



Recommendations and Guidelines of Comparison

1.3 Comparative Report

of the automotive industry, educational contents and technical infrastructure in participating countries

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Introduction

This comparative report is structured as follows:

First a short profile of each participating HEI was exported from the desk research reports and summarized into the main facts. These facts include for each partner: no. of researchers at the participating institute, no. of business subjects taught, mandatory internships (scope/h), testing bays and structure, existing collaborations with companies and main fields of interest.

In the next section the national automotive industries are shortly presented. The information given from the desk research reports are used here as well. At the end the reader will have a short overview of strengths and weaknesses of national industries in the automotive sector.

Before the methodology of the comparative report is discussed an ease overview of main issues brought up during definition of the focus groups is presented for a better understanding of the topic in general.

The last pages include the key indicators and comparison of most essential indicators that are used as a guidance for the development of the training curriculum and also further discussed in the gap report.

Profile of ASCENT HEIs

All non-European ASCENT countries are production-based. It is important to the automotive industry in ASCENT from the point of view of a producer of parts.

In the following some hard-facts concerning participating institutions are collected. Thereby we mention the number of available researchers in the field, the business subjects that are already taught at the HEIs, information concerning hands-on training for students, the testing bay structures and the main areas of interest that the partners would like to cover in the future.

Argentina	
UNS (mechanical engineering: 280 students)	10 researchers in mechanical engineering, one business subject (planning and control of the fabrication), supervised professional practice in company 7 testing bays with 12 engineers and 6 technicians, already cooperating with industry Main areas of interest: aerodynamic studies, metallurgical and forming process of automotive parts studies, dynamics behaviors, active suspension systems, stability control systems, noise control
UNLP (mechanical engineering: 650 students)	20 researchers in mechanical engineering (teachers who must do research concomitant with teaching activities according to UNLP rules), 1 business related subject in engineering degree (Economics and industrial organization), 200hrs of professional practice before graduating needed

	<p>3 testing bays with 5 engineers, already cooperating with industry in testing bays research. Testing bays means exclusively internal combustion engine test dynamometers</p> <p>Main areas of interest/seek to cover: improve student's skills of engine testing</p>
Mexico	
<p>ITESM (mechanical engineering: 150 students)</p>	<p>1 researcher, 3 business related subjects (Economics, Entrepreneurship, Communication), industry internship foreseen</p> <p>Different testing bays distributed over several campuses: automobile testing bay facilities (Campus Toluca), manufacturing labs equipped with CNC machines (Campus Querétaro), Electronics and IT (Campus Guadalajara), labs for general engineering training as well as research (Campus Monterrey)</p> <p>ITESM is cooperating with major automotive companies</p> <p>Main areas of interest/seek to cover: multilingual, autotronics/virtual and augmented reality for automotive and transport applications, a center connecting the academic community and the industrial sector.</p>
<p>IBERO (mechanical engineering: 136 students)</p>	<p>2 researchers, no business related subjects, professional practice for at least 100 hrs</p> <p>2 testing bays available (wheel alignment bay with four post lift, general inspection bay with two post lift)</p> <p>Main areas of interest/seek to cover: Hybrid and electric engines, vibrations and fatigue.</p>
Brazil	
<p>USP (mechanical engineering: 350 students)</p>	<p>50 faculty members (mechanical engineering; academic + research), 3 business related subjects (Principles of Business Administration / Design Methodology I+II), internship of 120 hrs</p> <p>Main areas of interest are: Automotive Engineering, Analysis of the automatic transmission in comparison to the double clutch transmission, the future of transport systems (in South America), Center of Automation and Design Technology – CAETEC. A laboratory is installed in an independent two-story building with 120 square meters. It is currently equipped with machines and tools for manual construction of prototypes, computers, engineering workstations, printers, data exchange network, measuring equipment and data acquisition systems., a library with both classic and state-of-the-art texts on relevant subjects as well as the most widely used computer programs for product development (CAD/CAE systems) and project management (PLM) are available.</p>
<p>UFRJ (mechanical engineering: 1080 students)</p>	<p>35 professors, 10 engineers and 20 technicians, 2 mandatory and 7 optional elective business related subjects, a 160 hrs mandatory internship is required</p> <p>7 testing bays, including both chassis and bench dynamometers for naval (500kw and 800kw), diesel (350kw) and gasoline (160kw) engines; a torsional stiffness and a braking test benches for student competition prototypes</p> <p>Main areas of interest: Specific knowledge and abilities needed to develop electric vehicles. Powertrain future trends (electric and hybrid). Driving assistance</p>

Austria	
<p>FHJ (automotive engineering: 259 students)</p>	<p>20 researchers (automotive engineering), 6 business related subjects (3 bachelor, 3 master): business admin., law, quality mgmt., HR Mgmt. Leadership and Intercultural Business Practices, Strategic Mgmt., compulsory internship of min. 450 hrs</p> <p>15 testing bays with 6 engineers and 4 technicians for R&D, student’s work and cooperation with companies</p> <p>Main areas of interest/seek to cover: e-mobility, fuel reduction, light weight design, flexible with respect to whatever industry needs (see automotive industry, future global trends)</p>
Spain	
<p>UAB (electronic engineering: 140 students)</p>	<p>52 researchers (academic & research), 3 business related subjects: Organization and Business Mgmt., Project Mgmt. and Legislation; Quality mgmt.</p> <p>No testing bays available.</p> <p>Main areas of interest/seek to cover: This partner is well experienced in engineering hot topics and future trends, even though having their focus on telecommunication and engineering their input is essential to bring also content from new job roles, emerging from current into the ASCENT training.</p>
Germany	
<p>HSD (mechanical engineering: 40 students)</p>	<p>22 researchers in mechanical and process engineering, 6 business subjects (in bachelor: basics of business administration, statistics, production planning and control; in master: life cycle and services management, international technical sales management, methods of quality management), 1 soft skill subject (engineering conferences), 1 internship semester and other internships</p> <p>Testing bays: Air monitoring, simulation system for factory planning and logistics, CFD software, gearbox test bay, laboratory of fluid mechanics, vibration engineering and acoustics, planning desk with eyetrackers, PPS/ERP, “Ring project”, E-traxx.</p> <p>Main areas of interest/ seek to cover: environmental measurement technology, product development and innovation, modeling and simulation, energy systems, fluid mechanics and acoustic, services and life cycle management, automation engineering and learning systems</p>

National Automotive Industries

Concerning the national **automotive industries** and **related efforts** in each country, the following highlights have been collected through the country based reports:

Strengths of the **Austrian** automotive industry are the long history in development, highly qualified engineers, a good combination of suppliers, developers and manufacturers in the market place as well as the geographical proximity to OEMs in Germany and Italy which facilitates trade and transfer immensely. Current weaknesses and threats include that new mobility requires more software engineers and means fewer vehicles, which is why mechanical engineers are needed less. Further education in the automotive sector must be harmonized and updated.

The automotive industry in **Spain** is characterized by a long tradition in car manufacturing and competitive auxiliary industries. It is the 2nd largest car manufacturer in Europe after Germany. SEAT is the sole active Spanish brand with a mass production potential and capability of developing its own models in-house. Spain is recognized to be the best European platform for doing business with Latin America. Consequently, many agreements are necessary to avoid double taxation or to protect investment.

The automotive sector is the backbone industry in **Germany**, and the German automotive industry is a global leader. No other industry is investing more money in R&D (22 billion€ in 2017). Germany is also one of the strongest countries in the world when it comes to high-tech automotive products, including autonomous driving technology. The automotive industry in Germany is very reputable because of its long history, its high quality in development and production, its highly qualified engineers and its well-known makes of car. In addition, the geographical location of Germany in the middle of Europe makes trade and transfer a lot easier. The German automotive industry generated nearly 405 billion Euros in sales in 2016. Of these, 37 percent were implemented domestically. As a result, the share of sales generated abroad was approximately 63 percent. The majority of exports went to Europe in recent years, but also Asia and North / South America were buyers of a variety of cars from Germany.

The German universities educate their students on a high level. Furthermore, the universities have good connections to the automotive industry. Industry-related challenges are the CO₂-reduction, more development in e-mobility, autonomous driving and car sharing models.

In **Argentina** enterprises offer summer programs to students. Many of these students continue as employees in those companies afterwards.

The industry in Argentina is described as: attractive, many areas of expertise and systems, vanguard of production industry, skilled professionals are needed, constant improvement and advances in the industry, reference for other industries, cars are deeply linked to Argentinian culture; easy to find interested new professionals (new engineers seek for immediate results – they cannot find them in the automotive industry), further part-time jobs or homeworking is not easily found in that industry.

In **Mexico** current improvement in material pressing technologies and use of lightweight materials might open new opportunities in the industry. The cooperation between governmental and educational institutions is challenging. Still participating institutions outline that qualified workforce is available.

Manufacturing costs and duties in Mexico are low, and experience and infrastructure for manufacturing are strengths in the automotive industry. However, the low manufacturing costs (low salaries) should also be seen as a disadvantage because it hinders development in general.

This makes Mexico an attractive place to produce cars/parts. However, Mexico faces a lack of national providers, R&D centers and educational services which are aligned with the industry needs. The NAFTA agreement is probably a threat to the national industry.

Brazil, the “B” in the BRIC acronym, showed consistent economic growth between 2011 and 2013. Brazil’s gross domestic product per capita exceeded the significant 10,000 U.S. dollar benchmark in 2010, but fell to around 8,700 in 2016. Most parts of Latin America have entered a recession and it is projected that Brazil's per capita gross domestic product will stay below 12,000 U.S. dollars until at least 2021. In light of Brazil’s increasing affluence, automakers have begun to focus on this growing market in recent years. In terms of market share, Brazil’s automotive market is dominated by Fiat Chrysler Automobiles, General Motors and Volkswagen. Market protection in the form of tariffs and quotas on imports has prompted companies to open or expand automotive production facilities within Brazil, which helped stimulate the local economy. Some of the most recent protections went into effect in 2012, including putting a quota on imports from Mexico. Brazil produced about 2.3 million passenger cars in 2017, a slight resurgence for a market that has declined significantly over the previous few years.

The main trend regarding further developments for the lightweight vehicles industry in Brazil is hybrid cars. For example, the Toyota Prius showed a 506% sales growth from 2016 to 2017. The main trend for the heavy trucks industry in Brazil is biodiesel. The parliament is currently discussing passing a law banning the production of new combustion vehicles for 2030.

The main challenges faced by the automotive industry in Brazil are the political and financial instability and the insufficiency of qualified labor. The state of Rio de Janeiro has 4 factories (Nissan, Land Rover, MAN “VWCO” and PSA Peugeot-Citroën), meanwhile São Paulo has 15 and Amazonas has 13 factories. São Paulo attracts more plants because of a better infrastructure and proximity to the most consuming states, and Amazonas offers tax advantages. The factories in Amazonas are most CKD

Experts' Input in a Nutshell

- Topic I: Trends in Automotive Industry
- Topic II: Employment in the automotive industry and cooperation with HEIs (cooperation, which particular points should be considered)
- Topic III: Training Topics for the ASCENT Competence Centres and Testing Bays

During the focus group interviews which were implemented in all participating countries and institutions, more than 35 different experts from various sectors and companies in the automotive industry had the chance to discuss the above mentioned topics and more.

Even though challenges and training needs faced by partnering institutions are different and the **skills required from engineers are different similarities were found** and the needs for high expertise of engineers in Quality Management and Soft Skills, apart from Marketing (which is not in the scope of this project) as well as more intensive practical-trainings are highlighted regularly by all participating countries and institutions.

Another issue the experts have mentioned often, was the up to date knowledge on future trends in the automotive industry. This knowledge is important for all graduates and also for already employed engineers to understand the needs and aims of their employers.

Due to the fact that the automotive industry was “born” in Europe, the partners from non-European countries in Latin America desire an upgrade of technical skills of their students. As participating countries are mainly production based countries they think that more emphasis on R&D and software skills is needed in order to be competitive on the global market. This is basically needed in order to give graduates a higher chance of a well-paid employment after university or also to continue to be attractive employees for companies.

Furthermore, it was discussed intensively that the hands-on training and in this context also the cooperation with universities is crucial to prepare future engineers and to create a win-win situation. Thereby both, universities and companies, expressed the wish to collaborate more with universities. The challenge faced is that neither companies nor universities do have a “business plan” or a clear idea on how to start such a collaboration – making sure that it will be fruitful for both. Thereby they face bureaucratic obstacles but also do often not know where to get advice etc.

To sum it up there have been many similarities among the results from the focus group interviews. All these similarities will however be discussed also by considering differences and capacities in the next section in more detail especially among European and non-European partners in order to identify the respective gaps for the ASCENT training.

Aims & Methodology

The aim of this report is to compare the findings out of completed national and institutional research in order to uncover possible gaps and needs which are important to be discussed before the development of the training curriculum.

The methodology is as follows:

Compare the given input from country reports (desk research & focus group with experts)

- 1) Select **main areas of interest of partners, stakeholders and experts**
- 2) Uncover topics which partners do NOT have in common
- 3) Discuss, which European partners can cover those gaps in the ASCENT training according to researchers and experts on these topics available

The following main areas of interest have been identified quickly, once all desk research reports and focus group reports were handed in. They represent the **key indicators and main training needs** and are therefore discussed in more detail:

- 1) Soft skills for engineers
- 2) Technical skills upgrade
- 3) Engineering trends
- 4) Collaboration university-businesses
- 5) Test benches

Key indicators & Recommendations

SOFT SKILLS FOR ENGINEERS

The focus group interviews in **Argentina** have revealed that especially **SOFT SKILLS** are needed in order to face new developments and mentioned leadership, teamwork, problem solving and basic management tools ... and also

- Communication abilities with colleagues, clients and providers
- Willingness to accept changes and paradigms
- Leadership and management skills – ability to interact with different groups
- Negotiation abilities
- HR management abilities
- 5S Concept must be understood by all graduates!

When it comes to soft skills, also the industry experts from Mexico mentioned that the command of different languages and leadership skills, conflict and presentation skills as well as communication skills are important for being a future engineer.

All countries agree that as there is the need for high adaptability for changes also teamwork is a must to be successful as an engineer in the automotive industry.

The intensive need of more soft skills for engineers is also evidenced by the realistic view of industry experts, who know that an engineer will spend up to 90% on managing and 10% on engineering tasks.

When discussing future skills needed, the relevance of “environment-friendly” products and the internet of things / digitalization of cars for increasing and upgrading passenger security (Six Sigma) as well as the usability of cars were mentioned as to be considered within the hot topics of engineering trends by all participating countries.

SAFETY ISSUES (how to carry out crash tests, simulation of the impact and its consequences to take certain preventive actions) have been an important result from research done in Mexico. Thereby also the knowledge of safety standards and regulations linked to product safety are mentioned.

COMPARATIVE:

When comparing the mentioned topics with the input from European partners it can be recognized that soft skills are already important in the engineering curriculum of participating universities.

- Soft Skills: UAB focuses on
- Safety Issues: standards and regulations, Six Sigma, Engine & Combustions ... FHJ focuses on
- Trends in Engineering (Autonomous Driving, Internet of Things): HSD focuses on

When comparing these results, it is easy to notice that soft skills are more important at universities in Europe than in Latin America and that engineers have at least 3 business related subjects during their studying career, whereas Latin American students do have on average one, which is not mandatory.

As the participating countries are mainly production based, safety management and functional safety is very important and the industry therefore needs sufficient engineers with respective knowledge.

You can only achieve plant safety if existing risks are recognized in advance and, where necessary, reduced as quickly as possible. In order to achieve that, an optimal production planning process with a regular control mechanism has to be established. The manufacturing industry also faces the challenges of meeting current standards and legislation. With the relevant safety standards that need to be fulfilled, also quality management should be treated in this context. Research has revealed that especially Austria and Germany are pioneers in functional safety management in automotive engineering as well as implementing several quality management systems in the automotive industry. Also the participation in international projects on safety management highlights the existing expertise in this field.

Soft Skills, Safety/Quality Management and Engineering Trends are therefore identified as gaps and are going to be discussed and addressed in more detail in the ASCENT gap report.

TECHNICAL SKILLS UPGRADE

Apart from the importance of soft skills for engineers, country-based research had in common, that an update on **TECHNICAL SKILLS** is desired as well by the automotive industry in Latin America. Skills related to design and innovation (e.g. cad-cam simulation technology or applied mechanics) have been mentioned specifically. Further these topics relate as well directly to functional safety management – mentioned before – which should anyhow be highlighted once more in the curricula of mechanical engineering.

Consequently, respective contents need to be considered. Additionally, skills on industrial maintenance and hybrid vehicle technology are a desired topic to be taught.

Concerning technical skills especially cutting and measuring welding to train experts in laser welding turned out to be a need from the industry in **Mexico** (North Region), but nowhere else. The team will discuss this topic with the partners from the region in order to decide or discover if maybe other non-European partners would like to bring in some experiences or if European partners should maybe provide specific information which is of interest.

When it comes to the desired update on technical skills of students and employees in **Northern Mexico**, the research reveals especially the need of additional knowledge on low weight materials (from metal to plastic), whereas the Southern part of the country would rather put the focus on hands-on training, the usage of specialized software, in-depth knowledge of theoretical and experimental analysis.

The interviews in **Argentina** have revealed that specific and operative knowledge of software tools is needed – while a strong connection to the physical world should not be lost. Argentina also highlights that regarding the new paradigm for transportation based on electric energy increased effort to transfer knowledge on vehicle engineering and energy storage systems is needed.

It resulted from the **Argentinian** country report that there is the perception that graduates of engineering need more experience with real systems (test, mounting) as well as with vehicle engineering and simulation platforms.

Conclusion:

The European Partners do have in common that they are on a constant hunt for new engineering trends in the automotive sector. Due to an already existing fixation of management training techniques and Soft Skills in the curricula, the students are already well educated in these areas. However, the cooperation between HEIs and industry is a process, which requires ongoing effort from both parties and therefore stays a number one priority.

European partners can provide expertise, knowledge, insights, examples, experts in “Engineering Trends, Quality Management, Design and Innovation” (HSD), “Mechanical and Combustion” (FHJ)

Mechanical combustion: due to the high number of local companies in the automotive industry (from developers to producers) and the long history of engineering within all participating European countries, the explanation and discussion of any content related to mechanical combustion can be fulfilled - however when compared, one can observe that while Latin American partners desire to learn more about this topic, it is not a field of interest in European countries.

Engineering Trends, Quality Management, Design and Innovation: Being located next to the big Daimler production plant and having several practical exchange programs with the regional as well as national automotive industries and OEMs, the HSD has a good insight view on current and future hot topics and trends. One of the main topics is the production site optimization with regards to the requirements of Industry 4.0 (Digitalization, Quality Management).

ENGINEERING TRENDS

From expert interviews in Latin America we got to know that respective skills required for **QUALITY MANAGEMENT** in the automotive industry are needed. As this field is definitely relevant in the future and will support our partners not only in raising its quality but also in intensified cooperation with companies (e.g. through implemented quality management it is possible to get certified and to cooperate with the industry), this was selected as being part of gap analysis, because of the high standards and experience of European partners in this field. Another group of experts added that the use of statistics and Six Sigma as well as control tools for quality management would create a high additional value for (potential future) employees and the companies.

All desk research and focus group reports have shown the significant importance of alternative power systems, which is responsible for a re-thinking in all related areas. The importance to equip students with related challenges, solution-finding and the state of art in research today has been highlighted various times.

Experts from Austria who are also part of international communities, researching on future trends in the automotive industry will be able to bring powerful examples and scenarios of hot topics in the industry. Further the participation in related EU projects allows us the usage of a training developed for students in order to certify them as quality managers. Currently students have this possibility at HSD and certificates are highly valued by the automotive industry. So far more than 100 students have been equipped with certificates. This training can be implemented by FHJ, at least partly as well. Currently participating countries from Europe follow already high standards in Quality Management and do currently research on specific job roles in the area of automotive engineering which can benefit the ASCENT training.

COLLABORATION AUTOMOTIVE INDUSTRY - HEIs

Another important aspect that appeared from desk research and focus group interviews was to be trained on “how to increase collaboration” among **UNIVERSITIES AND BUSINESSES**.

Experts put emphasis on the following topics, and underlined that those are very crucial for both, companies and students:

- Global trends in engineering, devices and measurement of pollutant emissions from combustion engines.
- Test benches and testing procedures (road test) with hands-on training possibilities. Design of testing laboratories.
- To create internships and programs for postgraduate students is a desire among experts from universities and companies in Latin America.
- To establish a transfer center, where ideas are disseminated properly and where funding possibilities for future cooperation between HEIs and industry.

Argentina evaluates the current university-business collaboration as to be poor and suggests the following actions:

- Agreements and internships
- Bringing together professionals and professors to create content
- Collaborate on projects (research together)
- Understand mutual needs and capacities
- Company visits, talks, workshops, specific courses
- More interaction to achieve more practical experience
- Train collaborators!

When it comes to the results from implemented focus groups in Germany, Spain and Austria a common pattern of an international network with universities and companies becomes visible. Universities and companies in Europe are well connected – even more in the Universities of Applied Sciences as we have them in Germany and Austria. Cooperating with companies and mandatory internships of not less than 450 hours is quite common and seen as a prerequisite to establish graduates with the skills needed from industry.

This was further identified as a gap and will be discussed as a possible module or topic in the gap report, which builds the basis for the training curriculum.

TEST BENCHES

When interviewees have been asked concerning highly useful outputs from **TRAINING ON TEST BENCHES** they referred mainly to:

- Test bench for engines suspension and crash tests
- Emissions laboratory (for air pollution control)
- Cooling systems for combustion chambers (particularly important for small but powerful engines)
- Testing bench for hybrid, electric engines, different fuels, crankcase breathing
- Test bench for motors, multimedia interface
- Current dynamometers for testing engines and rollers for testing vehicles

In order to serve the industry best, basic capacities for testing bays must be considered and taught. Thereby especially international standards and certifications have been mentioned in the research reports. Whereas European partners manage partly even accredited testing laboratories, standards and the usage of a variety of test benches is common. With common efforts of all European partners the desired mentioned topics can and should be addressed.

The groups of experts and research teams agreed that the conduction of a seminar on current trends in the automotive industry and the testing of vehicles considering standards should be included as well. All European partners agree that up-to-date knowledge is crucial to remain attractive in the industry.

Concerning the establishment of testing bays, experts added that especially the design of the basic infrastructure should be discussed within the ASCENT training. As already mentioned the German as well as the Austrian partner do manage their own testing laboratories with both more than 15 testing benches. Consequently, this was identified as another gap in this comparative report and will be topic to further discussions in the report treating the training needs in form of gaps.

The comparative report shows that the topics:

- Soft skills and specific management skills for automotive engineers
- Test benches
- Technical skills (Quality Management etc.)
- Exploitation center for HEIs-industry cooperation

have been identified as crucial areas for improvements for the universities in Mexico, Argentina and Brazil in order to succeed in their education of the future automotive engineer. The European university partners do have a long history of experience in the area of automotive engineering education.