/Eléctrica Avanzada – CIMA (Center of Advanced Mechanical/Electrical Engineering).

Good Practices

Through the relationship with members of engineering centers or departments of the automotive industry a need for developing prototypes to test ideas and designs was identified, in order to allow them to go more easily beyond computer-based models and simulations, in which their works has been concentrated. Such prototypes would aid in running proof of concept trials and/or asses better the ideas or solutions being conceived. Therefore, there is an opportunity in offering prototyping services to those engineering centers or departments, allowing them to expand their reach.

Considering the former, CEDPRA is aimed to offer a range of prototyping, engineering, and testing services to prospective customers in the automotive industry, with focus on the engineering centres and departments of the automotive companies established in Mexico, but also inlcuding the vast array of car part manufacturers that

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operate in the country. Moreover, a secondary market that can be addressed include medium to small businesses or individual customers that make special parts or adaptations for vehicles with specific purposes, like racing or tuning.

CEDPRA's main equipment includes a state of the art 3D SLS printer and two powerful workstations with specialized software for engineering design analysis and simulation, including 3DFlow Zephyr Pro software for virtual reconstruction of physical pieces or elements from photos. However, it will operate mostly as a virtual center, supported by all the Mechanical Engineering program´s infrastructure and part of its personnel, allowing to offer a wide range of prototyping, engineering, and testing services to prospective customers. This integration will also facilitate interaction with teaching activities, expanding the reach of the center in the training of new engineers (for example, some subjects in the automotive area of the new academic curriculum of the program were designed from the creation of CEDPRA).

Activities such as the counselling sessions had to be performed as virtual meetings due to the pandemic. Nonetheless, during the sessions several key players from auto part companies showed great interest on trying new approaches to their work and were ready to write down possible agreements.

Impact on regional development

As Mexico became a major player in the automotive industry at the international level, this industry became one of its most important components of its economy. In 2017, for example, it represented 3.7% of the national GDP (Gross Domestic Product) and 20.2% of the manufacturing GDP, generating more than 800 thousand direct jobs, and accounting for 1 of every 5 jobs in the manufacturing industries (AMIA - INEGI, 2018). Along this process, the industry had been concentrated on manufacturing, but in recent years the research, development and engineering activities have grown in importance. Nowadays, there are six engineering centers of major automotive companies within Mexico City or within 1 hour by car from the city. This in addition to the manufacturing clusters in Central Mexico also within easy reach from Mexico City, making central Mexico the axis of design and engineering activities of the industry in the country. And these engineering centers have also grown in importance. For a long time concentrated on activities such as adaptations of vehicles for the local market, they are now increasingly involved in the global engineering pipelines of their companies and charged with higher level tasks, as leading the development of a complete vehicle (like was the case for the new Bronco Sport). For CEDPRA, this offers an opportunity for offering prototyping services to those engineering centers or departments, allowing them to expand their reach without investing in new facilities, equipment and personnel. And with the new technologies for long distance work that have become common during the COVID-19 pandemic, a nationwide reach may also be easier.

Involvement of and Benefits for Students in the Project

Students were involved in several activities of the project, with training and learning experiencies as the major benefits. They participated in the folowing activities:

- ***Internal workshops*** - Intended to disseminate among a selected group of around 25 students the knowledge and experience gained by the members of the academic staff that participated in the project´s trainings on technical and soft-skills topics. The students who participated were mostly from Ibero´s Mechanical and Electrical Engineering Program, but also participated a few from the Mechatronics Engineering Program and from the National Polytechnic Institute (three students and one professor).
- ***Student workshops*** – These workshosps substituted the originally planned student mobilities, because of the problems posed by the COVID-19 pandemic, which made it impossible to travel. Althoug a less in-depth experience, they allowed to reach a far higher number of students, for immersion in current technical and soft-skills topics. Participantes were mostly Ibero´s Mechanical and Electrical Engineering Program.
- ***Student trainings*** – These more in-depth training activities were aimed at expanding the reach of training to students from institutions outside the ASCENT consortium. In this case, a two-day training was organized with engineering students from the Instituto Politécnico Nacional (National Polytechnic Institute), and also replicated with students from Ibero´s Mechanical and Electrical Engineering Program.
- ***2nd ASCENT Conference*** – The 2nd ASCENT Conference Engineering the Future, Trends and Challenges in Automotive Engineering, gave participants insights into relevant topics of how automotive engineering and mobility are evolving. Attendants included Ibero´s students, mostly from the Mechanical and Electrical Engineering Program.
- ***Staff of the competence centre*** - Two students participated as staff of the competence centre and performed the following activities: aided in the development of the 2nd ASCENT Conference as technical support staff, aided in the developpment of the counselling sessions with companies of the automotive industry (technical support and documentation).

Sustainability of the Competence Centre

CEDPRA will be run by the university´s Mechanical and Electrical Engineering Program and has a conditioned space for its operation, the SLS printer and the workstations with specialized software, along with flexible office space. However, it will operate mostly as a virtual center supported by all the program´s infrastructure and part of its personnel. This arrangement is designed to allow for the provision of a wide range of prototyping services and complementary engineering and testing services for the potential customers, taking advantage of technology acquired specifically for the center and all the other capabilities of the program. Likewise, CEDPRA´s equipment can also be used for academic purposes, mainly for training of students in engineering courses, and it is also considered that the center will have an internal market for its services, among students and academic personnel, not only of engineering programs, but also of programs like industrial design.

This symbiotic arrangement will therefore facilitate the continuity of the center over time and is expected to promote more involvement of the Mechanical and Electrical Engineering Program´s staff and students in its operation, in order to better support its services for external customers. As stated above, starting in 2021, the new curricula of the Mechanical and Electrical Engineering Program includes three courses that have among their primary objectives the design, prototyping and testing of automotive mechanical elements for which light design will be a priority, opening more opportunities for interaction between academic work and the competence center´s activities with the automotive industry.

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4 LESSONS LEARNT

This section presents some of the lessons learnt throughout the project in each of the project categories called work packages. The work packages are as follows:

- ***Work Package 1*** – Comparative analysis of the automotive industry and training needs for test bays in Argentina, Brazil, Mexico and the EU
- ***Work Package 2*** – Capacity building – training for trainers
- ***Work Package 3*** – Technical instalment of the competence centres (testing bays) that are integrated in the faculties of engineering
- ***Work Package 4*** – Operational instalment of the competence centres
- ***Work Package 5*** – Network for national and cross-country exchange
- ***Work Package 6*** – Dissemination and Visibility
- ***Work Package 7*** – Quality & Ethics Control

At a late stage of the project, partners collected the lessons learnt based on a template asking for "What went well?", "What would need a change?" and "Recommendations for improvements". The answers are summarized below. The collected information can be useful for the consortium on the one hand for the planning of follow-up projects, as well as for the sustainability of the operation of the CCs, and to evaluate the benefits of the project for the different target groups.

It is worth mentioning that some of the activities were implemented after the collection of the lesson learnt, and the comments listed below were given by individual partners and might not necessarily reflect the opinion of the whole consortium.

1. LESSONS LEARNT BY WORK PACKAGE

WORK PACKAGE 1

Desk Research

Regarding the first activity in the project, the desk research on automotive industry and training needs, the partners mentioned that

- the desk research provided valuable information about the automotive industry that was used during the rest of the project
- the desk research provided an updated panorama of the industry status of each LA country.

Recommendations for improvements included that

- clearer guidelines for the integration of the information on the country level might have been helpful
- more key contacts (e.g. associations) could have been involved

Desk Research

As a next step, focus groups in each of the universities were implemented with stakeholders from academia and industry. At this stage, first contact with industry and companies was established.
Positive aspects that were collected by the partners included:

- valuable information on the automotive industry was provided
- some of the contacts acquired for the focus groups were very useful in later stages of the project
- focus groups were interesting as an interchange of opinions and information
- people, who agreed to join, were motivated.

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Difficulties that arose by some of the partners were mentioned as well, e.g.

- The region around the university has very few companies working in automotive engineering.
- It was somewhat difficult to agree on the dates/times of the face-to-face sessions at the university campus. Then, no remote participation was considered as a primary alternative, which may had allowed enhancing the breadth of the participants.

Recommendation for future focus groups:

- Refine a recommended methodology for hybrid focus groups, combining face-to-face and remote participation.

WORK PACKAGE 2

Capacity building trainings (Transfer of knowledge within the project consortium)

The consortium came together in 4 capacity building trainings to transfer knowledge on the topics "Engineering Trends", "Train the Trainer", "Soft Skills", and "Technical Skills Upgrade".

There were a lot of positive aspects mentioned by the partners regarding these trainings:

- The trainings were good, with valuable and useful information.
- Very interesting topics were well attained and received by university members.
- The best aspects of the training where moments, where participants could discuss with trainers and other participants to share their experiences, doubts, and ideas.
- The content of the courses was adapted to participants needs. In general, consider that the content will be useful for participants and their institutions.
- The training activities were also a good moment to facilitate participant's networking.
- Visits were well organized, and everybody received a good impression of the location (technical equipment etc.) during on-site visits and activities to get to know the universities facilities and each other better.

Each of the trainings was evaluated by the trainees and trainers already at the end of each of the trainings. According to the trainees' and trainers' feedback, there were some aspects to be modified:

- The presentations of the different topics were, sometimes, too theoretical. So, more interaction with participants is recommended.
- Participants could engage in the training activities by presenting good practices of their own countries.
- Although the materials were put in the Moodle platform, it would be good to take more advantage of the resources available in this platform.
- Some of the materials have not been translated into the local language. Perhaps it would have been easier to implement, when possible, the training activities in the local language.

Based on the findings from the training assessments as well as the lessons learnt activity, some improvements have been suggested:

Curriculum

- Adjust the visits to laboratories according to ASCENT members' needs and expectations
- It would have been very useful to have longer and deeper trainings. A stay for one week would be useful considering the distance and time difference.

Methodology and in-class activities

- Intensify the active-learning approach: including interactions among participants and trainers, time for sharing opinions and engaging in discussions, and organizing people from different countries in small group tasks.
- Include videos, case studies and practical examples to analyze during the training.
- Share the trainers' presentations in advance and/or provide references to read before the training
- More references and research material should be provided.

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WORK PACKAGE 3

Technical needs identification

The technical needs identification formed the basis for the subsequent equipment purchase. Each LA partner university collected the needs for technical equipment related to trainings in the competence centers.

In general, partners were satisfied with the technical needs' analysis:

- A reasonable prospective study was done.
- The technical team identified needs related to the technical / engineering centers of automotive companies in Mexico, which have been growing in size and importance in recent years. These needs are well aligned with the engineering design focus of the Mechanical and Electrical Engineering program and it is expected that there will be a natural and productive interaction between the competence center and the academic program, which should allow better support to all the activities of the competence center and its interaction with the industry

However, some difficulties were identified and recommendations given by the partners:

- The project suffered delays due to the identification of suitable equipment and vendors, rigid internal structures and time-consuming tendering procedures in universities.
- There is still a limited culture of technological development in Mexico and of cooperation between industry and academia for this purpose. However, it is growing, particularly as Mexico's position within the global automotive industry begins to move from near-pure manufacturing to inserting the country into its global design and engineering activities. It is important to seize the moment when this shift towards design and engineering activities in the automotive industry is occurring, in order to position the competence center as a valuable partner to help in the process.

Tendering and equipment purchase

Based on the technical needs analysis, the LA partners implemented a tendering and equipment purchase procedure according to respective national rules and the guidelines of EACEA.

The feedback and lessons learned regarding tendering hat mixed results. Some positive aspects were that

- Purchase done in quite expedite way in few cases.
- The selected equipment adds important capabilities. The tendering procedure followed standard administrative protocols.

In general, the partners had some difficulties during the tendering and purchase process:

- For a private university, not required to run tenders for the purchase of equipment, getting into tendering processes was difficult and cumbersome. The bright side is that those processes went reasonably well.
- COVID affected the payment and delivery process. Political and economic uncertainties in Argentina affected seriously the possibility of purchasing more equipment.
- Often it was difficult to receive proper offers from the vendors.
- Tendering should be executed through the normal procedures of the partner.

Instalment (especially in light of COVID-19)

The instalment of the equipment caused some difficulties because of local restrictions due to the COVID-19 pandemic. Strict lockdowns prevailed in all partners' countries.

The feedback collected from partners is as follows:

- COVID affected the possibility of accessing laboratories in a normal way.
- To install the equipment, it is necessary to have authorization from the government to reopen educational institutions in and from the university´s authorities for actually going back to work in the campus.
- Actually, the problems were due to the lockdown procedures, which prevented users to get to the university.

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Roll-out

The roll-out was influenced by the pandemic as well, however, most partners were able to manage the opening of the CCs.

Partners' comments on the roll-out were as follows:

- Students started using the equipment in a small scale.
- It is necessary to have authorization from the government to reopen educational institutions in Mexico City and from the university´s authorities for actually going back to work in the campus.
- Actually, the problems were due to the lockdown procedures, which prevented users to get to the university.
- For partners who did not implement the roll-out, there are plans ready for instalment, roll-out and opening of the competence center as soon as the situation of the pandemic allows it.

WORK PACKAGE 4

Liaisons (communication, support, benefits, ...)

Two LA partners together with one EU partner built a liaison to facilitate closer collaboration and direct communication especially regarding the identification of suitable equipment, as well as the development and operation of the CCs.

The positive aspects of the liaisons were:

- Good and direct communication with partner universities as well as vendors, to find suitable equipment for the CCs.
- Liaison was very supportive and helped a lot in the selection of the equipment for the competence center.
- Good offer of possible suppliers not known by the partner.

One recommendation was given on the frequency of liaison meetings:

- Communication could have been more regular throughout the project.

Liaisons (communication, support, benefits, ...)

For the operation, marketing and sustainability of the CCs, the LA partner universities developed a strategic plan to ensure proper implementation of the CC services and trainings.

In general, the partners were satisfied with the activities involving the strategic development of the ASCENT CCs:

- Good involvement of the partner company during the revision stage of the strategic plans
- The team was actively involved in the development of the CC´s strategic plan. This was important in order to plan adequately the services to be offered.
- The framework of the original plan is still in place and well aligned with the human and material resources of the CC. In the short term no changes are foreseen.

The things that might be improved are:

- Preliminary plans were done but need to be adapted to the new COVID reality. Reexamine and complement the plans within the CCMS council when active.
- Somebody from the local business department at the university should be involved in order to approve the business site of the strategic plan.
- There is a disagreement with the content's specification of the strategic plan. Especially if it should be open to the general public. Strengths and Weaknesses analysis should never ever be made available to the general public.

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Students' mobility programs

The student mobility programs were not possible because of the COVID-19 pandemic and were substituted by a series of online student workshops. They unfortunately lacked the hands-on experience that was planned, but allowed to reach a greater number of students (from all the Latin American universities) with a larger variety of topics.

- Great efforts by all LATAM partners to implement workshops for students and transfer knowledge gathered in the project to them.
- Joint efforts were done to create online seminars for students in collaboration with all LA partners.

Some partners presented suggestion on future activities regarding student workshops:

- For the future, seek for funds to allow student interchange between partner's CC's.
- A plan can be devised for offering the hands-on experience to a limited number of students.
- A plan for practical training of students may be designed and operated. This plan may actually be permanent and could be a good way to recruit new student collaborators for the CC, as they usually are able to collaborate only during a finite time.

Operation of the CCs:

a) Development of training material

The partners gave some general comments regarding the training material for the CC services and trainings offered:

- There is a base for training material from what has been developed for online student workshops and counselling sessions, as well as from the project´s trainings.
- It would be a good practice to gather and organize all the training material that is already available and have a specific plan for the development of additional one.

b) Selection of staff for the CCs

The LA universities selected staff to implement the services and trainings in the CCs. Some general remarks were submitted by the partners:

- The initial selection of the CC staff still stands. Actually, this staff (including professors, lecturers, technicians and students) is the one that has been actively involved in most of the project´s activities so far.
- After startup, invitations will be sent to academic staff working on sustainable mobility projects to join and integrate the CCs.
- It is important to have a plan ready for substituting the student collaborators as they leave when graduating.

c) Contact to industry, companies and other stakeholders

Here, partners were asked to comment on the contact to industry, companies and other stakeholders as target group of the CCs' offers:

- Contacts of professors and lecturers have been used wisely as required for the project's activities so far. They have also been a good base for expanding the pool of contacts through their recommendations. A few informal contacts were also done.
- It should be implemented as soon as equipment purchase is done, to reach the stakeholders and spread the word of the CCs
- Define specific personnel for this task
- Organize a more formal system for expanding the pull of contacts, considering the services and objectives of the CC.

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d) Dissemination of training and service offers

LA universities disseminated the training and service offers to the stakeholders during the course of the project. There were some comments or suggestions on how to improve the dissemination in the future:

- COVID imposed difficulties.
- Design a specific plan for the dissemination of the CC services, with advice and/or collaboration of areas such as Institutional Communication.
- Define specific personnel for this task
- Dissemination so far has been based mostly on current contacts in the automotive industry and it is good that the initial response has been positive. A more systematic strategy for the dissemination of the services of the CC is recommended.
- Status and normal practices of the local industries should be taken more into consideration.
- Each country and each industry has its own peculiarity and the cooperation between industry and universities are developed to different degrees among participating countries. For this reason, the form of dissemination and ways of communication should be more autonomous for the university, as it better knows its objectives and its partners.

e) Implementation of counselling sessions

The operation of the CCs and implementation of counselling sessions was commented by the LA partners in terms of positive aspects as follows:

- There has been a reasonably good response of the companies contacted for implementing the initial counselling sessions. The sessions themselves have been productive as first steps towards collaboration with those companies have been taken.
- A series of online seminars for both the academy and the industry started on March 23rd and are planned to continue for the next April and May; focusing on the offer of different topics and capacities.

The aspects that would need a change or could be improved, or affected the implementation were:

- COVID delayed the implementation.
- Strengthen the dissemination process. Contact local industry inviting to participate.
- More material will be needed for subsequent counselling sessions, so it is necessary to have a specific plan for developing it.
- Devise a plan for the development of material for new and follow-up counselling sessions.
- Use of online offers was not that effective

f) Cooperation between university and stakeholders in the frame of the CCs

Below are recommendations from the partners on how to cooperate between university and stakeholders in the frame of the CC activities, which have been widely affected by COVID:

- Proposals will be made to the government of the city to explore possible projects or initiatives about sustainable mobility in the city.
- Cooperation with the stakeholders has been limited to what has been possible in light of COVID. Considering this, the possibility of advancing in the development of the counselling sessions has been the most important element of cooperation with the stakeholders.
- It is important to have the CC fully opened in order to take the cooperation to the next level.
- Maintain open channels of communication with the stakeholders in order keep them up to date on the situation of the CC and the things that would be possible to develop as the university advances towards a more normal operation.

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g) Engineering projects

Progress has been made by the development of counselling sessions, which are an initial step for defining and executing engineering projects.

- It is needed for the university to resume face-to-face activities in order to be able to deploy the full operation of the CC. For this, authorizations from health and city authorities are required, as well as authorization from the university's authorities themselves.
- Still some difficulties due to COVID. Different countries and partners will have different needs and approaches.

WORK PACKAGE 5

Network establishment (membership, constitutional documents, planning of network activities)

The ASCENT network was established as a main output of the project to establish international exchange of knowledge on automotive engineering, enhance collaboration between companies and universities in the field of mechanical and automotive engineering, promote the competence centres and enhance the possibility of bringing industry and HEIs closer together.

The positive aspects of the network were reported by the partners as follows:

- Network was established with several participants.
- The network is already active in ASCENT. The university contributed with dissemination, and promotion of the initiative
- The framework, the documentation, and the webpage of the network were well designed and implemented.

Also, some recommendations were given on what would have needed a change, or could be improved:

- Create agreements with international journals of automotive engineering to offer the network space for sharing information. Contact automotive companies to offer also a dissemination space.
- The network was launched just at the beginning of the COVID-19 pandemic, which affected several dimensions of the project.
- Maybe the launch of the network could have been planned to be earlier in the project. Regardless of the pandemic, this would had allowed to give it more space to grow. Now the competence centers are established, it may be possible to dedicate more time for the actual development of the network.
- The network is a living instrument that relies on the participants beyond the partners. It is not possible to predict achievements and the timing of the network.

Knowledge Transfer Platform (forum activities, implementation of planned network activities,...)

The ASCENT network provides a platform for knowledge transfer and fora on different kind of topics related to automotive engineering education and industry, university-industry collaboration and many more.

In general, the platform was rated as interesting and well appearing, as can be seen below:

- A number of active members is already interchanging contacts, material, information, etc.
- Interesting platform developed.
- Networking website is appearing well, forum activities increased during the last months.
- The networks´ web platform has a good conceptual design.

Nevertheless, some changes were suggested by the consortium:

- The forum should be more active.
- Seek for dissemination options and new activities that could increase the interest on the network.
- Review the mentioned functions and procedures of the web platform in order to make it easier, more intuitive, to make posts and foster discussion.
- Benefit for participants in the network should be more present. Clear description of benefits for stakeholders to participate in the network.

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Training sessions for non-partner universities (cooperation with other universities, benefit for participants, feedback from participants, ...)

As part of the ASCENT network, LA partners implemented training sessions for non-partner universities and other stakeholders. Due to the pandemic, the implementation of these trainings was affected and commented as follows:

- Cooperation with other universities is already active in many other knowledge areas.
- An effort was made to develop training activities with an external institution.
- Involve non-partner institutions earlier in the project. An idea for this may be to invite them to participate in a limited way in some activities like the internal workshops.
- Link the training sessions more closely with the internal workshops. This may make easier to establish a relationship and maintain it through the rest of the project.

1st cross-border conference Sao Paulo

Although the 1st cross-border conference in Sao Paulo, hosted by USP, was directly affected by COVID, the partners mentioned a lot of positive aspects:

- It was possible to hold the conference reasonably well amidst the disarray caused by the global panic caused by the initial spread of the COVID-19 pandemic.
- A good job was done in order to use the available options and resources in order to keep the conference running.
- Despite the breakout of the pandemic, the team managed to implement the conference and inaugurated the network.
- Well organized, many attendants, qualified key-note speakers.
- ASCENT was further promoted on university level, organization went well.
- Some activities had to be substituted or changed in format at the last minute. For example, keynotespeaker sessions moved to online format.
- Very interesting presentations.

Although the 1st cross-border conference in Sao Paulo, hosted by USP, was directly affected by COVID, the partners mentioned a lot of positive aspects:

- More dissemination using many other channels.
- It is important to always have a contingency plan for important events or actions. It should include plans/options for both, major and minor disruptions or problems.

1st cross-border conference Sao Paulo

The 2nd cross-border conference, hosted by IBERO, was held as an online event.

- Great conference with interesting key notes, a large number of scientific talks and international audience
- Well organized, good number of attendants, qualified key-note speakers, technical papers of high quality.
- ASCENT was further promoted on university level, organization went well
- From the technical point of view everything worked smoothly. Also, most of the activities were kept on schedule, the moderators in general did a good job and the assistance was good in general terms.
- Very interesting presentations.

Only minor improvements were suggested:

- More dissemination using many other channels
- Online conferences do not allow extensive interaction between partners.

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WORK PACKAGE 6

Dissemination activities within the project

Diverse dissemination activities were implemented by the partners to spread the word of the project, disseminate project activities, invite stakeholders and increase the number of network members.

A lot of positive aspects were mentioned by the partners on dissemination activities:

- Social media, webpages, printed material, videos, face to face contacts, etc. were used to disseminate ASCENT activities.
- Nice merchandise; Instagram and Facebook were well used.
- In particular points of the project we had good support of specialized areas of the university, such as Institutional Communication. Some examples were the local ASCENT web page or several dissemination actions for the 2nd Conference.
- The first reports were submitted complete and opportunely.
- All partners were involved in dissemination activities.

Some difficulties arose as well:

- Day-to-day dissemination was more difficult. This may be due to the profile of most of the members of the local ASCENT team as they are not prone for social networks and constant communication activities.
- Each partner should do more dissemination and be creative.
- There has been a little more problem with keeping the pace or reporting in the later phase off the project because of the many things to be done.

Things that could have been improved regarding dissemination:

- Seek for easier mechanisms for reporting activities.
- Recommend from the beginning of the project to include at least one team member with expertise and affinity with regular dissemination activities.
- Online means of dissemination could have been improved since on-site activities were restricted due to the pandemic.

WORK PACKAGE 7

Quality & Ethics Board (members, meetings, outcomes)

The Quality & Ethics Board met on a yearly basis to discuss the quality and timely implementation of project activities and outputs.

Partners mentioned that

- The people directly responsible for quality control did a very good job.
- Regular QEB meetings were implemented.
- All of the Quality & Ethics Board meetings were adequately performed.

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Quality & Contingency Plan (development, support for quality control, …)

At an early stage of the project, a quality & contingency plan was developed and updated during the project, to ensure constant quality and feedback mechanisms being implemented by the consortium.

What went well:

- The validation of the quality and ethics was easy, and all the partners worked considered the ethical principles we agreed upon at the beginning.
- Adequately prepared.
- Some possible threats were well documented and discussed.
- The quality and contingency plan became particularly important in the wake of the COVID-19 pandemic. In fact, during the pandemic most project meetings involved important quality and contingency analysis and planning.
- Project worked even in face of COVID.
- The development of the contingency plan was a good moment to share problems and solutions among partners.

Some aspects that would need a change regarding the development and implementation of the quality plan:

- The staff members that were meant to participate in the Quality and Ethics Board were not always available to participate in the meetings, and instead asked project staff to participate on it.
- Highly time-consuming activity.
- Not all the partners were using or updating the contingency plan according to the situations that emerged during the project.

Recommendations that were given:

- Future contingency plans should consider the possibility of lockdowns and the problem of mobilizing people from one country to another.
- The contingency plan could consider the collaboration between national and international partners to solve and fix political or economic constrains.
- Strategies to strength the commitment of the board members with the project will be needed. Perhaps in future projects it would be necessary to plan on-site meetings.
- Enhance the role of the quality and contingency activities as an integral part of all the other activities of the project.

Feedback mechanisms to evaluate project meetings, outputs and satisfaction

As part of the quality plan, there were several feedback mechanisms established to evaluate the project meetings and activities, e.g. trainings, workshops, conferences etc.

A lot of positive aspects were mentioned:

- In general, there has been a good participation in the activities proposed to get feedback from the activities implemented, and the project itself.
- Adequate mechanisms.
- The online survey was well designed.
- The feedback mechanisms were good in general. There was a very positive evolution along time, switching from cumbersome paper-based formats to efficient online formats.
- Substituted all paper-based feedback mechanisms with electronic/online alternatives.
- Running as expected.

In the future, the following could be considered to improve feedback mechanisms:

- We should have sent the results of previous meetings not only to the ones that organized them, but to the ones in charge of the organization of next meetings.
- Results of the meetings could be better listed and made available to the partners.

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2. GENERAL COMMENTS ON THE BENEFITS FOR DIFFERENT GROUPS BEING INVOLVED IN THE PROJECT, AS WELL AS THE SITUATION REGARDING COVID-19

Benefits for the academic staff of HEIs involved in the project

- Increased the capacities of academic staff on important areas of automotive industry. Provided new important equipment useful for developing industry and academic projects.
- Great contacts and new international relations, knowledge improvement.
- Benefits for the academic staff include training in technical and soft skills topics, relationships with colleagues with similar interests, and relationships with people from the industry. Both kinds of relationships may lead to different kinds of collaboration.
- More than change, it is important to maintain alive the relationships that have been established and continue developing new ones.
- Do not forget to foster the idea of the ASCENT Network as a functional organization.
- Access to updated information and nice training materials.

Benefits for the students involved in the project

- Offered and continues offering many periodic opportunities of capacitation to students
- Students got good insights into the different local markets and increased their intercultural competences.
- The number of students served increased significantly with the substitution of mobility activities with a series of workshops.
- For some students, particularly the ones involved more deeply with the project as assistants in various of its activities, the experience acquired is also an important benefit.
- It was unfortunate that student mobility was cancelled, since it would had help to develop more close and durable relationships. It may be good to seek, as possible, opportunities of interaction among students of different institutions, either at the distance or in face-to-face form.
- Usually, students are able to collaborate during a limited period, so it is necessary to have a well-established plan or mechanism for their renewal.
- Access to updated information.

Benefits for local industry and stakeholders

- Will offer opportunities for joint projects, trainings and technology transfer.
- Dinner invitations to motivate cooperation and interaction.
- Received new theoretical background information.
- Local industry and stakeholders will benefit from new options of specialized training and services. Services that are aligned with particular needs must be identified within that same industry.
- More than change on what has been done up to this point, it is important to go ahead with has been started and produce tangible results from the interaction with industry and stakeholders.
- It is important to maintain a constant communication with industry and stakeholders in order to maintain alive the relationship through time. This includes current contacts as well as new ones.
- Improvement of capabilities of the partner universities.
- It is not possible to foresee results in this time frame. The cooperation will evolve as the CC evolves. It takes time.

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Benefits for local industry and stakeholders

- Online replacement for presence activities.
- Online activities (Teams, Zoom calls) were mostly on point and without difficulties.
- The COVID-19 pandemic disrupted the flow of the project in a very sudden manner, but the ASCENT team as a whole reacted opportunely, proposing alternatives for affected activities and plans, that were actually implemented.
- The disruption caused by the pandemic has had a longer than expected impact, so in the end some plans, activities and results were inevitably affected. It is necessary to continue to deal as effectively as possible with this unstable environment.
- Continue to plan for the development of the project, through the operation of the CCs. Remember that the CCs should operate at least for a minimum of two years after project end, so there should be a plan to ensure that.
- Extensive use of online meetings.

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5 CONCLUSION

Through the ASCENT Project, the design and action plan of each of the six centers of competence in automotive engineering in Latin America were successfully carried out. Over three years the profiles, services, equipment and other components were defined. Additionally, during that time other very relevant activities were carried out, such as the training of teachers and students, trips and visits to laboratories of universities and companies, strengthening of the personal relationship between the members of the network, among others. The work carried out was very extensive and comforting. Some of the most important insights of the collaboration are:

- Bold projects are perfectly possible to be started and developed, even under weak initial conditions, when the human group has the best positive action and willingness.
- Dreams become reality after hard collaborative work.
- Students have hunger for opportunities and extra trainings. All workshops and activities done were very well received and qualified.

ASCENT at UNIVERSIDAD NACIONAL DEL SUR (UNS)

In general aspects, ASCENT had a positive impact at UNS in several important areas:

- **Institutional:** The project increased the visibility of UNS in the automotive industry and soft skills areas, increased the capacity and abilities of administrative staff and Authorities in Erasmus projects, motivated interdisciplinary work between different departments by joining colleagues of different areas to work towards a common objective. Promoted the creation of a Competence Center on Sustainable Mobility, oriented to be an attractive pole for teachers and researchers working on areas related to automotive engineering, soft skills, sustainable mobility etc.

- **Academic:** increased the capacities of academic staff on important areas of automotive industry. Provided new important equipment useful for developing industry and academic projects. Offered and continues to offer many periodic opportunities of capacitation to students of UNS

- **Personal:** related to the academic and administrative staff involved in the project: Everyone had the opportunity to work collaboratively, creating a very important synergy in the group that will certainly motivate new future common projects to be started.

ASCENT at UNIVERSIDAD NACIONAL DE LA PLATA (UNLP)

It can be said that the participation of UNLP in the ASCENT Project was very positive in several items detailed as following:

- **Institutional:** The UNLP has previous experience in Erasmus projects but none in the area of Mechanics before ASCENT. So, it was necessary to build experience which with no doubts was capitalized. Every single task required by the project leaves valuable experience in areas not known before. The first one is the creation of the Center of Competences and the contact taken with the target group which are the potential customers of the CC. Soft skills is another important subject since its development into the degree courses is not enough. To follow the wide kind of actions required by ASCENT Project it was necessary to involve administrative and commercial staff and authorities into specific processes. Teachers and researchers found in the ASCENT project a new and different environment for their lessons and cooperation projects.

- **Academic:** Capacity building training as well as internal training and those given for students in replacement of student's mobility due to pandemic were of very high quality and of interest to a good number of students and teachers. New equipment marks a starting point for the degree training in the automotive line. This comes at a time when the Mechanics Degree at UNLP is trying to recover this focus, which was lost in a past change of study plans.

- **Personal:** Being UNLP a huge university it was necessary to work in collaboration between the International Office which belong to the Presidency of UNLP and the staff belonging to different Faculties located in other places of La Plata City. So, people had to work with the initial task of meeting each other and then adjusting their particular work ethics in order to make possible a fluid collaborative work, which absolutely necessary to lead the project to success.

ASCENT at INSTITUTO TECNOLOGICO Y DE ESTUDIOS SUPERIORES DE MONTERREY, CAMPUS SALTILLO (ITESM)

- **Institutional:** The Tecnológico de Monterrey Campus Saltillo is located in a city with a high vocation in the manufacture of automobiles, so the creation of the ASCENT CC was very pertinent. Through the CC in Saltillo, companies will be helped to train their engineers in specialized topics in automotive engineering, specifically in the efficiency of operations through the 4.0 industry. Likewise, the CC will serve to carry out internship-type projects that facilitate the hiring of students by companies.

- **Academic**: The teachers of the CC in Saltillo received knowledge in technical and soft skills that they will transfer to students from the Saltillo and Monterrey region. The installed equipment will add to the infrastructure of the ITESM Campus Saltillo for an experiential learning of the students.

- **Personal:** A very good work team was formed with the members of each member university. The personal relationship facilitated the solution of difficulties, such as the pandemic, throughout the project.

ASCENT at UNIVERSIDAD IBEROAMERICANA (IBERO)

- **Institutional:** As a first experience of an Erasmus+ project in the Department of Engineering Studies for Innovation through its Mechanical and Electrical Engineering Program, the ASCENT project was challenging and a continuous learning experience. Numerous processes had to be defined at different levels (program, department, institution) and with several different entities in the university (Academic Cooperation, Finance, Legal, etc.). Getting all to work in a harmonious way was rewarding. The project also allowed the Mechanical and Electrical Engineering Program to look further into collaboration with industry, setting up not only new valuable infrastructure, but new mechanisms and ideas on how to better interact with industrial partners, adding value for all parts. Finally, and hopefully, it will also allow contributing in the effort of transforming the Mexican automotive industry, from mainly a manufacturing one, into one that has design and engineering among its most relevant activities.

- **Academic**: Training may be the best word to summarize what the ASCENT project represented in the academic area. Trainings for the academic staff quickly multiplied with trainings for students in different levels. Not limited only to the project´s own activities, but permeated to regular courses of the program´s curricula. It is relevant to mention that these trainings were not only technical, since soft skills, always so important for engineers, also had a relevant role. New equipment and software acquired through the project, alongside its use for projects with industry, will also benefit educational activities for students.

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- Personal: A challenging project for its development leaves a rewarding experience in the team of academics and students that participated in it. A united, hardworking team, where everyone complied adequately with its responsibilities. Also rewarding the relationships with colleagues from all the other universities of the consortium.

ASCENT at UNIVERSIDAD NACIONAL DE LA PLATA (UNLP)

The participation of the University of São Paulo in the ASCENT project was very positive. It helped to form an interaction not only with the European Partners but also with the Latin-American counterparts. It helped the University of São Paulo be selected to have a Brazilian Institution (EMBRAPII) unit dedicated to the collaboration between industry and academia.

- Institutional: As mentioned before, ASCENT created new academic ties between the partners. The University of São Paulo has one of the strategic objectives to become more international and develop collaboration ties with more institutions worldwide. It also allowed the University to form a new laboratory dedicated to Experimental Engineering for Automotive Engineering, filling a gap that existed before the project. This lab will be part of a larger initiative that will connect the University with the Automotive Industry.

- Academic: The competence center will impact the development on automotive engineering with an increased capability to perform experiments and measure data on actual vehicles and systems. Undergraduate and Graduate students now have access to state-of-the-art equipment for experimental engineering to be used in the project, extra-curricular projects, and capstone design projects developed by the students. The opportunity for training in experimental engineering and the other developed subjects during the project (Sales, Project management, presentation techniques, acoustics, vehicle dynamics, robotics, among others) will be shared with more students. It was also essential to contact how colleagues from Europe and Latin America deal with problems common to academia, such as funding, collaboration with industry, internationalization, and integration of research into the curricula.

- Personal: It was excellent to form a team with colleagues from Europe and Latin America. It was essential to discuss the common problems that different academic institutions face in different environments. It was also essential to be involved with the students from the other Latin American universities, even by online teaching, since personal mobility had to be suspended due to COVID-19. Another significant accomplishment was to work on a project funded by the European Union that has high levels of quality control and demands of sustainability and results.

ASCENT at UNIVERSITY FEDERAL OF RIO DE JANEIRO (UFRJ)

There are many positive aspects due to the participation of the Federal University of Rio de Janeiro in the ASCENT project. The presence of the main research center from PETROBRAS inside the campus is a major asset for UFRJ, nevertheless, it has directed most of the research and development efforts, as well as the formation of the engineers towards the Oil & Gas industry. ASCENT provided excellent menas of creating a competence center to diversify the actuation of the university. It has opened opportunities to improve cooperation with the automotive industry in the state of Rio de Janeiro. Among these many positive aspects can be cited

- Institutional: UFRJ has, in the past, created an automotive specialization in its mechanical engineering course. However, in the late 1970´s the concentration of the industry in the state of São Paulo, and the emerging of PETROBRAS investing in R&D caused the number of engineers seeking for this specialization to diminish. Eventually the offer was abandoned. The ASCENT project allowed new ideas and infrastructure to be directed towards the automotive industry and opened opportunities for the university to cooperate in solving the challenges faced in this branch.

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- Academic: The creation of up do date training materials will aid the offer in the engineering courses, especially related to the new trends in automotive mobility and electrification. The students will be more motivated to participate in the experimental projects developed due to the new available measurement hardware.

- Personal: The creation of the competence center allowed different faculty staff members to cooperate towards the solutions of challenges of the automotive industry. The group is already working in order to obtain funding from different projects.

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